Panasonic

No.SX-DSV02301

TECHNICAL REFERENCE

—Basic function specifications—

MODEL

AC servo drive
Part No. MINAS-A5 series Linear motor drive (-L01/-LA1)

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Checked	Checked	Designed

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Motor Business Unit, Home Appliances Company, Panasonic Corporation

REVISIONS

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Contents

1. Specification Overview

Please note that the specification is different according to the end three characters of the product number.

- Ending characters same as L01(an below [L01]) ex) MADHT1507L01 etc...
  All functions described in these specifications can be used.
- Ending characters same as LA1(an below [LA1]) ex) MADHT1507LA1 etc...
  A part of function that cannot be used is provided.
  (Analog input, Thrust control mode, and RS232/485 communication, etc.)
  Details describe "[LA1] is not possible to use it" in the explanation part and confirm it, please.

Please note that “unit” in this specification sheet, basically it’s written for linear motor type.
If you use rotary motor, please exchange the unit as below on your side.
“Mass” to “Inertia”, “Thrust” to “Torque”, “mm/s” to “r/min” (Linear motor type to Rotary motor type)

- The main difference point of [L01] and [LA1]

Title	[L01]	[LA1]
Control mode	Position, Speed, Thrust	Position, Speed(Internal speed command only)
Analog input	Available (16bit 1ch、12bit 2ch)	Not Available
Digital monitor output	Available	Not Available
Analog Thrust Feedforward	Available	Not Available
Analog Thrust Limit function	Available	Not Available
Safety Function	Available	Not Available
Communication Function	USB(for PC software “PANATERM”). RS232, RS485	USB(for PC software “PANATERM”)

- Specifications

Basic Specifications	Control method		IGBT PWM method sine wave drive
	Control mode		Parameter-selectable between 6 modes: 1) Position 2) Velocity 3) Thrust 4) Position/velocity 5) Position/ Thrust and 6) Velocity/ Thrust
	Feedback scale		Phase A/B / home signal differential input Mitutoyo Corporation AT573A / ST770A / ST770AL Made by Magnescale Co., Ltd. Compatible with SR75 / SR77 / SR85 / SR87 that are compatible Panasonic serial parts
	Magnetic poles position detection signal		CS signal (CS1, CS2, CS3) or Magnetic poles position estimation (CS signal not need) Selected by parameter
	Control signal	input	10 multi-function inputs Functions of multi-function inputs: parameter-selectable
		output	6 multi-function outputs Functions of multi-function outputs: parameter-selectable
	Analog signal, Monitor output	Input	3 inputs (1 16-bit A/D input and 2 12-bit A/D inputs) *1
		output	2 outputs (analog monitor 1/2), digital output 1 (digital monitor 1) *1
	Pulse signal	Input	2 inputs each Both line driver interface and open collector interface supported using optocoupler input Line driver interface supported by using line receiver input
		output	4 outputs each Feedback scale pulses (phase EXA, EXB and EXZ signals) output by line driver. Open collector output is also available for phase EXZ signals.
	Communication function Safety terminal	USB	Personal computer, etc. can be connected for parameter setting configuration and status monitoring.
		RS232 *1	1:1 communication is available using a device having an RS232 interface as a host.
		RS485Serial bus *1	1:N communication is available using a device having an RS485 interface as a host.
	Terminal for providing functional safety *1		Terminal for the safety function
	Front panel		1) KEY (5); 2) LED: 6; 3) Analog monitor output (analog monitor 1/2) 4) Digital monitor output (1ch) *1
	Regeneration		Size C-F: regen resistor provided (external resistor can also be used)
	Dynamic brake		Provided

*1 : [LA1] is not possible to use it.

Function	Position control	Control input		Deviation counter clear, command pulse input inhibition, electronic gear switching, damping control switching, etc.
		Control output		In-position, etc.
		Input pulse	Maximum command pulse frequency	500 kpps (with optocoupler input) 4 Mpps (with line receiver input)
			Input pulse train	Differential input; parameter-selectable (1) Positive/Negative 2) Phase A/Phase B 3) Command/Direction)
			Command scaling (electric gear ratio setting)	1/1000 - thousandfold Feedback scale resolution (numerator) and command pulse count per revolution (denominator) can be arbitrarily specified between 1-2^{20} for numerator and 1-2^{20} for denominator but use within the range above.
			Smoothing filter	Selectable between first order filter and FIR filter for command input.
		Analog input *1	Thrust limit command input	Separate thrust limit can be used for individual direction.
		Instantaneous speed observer		Available
		damping control		Available
	Velocity control	Control input		Internal speed selection 1, Internal speed selection 2, Internal speed selection 3, speed-zero clamp, etc.
		Control output		Speed reach, etc.
		Analog input *1	Speed command input	Speed command can be input by analog voltage. Scale and command polarity: specifiable with parameters.
			Thrust limit command input	Separate thrust limit can be used for individual direction.
		Internal speed setup		Selectable between 8 preset velocities by control input.
		Soft start/down function		0 - 10 s / 1000 mm/s separately selectable for acceleration/deceleration. S-curve accel/decel available.
		Speed zero clamp		Internal speed setup can be clamped to 0 by speed zero clamp.
		Instantaneous speed observer		Available
		Velocity command filter		Available
	Thrust control*1	Control input		Speed-zero clamp, input of thrust command signal
		Control output		Speed reach
		Analog input	Thrust command input	Thrust command can be input by analog voltage. Scale and command polarity: specifiable with parameters.
		Speed limit function		Speed limit parameter-specifiable
	Common	Auto tuning		Identifying load mass real-time and automatically setting gain that meets set stiffness when the motor is driving by a operation command from the host or drive
		Dividing pulse output		Pulse count can be arbitrarily specified (up to encoder pulse count).
		Protective function		Overvoltage, undervoltage, overspeed, overload, overheat, overcurrent, feedback scale abnormalities Position deviation fault, Command pulse division, EEPROM error, etc.
		Alarm data trace back function		Alarm data history can be viewed.

*1 : [LA1] is not possible to use it.

[coverage]

The following table shows the coverage of motor/feedback scale used by the combination with this servo drive.

Motor	Linear motor type	Rotary motor type
Magnetic pole	Magnetic pole pitch 1 - 300mm *4	Number of pole pairs per rotation 1 - 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 (reference) *1	Carrier 6kHz : 1ms and more 12kHz : 0.5ms and more	
Correspondence speed	Electrical frequency up to 500Hz	
Feedback scale	**Linear motor type**	**Rotary motor type**
Resolution	0.01 - 10[μm/pulse] *4	10000 – 2^{24} [pulse/r] *4
Maximum length	Up to Resolution * (2^{30}-1)	-
Scale type	- Phase A/B / home signal differential input - Mitutoyo Corporation AT573A / ST770A / ST770AL - Magnescale Co., Ltd. SR75 / SR77 / SR85 / SR87 (compatible Panasonic serial format)	- Phase A/B / home signal differential input Please inquire the serial communications type.
Scale correspondence speed *2	A/B phase type : up to 8Mpps Serial communication type : up to 400Mpps (However, it is up to 105Mpps when the rotation type set.)	

*1 The number value is a reference value. Please confirm the application judgment by the actual combination evaluation. (sound and motor generation of heat, etc.)

*2 This is a speed that can be the correspondence on the drive side it. At the correspondence speed on the scale side, please confirm specifications of the scale.

*3 Please refer to "4-7 Basic setting of linear motor/feedback scale" in detail for each specifications.

*4 Please give the pulse number for each pole pitch (one cycle in an electric corner) as 2048pulse or more.

2. Specifications of Interface

2-1 Specifications of Input Signal of I/F Connector

Input signals and their functions

Category	Signal	Code	Connector pin No.	Item	Control mode		
					Position	Velocity	Thrust
Common	Power supply	COM+	7	· Plus terminal of an external 12 - 24 V DC power			
		COM-	41	· Minus terminal of an external 12 - 24 V DC power			
Input pulse	Command pulse input 1	PULSH1	44	· Position command pulse input terminal dedicated for the line driver output. · This input is invalid with the default setting. To use this function, set Pr0.05 "Selection of command pulse input" to 1. · For details, see Section 4-2-1.	○	– *1	–
		PULSH2	45				
	Command direction input 1	SIGNH1	46				
		SIGNH2	47				
	Command pulse input 2	OPC1	1	· Position command pulse input terminal possible with both line driver and open collector. · This input is valid with the default setting. · For details, see Section 4-2-1.	○	–	–
		PULS1	3				
		PULS2	4				
	Command direct on input 2	OPC2	2				
		SIGN1	5				
		SIGN2	6				
Control input	Servo On	SRV-ON	29 (SI6) *	· Digital input to enable/disable the drive (with and without power to the motor).	○		
	Positive overtravel limit	POT	9 (SI2) *	· This is an overtravel limit to the positive direction. · The operation when this input is turned on is set by Pr5.04 "Over-travel inhibit input setup". · Before use, set "Over-travel inhibit input setup" to any value other than 1, and connect pins so that the input is turned on when the signal input exceeds the moving range in the positive direction of the moving part of the machine.	○		
	Negative overtravel limit	NOT	8 (SI1) *	· An overtravel limit to the negative direction. · The operation when this input is turned on is set by Pr5.04 "Over-travel inhibit input setup". · Before use, set "Over-travel inhibit input setup" to any value other than 1, and connect pins so that the input is turned on when the signal input exceeds the moving range in the negative direction of the moving part of the machine.	○		
	Deviation counter clear	CL	30 (SI7) *	· Digital input to clear the deviation counter. · This input clears the counter at the edges with the default setting. To change the setting, use Pr5.17 "Counter clear input mode." · For details, see Section 4-2-5.	○	-	-
	Alarm clear	A-CLR	31 (SI8) *	· This input clears the alarm state. · Note some alarms cannot be cleared with this input.	○		
	Command pulse inhibition input	INH	33 (SI10) *	· Digital input to inhibit the position command pulse input · Before use, set Pr5.18 "Invalidation of command pulse inhibit input" to 0. · For details, see Section 4-2-7.	○	-	-
	Control mode switch	C-MODE	32 (SI9) *	· Digital input to switch the control mode. · Please do not input the command between 10ms before and after the control mode switch.	○		

*1 "-" in the table means that operations do not depend on "on/off" of the input signal.

Category	Signal	Code	Connector pin No.	Item	Control mode		
					Position	Velocity	Thrust
Control input	Command scaling switch 1	DIV1	28 (SI5) *	· This input switches the command scaling numerator. · For details, see Section 6-4.	○	–	–
	Damping switch 1	VS-SEL1	26 (SI3) *	· This input switches frequencies applied for the damping control. Together with the damping switch 2 (VS-SEL2), it is possible to switch between four frequencies at the maximum. · For details, see Section 5-2-7.	○	–	–
	Gain switch	GAIN	27 (SI4) *	· Digital input to switch the gains between the 1st and 2nd in the servo loop. · For details, see Section 5-2-5.	○		
	Thrust limit switch	TL-SEL	–	· Digital input to switch between the 1st and 2nd thrust limits. · For details, see Section 6-1.	○	○	–
	Input internal speed selection 1	INTSPD1	33 (SI10) *	· Digital inputs to select a internal speed setup from 1 through 8. · For details, see Section 4-3-2.	–	○	–
	Input internal speed selection 2	INTSPD2	30 (SI7) *		–	○	–
	Input internal speed selection 3	INTSPD3	28 (SI5) *		–	○	–
	Speed zero clamp	ZEROSPD	26 (SI3) *	· Digital input to clamp zero on the speed command. · Before use, set Pr3.15 "Speed zero-clamp function selection" to any value except 0. · For details, see Section 4-3-3.	–	○	○
	Damping switch 2	VS-SEL2	–	· This input switches frequencies applied for the damping control. Together with the damping switch 1 (VS-SEL1), it is possible to switch between four frequencies at the maximum. · For details, see Section 5-2-7.	○	–	–
	Speed command sign	VC-SIGN	–	· Specify a sign of "speed command input" when speed is controlled. · For details, see Sections 4-3-1 and 4-3-2.	–	○	–
	Thrust command sign	TC-SIGN	–	· Specify a sign of "Thrust command input" when thrust is controlled. · For details, see Sections 4-4-1 and 4-4-2.	–	–	○
	Command scaling switch 2	DIV2	–	· This input switches the command scaling. · For details, see Section 6-4.	○	–	–
	Forced Alarm Input	E-STOP	–	· Generates Err87.0 "Compulsory alarm input protection".		○	
	Mass ratio switching	J-SEL	–	· Switches mass ratios. · For details, see Section 5-2-13.		○	
Analog input *1	Positive analog thrust limit	P-ATL	16	· Specifies the positive thrust limit using analog voltage. · For details, see Section 6-2.	○	○	–
	Negative analog thrust limit	N-ATL	18	· Specifies the negative thrust limit using analog voltage. · For details, see Section 6-2.	○	○	–
	Speed command input	SPR	14	· Inputs a speed command using analog voltage. · For details, see Section 4-3-1.	–	○	–
	Thrust command input	TRQR	14	· Inputs a thrust command using analog voltage when Pr3.17 "Selection of thrust command" is set as 0. · For details, see Section 4-4-1.	–	–	○
			16	· Inputs a thrust command using analog voltage when Pr3.17 "Selection of thrust command" is set as 1. · For details, see Section 4-4-2.	–	–	○
	Analog speed limit	SPL	14	· Inputs a speed limit value when Pr3.17 "Selection of thrust command" is set as 1 using analog voltage. · For details, see Section 4-4-2.	–	–	○

*1 : [LA1] is not possible to use it.

· The "*" mark attached to pin numbers indicates that functions of signals and logics can be altered among pins with number Pr4.00 - Pr4.09 (SI* input selection). Note that pin numbers assignable to the following functions cannot be changed. Deviation Counter Clear Input (CL): SI7; Command Pulse Inhibition Input (INH): SI10

· No function is allocated to the connector pins marked with "-" in the default setting.

2-2 Specifications of Output Signal of I/F Connector

Output signals and their functions

Category	Signal	Code	Connector pin No.	Item	Control mode		
					Position	Velocity	Thrust
Common	Frame ground	FG	Shell	· Internally connected with the earth terminal.			
Common	Signal ground	GND	13,15 17,25	· Signal ground · The signal ground is internally isolated from the control signal power supply (COM-).			
Pulse output	Phase A signal Output	OA+	21	· Differential outputs after the parameterized scaling of either an feedback scale scale signal (A, B, and Z phases) (RS422 equivalent). · The ground terminal of the line driver in the output circuit is connected to the signal ground (GND) and thus not isolated. · The maximum frequency of the pulse output is 4 Mpps after quadrature.	○		
		OA-	22				
	Phase B signal output	OB+	48				
		OB-	49				
	Phase Z signal output	OZ+	23				
		OZ-	24				
	Phase Z signal output	CZ	19	· Open collector output of phase Z signal · The emitter terminal of the transistor in the output circuit is connected to the signal ground (GND) and thus not isolated.			
Control output	Servo alarm output	ALM	36 37 (SO3) *	· Digital output to indicate the alarm state. · Turns on the output transistor in a normal state, and turns off the output transistor when an alarm is issued.	○		
	Servo ready output	S-RDY	34 35 (SO2) *	· Digital output to indicate the driver is ready to be enabled. · The output transistor turns on when both the main and control power supplies are properly provided and no alarm is shown. Turns on the output transistor after absolute data are transferred, when the absolute I/F function is valid in the absolute mode.	○		
	Motor holding brake release	BRK-OFF	10 11 (SO1) *	· Outputs a timing signal that activates the electromagnetic brake of the motor. · Turns on the output transistor at the time the electromagnetic brake is released.	○		
	In-position	INP	38 39 (SO4) *	· Digital output to give an in-position signal. · Turns on the output transistor in the in-position state. · In case of bit7=1 on Pr6.10, Pr9.20=2(Magnetic pole position estimation method) and magnetic pole position estimation is not completed, this signal compulsorily turned off. In case of bit7=0 on Pr6.10, it doesn't depend in the state of the magnetic pole position estimation completed, according to the position error and the position command. · For details, see Section 4-2-6.	○	– *1	–
	At-speed output	AT-SPEED	38 39 (SO4) *	· Digital output to indicate the at-speed state. · Turns on the output transistor while the speed is reached. · For details, see Section 4-3-4.	–	○	○
	Thrust limited	TLC	40 (SO6) *	· Digital output to indicate the thrust is limited. · Turns on the output transistor while thrust is limited.		○	
	Zero speed	ZSP	12 (SO5) *	· Digital output to indicate the zero speed state. · Turns on the output transistor while zero-speed is detected.		○	

*1 "-" in the table indicates that the output transistor is always off.

Category	Signal	Code	Connector pin No.	Item	Control mode		
					Position	Velocity	Thrust
Control output	In-speed output	V-COIN	–	· Digital output to give a velocity coincidence signal. · Turns on the output transistor while the in-speed signal is detected. · For details, see Section 4-3-5.	–	○	○
	In-position 2	INP2	–	· Outputs the in-position 2 signal. · Turns on the output transistor in the state of in-position. · In case of bit7=1 on Pr6.10, Pr9.20=2(Magnetic pole position estimation method) and magnetic pole position estimation is not completed, this signal compulsorily turned off. In case of bit7=0 on Pr6.10, it doesn't depend in the state of the magnetic pole position estimation completed, according to the position error and the position command. · For details, see Section 4-2-6.	○	–	–
	Warning 1	WARN1	–	· Outputs a warning output signal that has been set by Pr4.40 "Selection of alarm output 1". · Turns on the output transistor while a warning is issued.	○		
	Warning 2	WARN2	–	· Outputs a warning output signal that has been set by Pr4.41 "Selection of alarm output 2". · Turns on the output transistor while a warning is issued.	○		
	Output for presence/absence of position command	P-CMD	–	· Turns on the output transistor when a position command is present.	○	–	–
	Output during speed limit	V-LIMIT	–	· Turns on the output transistor when thrust is controlled and the speed is limited.	–	–	○
	Alarm clear attribute output	ALM-ATB	–	· Turns on the output transistor when an alarm that can be cleared is issued.	○		
	Output for presence/absence of speed command	V-CMD	–	· Turns on the output transistor when the speed is controlled and a speed command is present.	–	○	–
	Output for complete of magnetic poles estimation	CS-CMP	–	· Turns on the output transistor when the magnetic poles estimation completed.	○		
Analog output	Thrust monitor output	IM	42	· Outputs the analog monitor output2 signal same as front panel. · For details, see Section 3-3.	○		
	Velocity monitor output	SP	43	· Outputs the analog monitor output1 signal same as front panel. · For details, see Section 3-3.	○		

- The "*" mark attached to pin numbers indicates that signal functions can be altered among pins with number Pr4.10 - Pr4.15 (which can be selected by SO* output).
- No function is allocated to the connector pins marked with "-" in the default setting.

2-3 Input/Output Signal Allocation

The assignment of the input/output signals can be changed from the default setting.

2-3-1 Allocation of Input Signal

An input signal that you wish can be assigned to an input pin of the I/F connectors. It is also possible to change the logic.

Note that for some signals, assignment is limited. For details, see (2) "Change the default assignment for input signals."

(1) Use the default signal assignment

The following table shows the default setting for the signal assignment. For the replacement of A4 series, please use the setting as shown below.

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

*1 "a connect" and "b connect" represent the following respectively:

a connect : A signal input is open with COM-, and thus the function is invalid (OFF state).
A signal input is connected with COM-, and thus the function is valid (ON state).

b connect : A signal input is open with COM-, and thus the function is valid (ON state).
A signal input is connected with COM-, and thus the function is invalid (OFF state).

In this specification, a signal input is defined ON when its function is valid; OFF when the function is invalid.

*2 For pin numbers assigned as input signals SI1 – SI10, see Specifications.

*3 The mark "-" indicates that there is no function assigned.

(2) Change the default assignment for input signals
To reassign an input signal, change the following parameter.

Category	No.	Parameter	Setup range	Unit	Function
4	00	SI1 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI1. Set this parameter with the hexadecimal system. *1 Following the hexadecimal form, set each control mode as follows: 00----**h: Position control 00--**--h: Speed control 00**----h: Thrust control Enter a function number in the place marked with "**." Please refer to the function number table shown later in this section. The setting of logics is also included in the function numbers. Example: If you wish to assign to a pin DIV1_a connect for the position control modes, INTSPD1_b connect for the velocity control mode, and make it invalid for the thrust control mode, the setting will be 00008E0Ch. Position = 0Ch, Velocity = 8Eh, Thrust = 00h *1 Displayed in the decimal number system on the Front Panel.
4	01	SI2 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI2. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	02	SI3 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI3. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	03	SI4 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI4. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	04	SI5 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI5. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	05	SI6 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI6. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	06	SI7 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI7. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	07	SI8 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI8. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	08	SI9 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI9. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.
4	09	SI10 input selection	0~ 00FFFFFFh	–	To assign a function to the input SI10. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.00.

Function number table

Signal	Code	Setting	
		a connect	b connect
Invalid	–	00h	Not available
Positive overtravel limit	POT	01h	81h
Negative overtravel limit	NOT	02h	82h
Servo on	SRV-ON	03h	83h
Alarm clear	A-CLR	04h	Not available
Control mode switch	C-MODE	05h	85h
Gain switch	GAIN	06h	86h
Deviation counter clear	CL	07h	Not available
Command pulse inhibition	INH	08h	88h
Thrust limit switch	TL-SEL	09h	89h
Damping switch 1	VS-SEL1	0Ah	8Ah
Damping switch 2	VS-SEL2	0Bh	8Bh
Command scaling switch	DIV1	0Ch	8Ch
Command scaling switch 2	DIV2	0Dh	8Dh
Input internal speed selection 1	INTSPD1	0Eh	8Eh
Input internal speed selection 2	INTSPD2	0Fh	8Fh
Input internal speed selection 3	INTSPD3	10h	90h
Speed zero clamp	ZEROSPD	11h	91h
Speed command sign	VC-SIGN	12h	92h
Thrust command sign	TC-SIGN	13h	93h
Forced alarm input	E-STOP	14h	94h
Mass ratio switching	J-SEL	15h	95h

Precautions:

- Do not set any value other than set values specified in the table.
- A function can not be assigned to more than one signal. If any function is assigned to more than one signal, Err33.0 "IF overlaps allocation error 1 protection" and Err33.1 "IF overlaps allocation error 2 protection" will occur.
- Deviation Counter Clear (CL) can be assigned only to SI7 Input. If it is assigned to the other signals, Err33.6 "CL fitting error protection" will occur.
- Command Pulse Inhibition (INH) can be assigned only to SI10 Input. If it is assigned to the others, Err33.7 "INH fitting error protection" will occur.
- To use the Control Mode Switch (C-MODE), settings of all control modes are necessary. If settings are made on one control mode or two, Err33.2 "IF input function number error 1 protection" or Err33.3 "IF input function number error 2 protection" will occur.
- Control input pins set as invalid do not affect operations.
- To use functions in two modes or more (such as Servo On and Alarm Clear), assign those functions and logics to the same pins in different control mode. If settings are incorrect, Err33.0 "IF overlaps allocation error 1 protection" or Err33.1 "IF overlaps allocation error 2 protection" will occur.
- Servo-on Input Signal (SRV-ON) must always be assigned. When it is not assigned, Servo-on cannot be activated.

2-3-2 Allocation of Output Signal

Output signals can assign any function except Servo Alarm Output (ALM) to output pins of the I/F connector. The logic cannot be changed for the output pins.

(1) Use the default signal assignment

The following table shows the default setting for the signal assignment. For the replacement of A4 series, please use the setting as shown below.

Output signals *1	Corresponding parameter	Default value (): Decimal number	Default status		
			Position control	Velocity control	Thrust control
			Signal	Signal	Signal
SO1 output	Pr4.10	00030303h (197379)	BRK-OFF	BRK-OFF	BRK-OFF
SO2 output	Pr4.11	00020202h (131586)	S-RDY	S-RDY	S-RDY
SO3 output	Pr4.12	00010101h (65793)	ALM	ALM	ALM
SO4 output	Pr4.13	00050504h (328964)	INP	AT-SPEED	AT-SPEED
SO5 output	Pr4.14	00070707h (460551)	ZSP	ZSP	ZSP
SO6 output	Pr4.15	00060606h (394758)	IM	IM	IM

*1 For pin numbers assigned as output signals SO1 - SO6, see Specifications.

(2) Change the default assignment for output signals
To reassign an output signal, change the following parameter.

Category	No.	Parameter	Setup range	Unit	Function
4	10	SO1 output selection	0~ 00FFFFFFh	–	To assign a function to the output SO1. Set this parameter with the hexadecimal system.*1 Following the hexadecimal form, set each control mode as follows: 00----**h: Position control 00--**--h: Speed control 00**----h: Thrust control Enter a function number in the place marked with "**." Please refer to the function number table shown later in this section. *1 Displayed in the decimal number system on the Front Panel.
4	11	SO2 output selection	0~ 00FFFFFFh	–	To assign a function to the output SO2. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.10.
4	12	SO3 output selection	0~ 00FFFFFFh	–	To assign a function to the output SO3. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.10.
4	13	SO4 output selection	0~ 00FFFFFFh	–	To assign a function to the output SO4. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.10.
4	14	SO5 output selection	0~ 00FFFFFFh	–	To assign a function to the output SO5. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.10.
4	15	SO6 output selection	0~ 00FFFFFFh	–	To assign a function to the output SO6. Set this parameter with the hexadecimal system. Settings can be made in the same way for Pr4.10.

Function number table

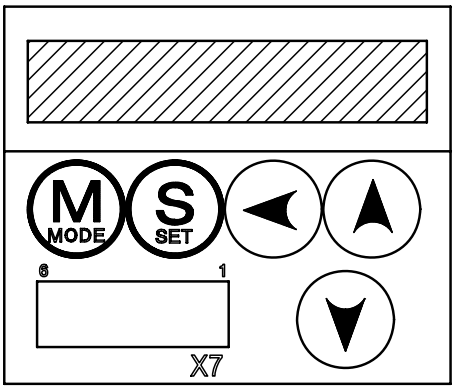
Signal	Code	Setting
Invalid	–	00h
Alarm output	ALM	01h
Servo ready output	S-RDY	02h
Motor holding brake release	BRK-OFF	03h
In-position	INP	04h
At-speed output	AT-SPEED	05h
Thrust limited	TLC	06h
Zero speed	ZSP	07h
In-speed output	V-COIN	08h
Warning 1	WARN1	09h
Warning 2	WARN2	0Ah
Output for presence/absence of position command	P-CMD	0Bh
In-position 2	INP2	0Ch
Output during speed limit	V-LIMIT	0Dh
Alarm attribute output	ALM-ATB	0Eh
Output for presence/absence of speed command	V-CMD	0Fh
Output for complete of magnetic poles estimation	CS-CMP	10h

Precautions:
- The same function can be assigned to multiple output signals.
- A control output pin set as invalid normally keeps the output transistor turned off.
- Do not set any value other than set values specified in the table.

3. Specifications of Front Panel

3-1 How to Operate Front Panel

3-1-1 Composition of Touch Panel and Display



3-1-2 Functions of Key Switches

Switch	Condition to be valid	Function
MODE	Valid at the selection display	1) Monitor mode 2) Parameter setting mode 3) EEPROM writing mode 4) Auxiliary function mode Four modes shown above can be switched.
SET	Always valid	Note: To switch between the selection display and the execution display
▲ ▼	Valid for the digit with a flashing decimal point	To change the display and data, to make selections such as for a parameter, and to execute an action in each mode
◀		To move to the digit higher than the one being changed

Note: The above five modes all have the "selection display" and "execution display."
Please refer to Section 3-1-3 for the details.

3-1-3 How to Operate

After turning on the main power, follow the procedure specified in Pr5.28 "LED initial status". Then the monitor mode is executed or indicated. To indicate a monitor datum in the initial display, set its data number (** of "d**") as a parameter. Example: In the case of Pr5.28=1, "d01.SPd" is indicated in the initial display. For data numbers of monitor data, see Section 3-2-1.

Selection display

Monitor mode

Meaning


Position deviation (command unit)

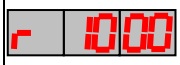

Motor speed

Press ▲ to move to the next display in the arrow direction, and press ▼ to go in the reverse direction.

DATA key

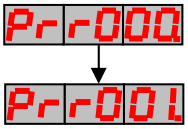
Execution display

Monitor mode

Display example	Meaning	Reference
	Position deviation 5 pulses	3-2-1 (1)
	Monitor speed: 1000 mm/s	3-2-1 (2)

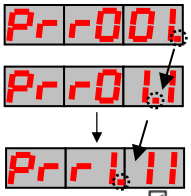
MODE key

Parameter setting mode [Selection display]


Pr 0.00

Pr 0.01

Press ▲ to move to the next display in the arrow direction, and press ▼ to go in the reverse direction.


Pr 0.01

Pr 0.11

Pr 1.11

To change a higher digit, press ◀ and move the blinking decimal point to the digit.
The first digit from the left is for changing the category number, and the others are for changing the parameter number.

Note Note that the change of the parameter with "r" indicated before the category number becomes valid after resetting the main power.

DATA key

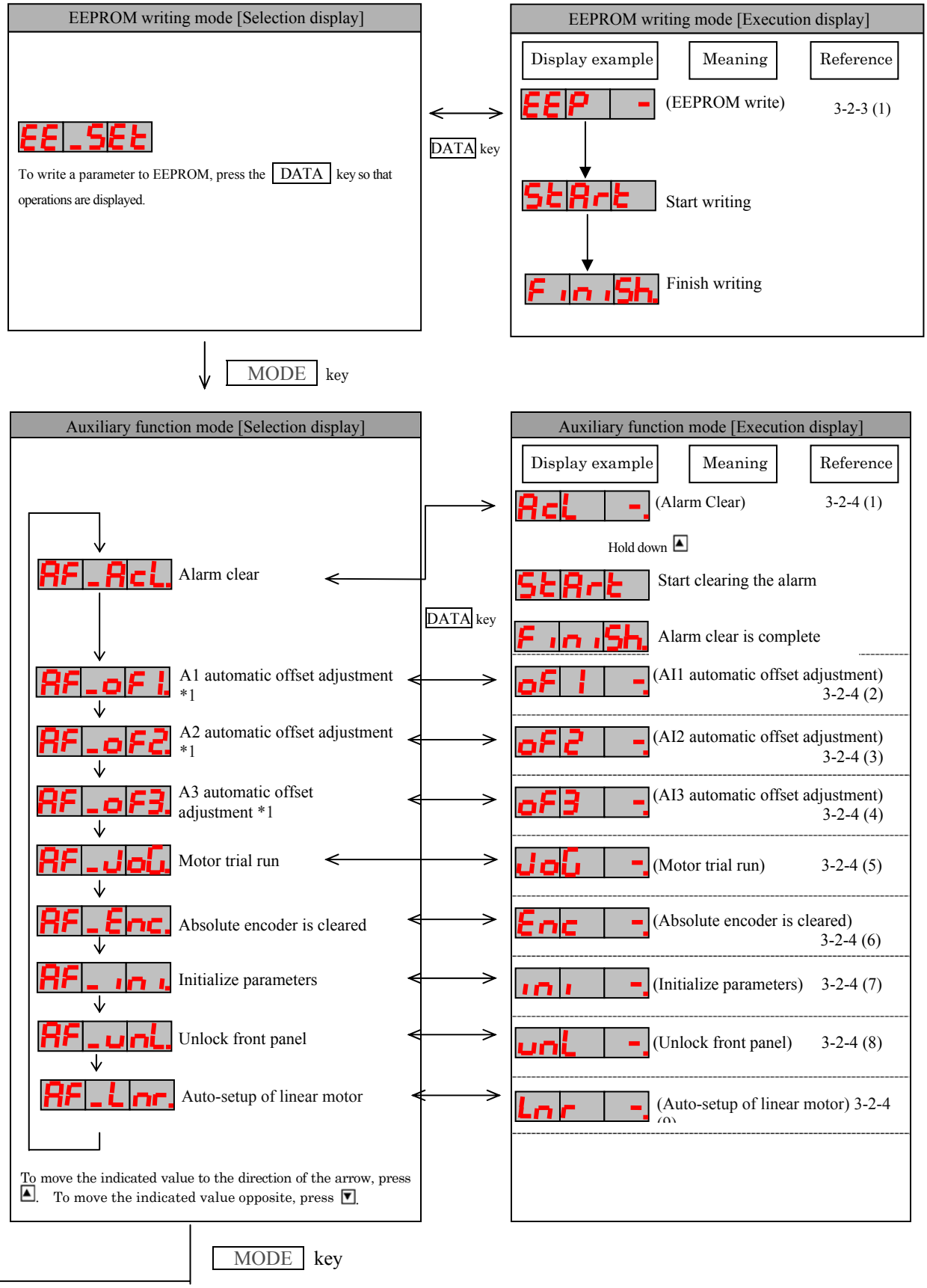
Parameter setting mode [Execution display]

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

▲, ▼, ◀ Use to set the parameter.
The digit with a flashing decimal point can be changed.

Continued to the next page

MODE key



- The display flashes slowly while there is a warning.
- If an error occurs, the display starts flashing and it switches to show the error factors.

*1 : [LA1] is not possible to use it.

3-1-4 Front Panel Lock

The front panel can be locked to prevent misoperation such as unexpected change of a parameter.
The limitations of locking the front panel are described in the table below.

Mode	Front panel locked
Monitor mode	All monitor data can be seen.
Parameter setting mode	Parameters cannot be changed. Note that set values of parameters can be seen.
EEPROM writing mode	Not executed. (Not displayed.)
Auxiliary function mode	All auxiliary functions except "Unlock front panel" cannot be executed. (Not displayed.)

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	35	Front panel lock setup	0-1	–	Operations by the front panel are locked. 0: Operations by front panel not locked 1: Operations by front panel locked

· Procedure to lock the front panel
[Common to setup assistance software and front panel operations]
1) Set Pr5.35 "Front panel lock setup" to 1, and write it to EEPROM.
2) Restart the main power of the drive.
3) The front panel will be locked.

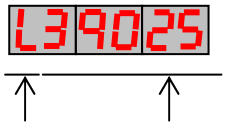
· To unlock the front panel
[When using setup assistance software]
1) Set Pr5.35 "Front panel lock setup" to 0, and write it to EEPROM.
2) Restart the main power of the drive.
3) The front panel will be unlocked.

[When using the front panel]
1) Execute "Unlock front panel" in the auxiliary function mode. (See Section 3-2-4 (8).)
2) Restart the main power of the drive.
3) The front panel will be unlocked.

3-2 Details of Specifications of Front Panel

3-2-1 Details of Monitor Mode

(0) Position command deviation [command unit]
Indicates position deviation by command in the form of higher/lower digits.

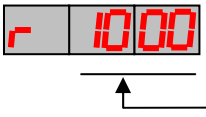


Lower (L) Position command deviation
Higher (H)

■ To switch between Lower (L) and Higher (H), press ◀

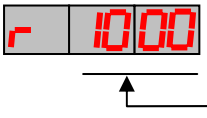
In the case of the following example, position command deviation is 10339025.

(1) Motor speed [mm/s]



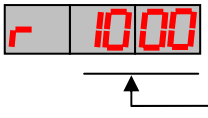
Indicates motor speed [mm/s].

(2) Position command speed [mm/s]



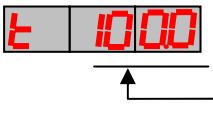
Indicates position command speed [mm/s].

(3) Velocity control command [mm/s]



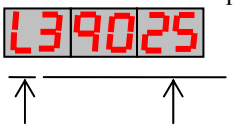
Indicates velocity control command [mm/s].

(4) Thrust command [%]



Indicates thrust command [%].

(5) Total of feedback scale pulses



Lower (L) Total of feedback scale pulses
Higher (H)

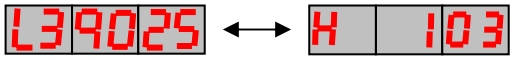
■ To switch between Lower (L) and Higher (H), press ◀

(6) Command pulse sum [Command pulse]

Lower (L)
Higher (H)

Total of command pulses

■ To switch between Lower (L) and Higher (H), press ◀



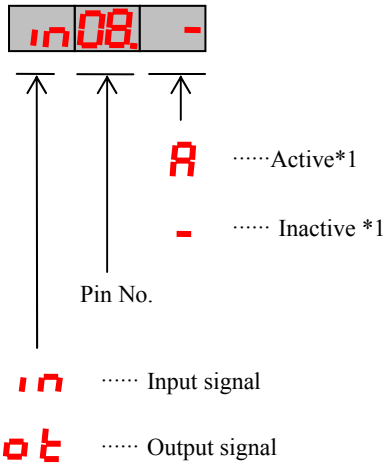
(9) Control mode

 ····· Position control mode

 ····· Velocity control mode

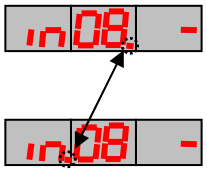
 ····· Thrust control mode

(10) Input/output signal status



*1 For input, "Active" and "Inactive" mean that the input coupler is ON and OFF, respectively.
For output, "Active" and "Inactive" mean that the output Tr is ON and OFF, respectively.

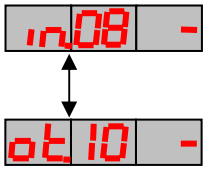
■ To move the blinking decimal point, press ◀



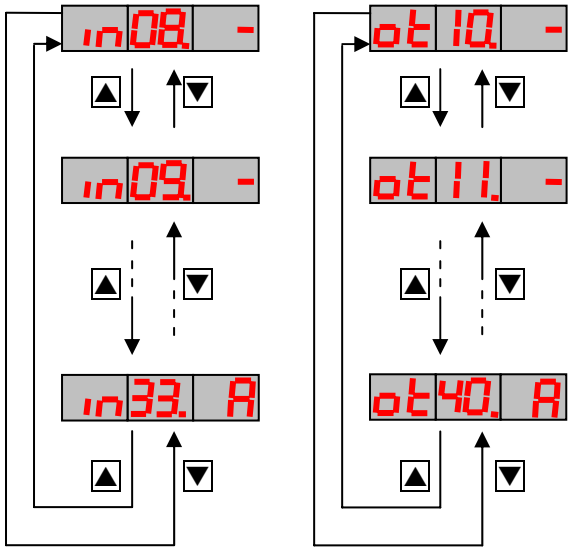
(Left of decimal point: Select the pin No.)

(Left of decimal point: Select the input/output pin No.)

■ To switch input/output, press ▲ or ▼



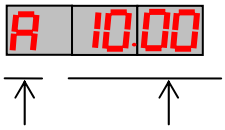
■ For monitoring, press ▲ or ▼ to choose the pin No.



(Lowest input/output pin No.)

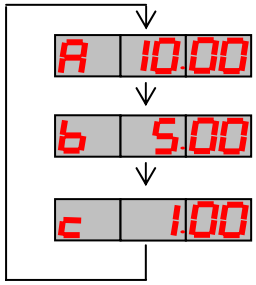
(Highest input/output pin No.)

(11) Display of analog input values [LA1] All 0 is displayed..



Input signal Input voltage value [V]

■ Press ▲ ▼ to select the signal you wish to display.



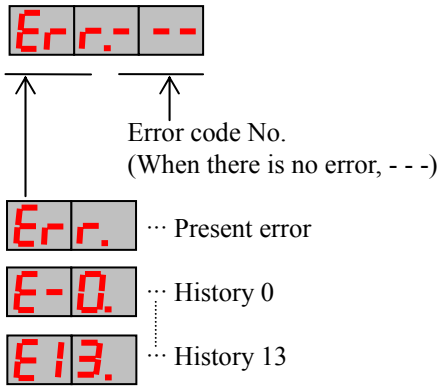
(Value for analog input 1, unit [V]) The value after the offset correction is displayed.

(Value for analog input 2, unit [V])

(Value for analog input 3, unit [V])

Note: Voltage exceeding +/- 10 V will not be displayed correctly.

(12) Error factor/history



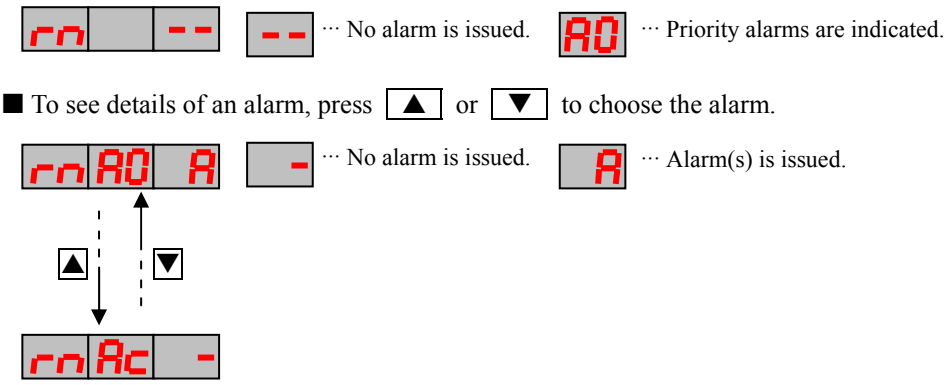
■ Error history shows 14 error factors including the present one.

To see a specific history, press ▲ or ▼ to choose its history No.

Note 1: Some alarms are not logged in history. For details such as alarm numbers, see Section 7-1.

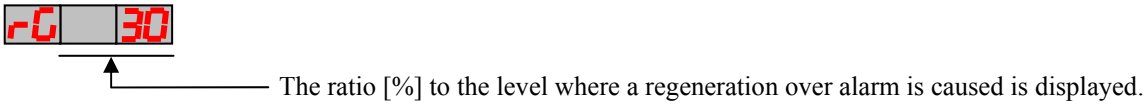
Note 2: When there are some errors logged in history, the present error is counted as History 0.

(13) Warning number

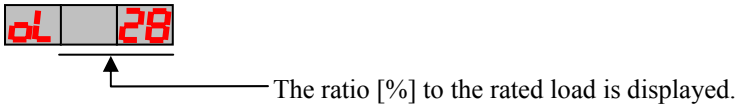


Note: For alarm numbers, see Section 7-3.

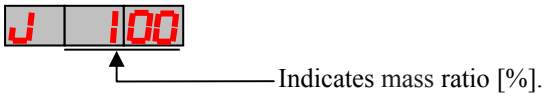
(14) Load factor of regenerative resistor



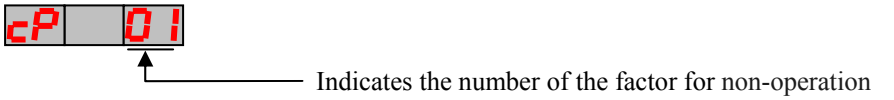
(15) Overload factor



(16) Mass ratio



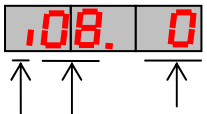
(17) Factor for no-operating



Relationship between numbers and factors for nonrotation

Number of factor for non-operation	Factor for non-operation	Number of factor for non-operation	Factor for non-operation
0	No factor for non-operation is found	7	Command pulse is not input
1	Not ready for servo	8	Counter clear is valid
2	Servo-on signal is not input	9	Speed zero clamp is valid
3	Drive inhibition input is valid	10	Analog speed command is small
4	Analog thrust limit is invalid, thrust limit of parameter is small	11	Internal speed command is 0
		12	Analog thrust command is small
5	Analog thrust limit is valid and small	13	Speed limit command is 0
6	Command pulse input inhibition is valid	14	Other factor

(18) Input/output signal change count display



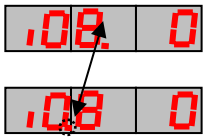
Times of changes in input/output signals

Pin No.

I ····· Input signal

O ····· Output signal

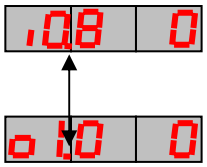
■ To move the blinking decimal point, press ◀



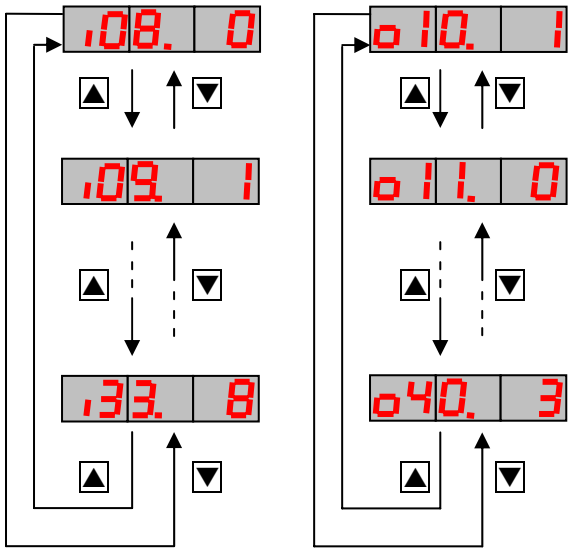
(Left of decimal point: Select the pin No.)

(Left of decimal point: Select the input/output pin No.)

■ To switch input/output, press ▲ or ▼



■ To see times of changes in input/output signals, press ▲ or ▼



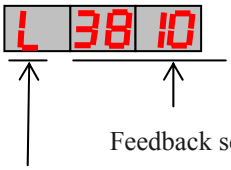
(Lowest input/output pin No.)

(Highest input/output pin No.)

*The change counts turning on the power supply as 0.

(21) Absolute feedback scale position

In case of serial absolute scale, this shows the absolute position of feedback scale.
In case of serial incremental scale, this shows the position at power-on as 0.
In case of A/B phase type scale, this shows always 0.

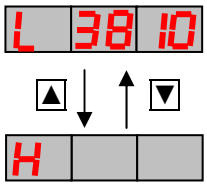


Feedback scale data

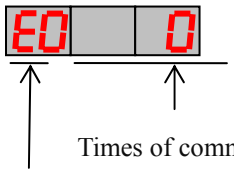
L ··· Position of absolute feedback scale: Lower (L)

H ··· Position of absolute feedback scale: Higher (H)

■ To switch between Lower (L) and Higher (H), press ▲ or ▼



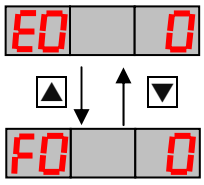
(22) Counter of feedback scale communication errors



Times of communication errors

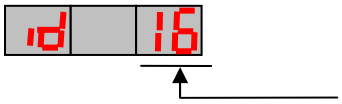
E0 : Encoder F0 :Feedback scale

■ To switch between Encoder and Feedback scale, press ▲ or ▼



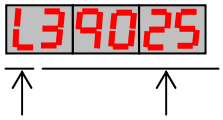
Counter of encoder communication error is fixed as 0.

(23) Communication axis address display



Indicates the value set for Pn5.31 "Axis address"

(24) Feedback position deviation [feedback scale unit]



Lower (L)
Higher (H)

Position deviation of feedback scale [by feedback scale unit]

■ To switch between Lower (L) and Higher (H), press ◀

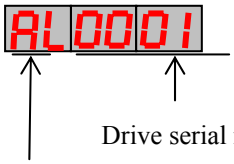
(27) P-N voltage [V]

Indicates voltage [V] between P and N.

(28) Software version

The software version of the drive is displayed. (Example: Ver1.00)

(29) Drive serial number

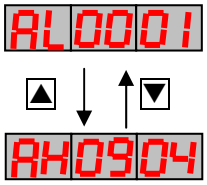


··· Serial No. of drive Lower (L)

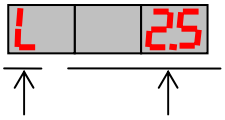
··· Serial No. of drive Higher (H)

■ To switch between Lower (L) and Higher (H), press ▲ or ▼

Example: Serial No. 09040001



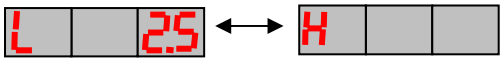
(31) Cumulative operation time



Lower (L)
Higher (H)

Indicates cumulative operating hours [h].

■ To switch between Lower (L) and Higher (H), press ◄



(33) Temperature information

Displays the drive temperature [deg. Celsius].

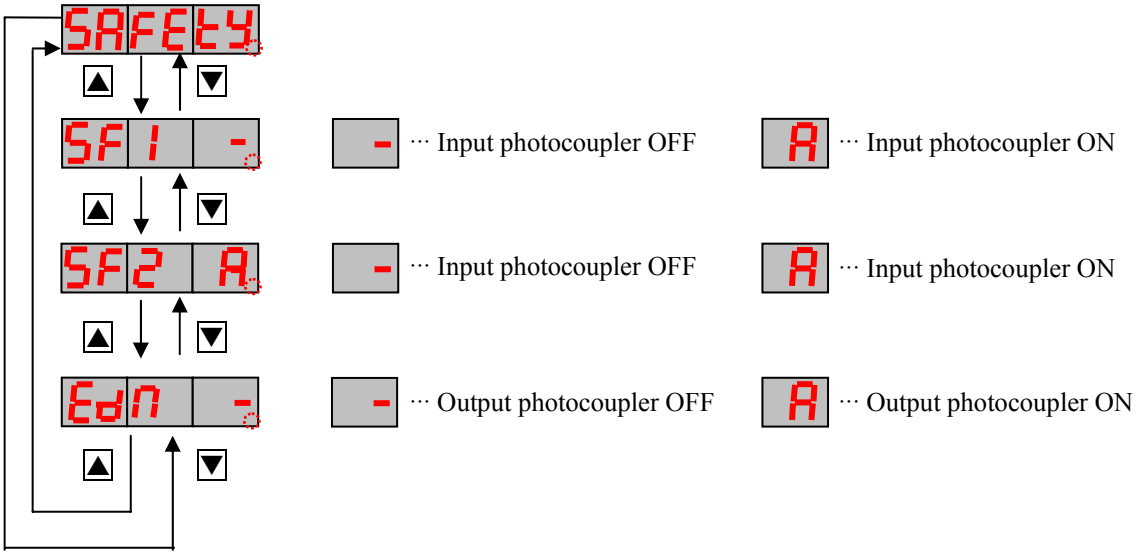
(35) Safety state monitor [LA1] The display is fixed as SF1:'A', SF2:'A', EDM:'-'

SAFEty: Safety state
SrVoFF: Servo-off state
SrVon: Servo-on state
ALArM: Alarm state
+ dot information

Blinking
State where normal changes can be made

Servo-ready state
OFF: Dots lit off
ON: Dots lit on

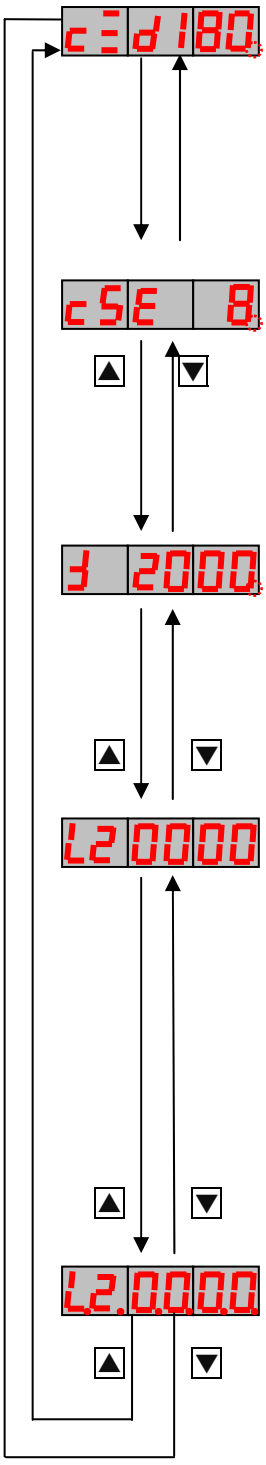
■ To switch monitors to be diplayed, press ▲ or ▼



(37)Linear motor state monitor

Peculiar information to a linear motor can be monitored.
(CS signal, electric angle, and magnetic pole position estimation)

■ To switch monitors to be diplayed, press ▲ or ▼



This shows the CS signal(CS1, CS2 and CS3) state as 3-cross bars. From above CS1, CS2 and CS3. "-" is on, " "(blank) is off. CS signals are displayed by the signals before reversing of Pr3.26 (original signal).
* In case of Pr9.20<>1 (do not use CS signals), it becomes non-display.

This shows current electric angle position (degree). (ex. 180 degree)

This shows the estimation accuracy of magnetic pole position estimation.
In this example, this shows that the estimation accuracy menas +/- 8 degrees.
However, this accuracy is accuracy presumed from the magnetic pole position estimation method, and no one to guarantee real accuracy. Please use it as a reference value.
* Monitor value is updated after completion of magnetic pole position estimation. And in case of Pr9.20<>2 (do not use magnetic pole position estimation), this shows 0.

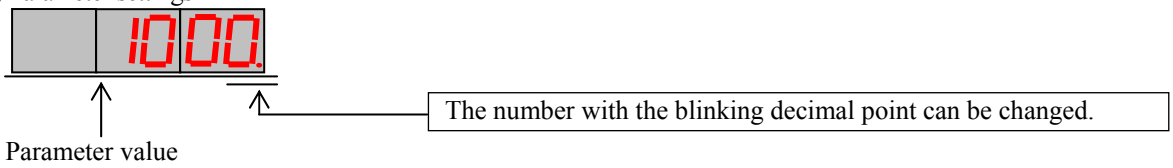
This shows the excute time(ms) when magnetic pole position estimation executed.
In this example, this shows 2000ms.
* Monitor value is updated after completion of magnetic pole position estimation. And in case of Pr9.20<>2 (do not use magnetic pole position estimation), this shows 0.

This shows the maximum movement value(unit : feedback scale) to the positive direction on the basis of magnetic pole position estimation start position.
In this example, this shows the motor moves 1020000(unit : feedback scale) to positive direction on basis of magnetic pole position estimation start position.
* Monitor value is updated after completion of magnetic pole position estimation. And in case of Pr9.20<>2 (do not use magnetic pole position estimation), this shows 0.

This shows the maximum movement value(unit : feedback scale) to the negative direction on the basis of magnetic pole position estimation start position.
In this example, this shows the motor moves 120000(unit : feedback scale) to negative direction on basis of magnetic pole position estimation start position.
It is indicated that "." in the lower right of each digit means a negative value.
* Monitor value is updated after completion of magnetic pole position estimation. And in case of Pr9.20<>2 (do not use magnetic pole position estimation), this shows 0.

3-2-2 Details of Parameter Setting Mode

(1) Parameter settings



■ To change the parameter value, press ▲ or ▼. (To increase the parameter value, press ▲. To decrease the parameter value, press ▼.)

■ To change a higher digit, press ◀ and move the blinking decimal point to the digit.

■ To update the parameter value in the drive, press DATA.
(The parameter value is not updated only by pressing ▲ or ▼)
At this time, if Pr6.17 "Front panel parameter writing selection" indicates 1, the parameter value is automatically updated, including writing to EEPROM.
(However, nothing is written into EEPROM during occurrence of Err11.0 "Control power supply undervoltage protection".)
If Pr6.17 indicates 0, follow the procedure specified in Section 3-2-3 to write the parameter value to EEPROM.

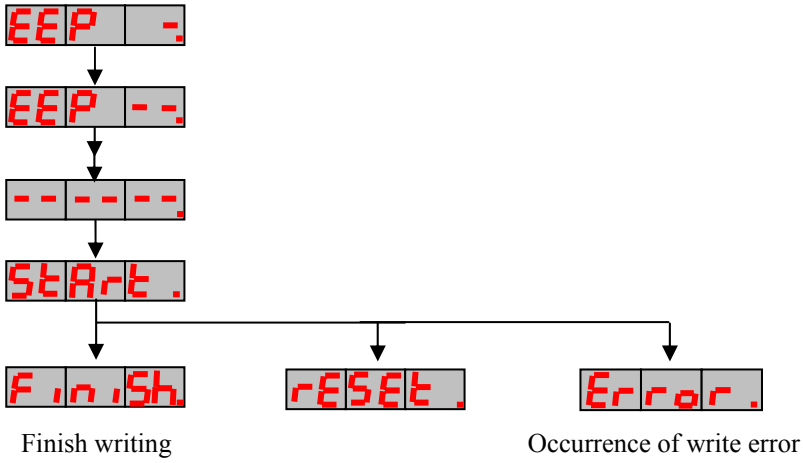
■ To cancel the change of the parameter value after changing it with ▲ or ▼, do not press DATA but press MODE key. Then the parameter value in the drive is not updated, and the monitor returns to indication of parameter numbers.

3-2-3 EEPROM Writing Mode

(1) Writing EEPROM

■ To write the parameter value, press ▲ until the indication changes to StArt.

Continue to press ▲ (for 5 seconds).
Then, the number of bars increases as shown in the figure on the right.



■ When setting/changing a parameter whose setting/change becomes effective after resetting, rESEt. is indicated when the writing is completed. Turn off the control power to reset it.

Note 1: If a write error occurs, re-try writing. If the error repeatedly persists, there may be a failure.

Note 2: Do not shut down the main power while writing to EEPROM. Wrong data may be written. If it should happen, redo the entire parameter setting, fully check it, and write in EEPROM again.

Note 3: "Error" is displayed during occurrence of Err11.0 "Control power supply undervoltage protection" and nothing is written into EEPROM.

3-2-4 Auxiliary Function Mode

(1) Alarm clear

Clears alarms.
Some alarms cannot be cleared. For details, see Section 7-1.

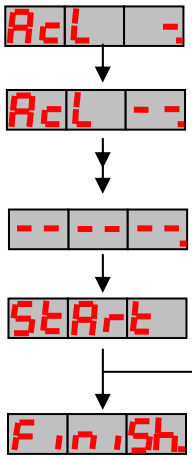
[Selection display]

[Execution display]

■ Press DATA to show the execution display of 

To execute the alarm clear, hold down ▲ until the display changes to 

If ▲ is pressed (about 5 seconds), the number of bars increases as shown in the figure on the right.



Alarm clear has started.

Completed

Alarm clear is complete.

Alarm clear is not complete.
Reset the power.

(2) Analog input 1 automatic offset adjustment [LA1] is not possible to use it.

Automatically adjusts the offset value Pr4.22 of analog input 1 (AI1) (Analog input 1 (AI1) offset setup).

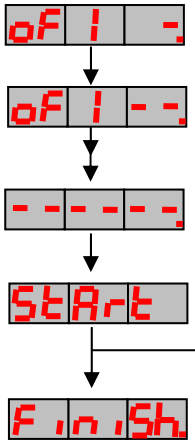
[Selection display]

[Execution display]

■ Press DATA to show the execution display of 

To execute the automatic offset adjustment, first turn the command input to 0 V. Then hold down ▲ until the display changes to 

If ▲ is pressed (about 5 seconds), the number of bars increases as shown in the figure on the right.



Automatic offset adjustment has started.

Completed

Automatic offset adjustment is complete.

Error has occurred.

(The control mode is invalid or the offset value has exceeded the parameter setting range.)

Note 1: Merely performing the automatic offset adjustment will not write the data in EEPROM. To keep the change for later, perform the process to write EEPROM.

(3) Analog input 2 automatic offset adjustment [LA1] is not possible to use it.

Automatically adjusts the offset value Pr4.25 of analog input 2 (AI2) (Analog input 2 (AI2) offset setup).

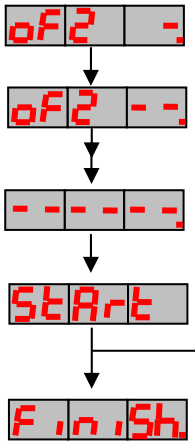
[Selection display]

[Execution display]

■ Press DATA to show the execution display of 

To execute the automatic offset adjustment, first turn the command input to 0 V. Then hold down ▲ until the display changes to 

If ▲ is pressed (about 5 seconds), the number of bars increases as shown in the figure on the right.



Automatic offset adjustment has started.

Completed

Automatic offset adjustment is complete.

Error has occurred.

(The control mode is invalid or the offset value has exceeded the parameter setting range.)

Note 1: Merely performing the automatic offset adjustment will not write the data in EEPROM. To keep the change for later, perform the process to write EEPROM.

(4) Analog input 3 automatic offset adjustment [LA1] is not possible to use it.

Automatically adjusts the offset value Pr4.28 of analog input 3 (AI3) (Analog input 3 (AI3) offset setup).

[Selection display]

[Execution display]

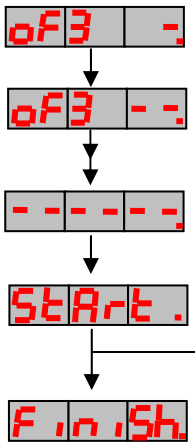
■ Press DATA to show the execution display of 

.

To execute the automatic offset adjustment, first turn the command input to 0 V. Then hold down ▲ until the display changes to 

.

If ▲ is pressed (about 5 seconds), the number of bars increases as shown in the figure on the right.



Automatic offset adjustment has started.

Completed

Automatic offset adjustment is complete.

Error has occurred.

(The control mode is invalid or the offset value has exceeded the parameter setting range.)

Note 1: Merely performing the automatic offset adjustment will not write the data in EEPROM. To keep the change for later, perform the process to write EEPROM.

(5) Test run of motor

Performing the following procedure will execute a trial run of the motor without making the wiring connection of CN1.

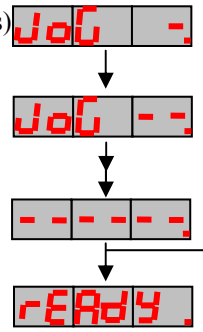
[Selection display]

[Execution display]

■ Press [DATA] to show the execution display of 

To execute test run of motor, press [▲] until the monitor indicates 

Continue to press [▲] (for 5 seconds)
Then, the number of bars increases as shown in the figure on the right.

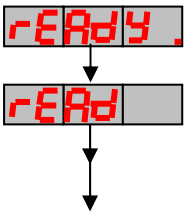


Preparation 1

When not in servo-ready state
(When alarm has occurred, or when main power is shut down.)

■ Next hold down [◀] until the display changes to 

Continue to press [◀] (for 5 seconds).
Then, "-" moves
as shown in the right figure



Preparation 2

When not in servo-ready state, or when SRV-ON is valid

■ After SRV-ON becomes valid, press [▲] or [▼] so that the motor operates in the positive or negative direction, respectively, at the speed set in Pr6.04 "JOG trial run command speed".

Note 1: Before conducting a test run, disconnect the load from the motor and remove the connector CN1.
Note 2: Before a test run, set appropriate values for gain-related parameters to prevent abnormalities such as damping. Specifically when disconnecting the load, set Pr0.04 "Mass ratio" to 0.
Note 3: During a test run, the motor is in the speed control mode. Set parameters and other settings so that the motor can operate normally in the speed control mode.
Note 4: If SRV-ON becomes valid during a test run, the display will show the following: 

The test run will be interrupted, and the normal operation will commence with external commands.

(7) Initialization of parameters

Initializes parameters.

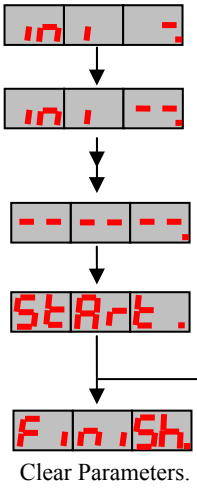
[Selection display]

[Execution display]

■ Press DATA to show the execution display of 

To execute the parameter initialization, hold down ▲ until the display changes to 

If ▲ is pressed (about 5 seconds), the number of bars increases as shown in the figure on the right.



Start clearing the external scales.

Completed

Clear Parameters.

Error has occurred.

(When some errors occurs)

Note 1: In the event of Err11.0 "Control power supply undervoltage protection" or other EEPROM-related error such as Err36.0, Err36.1, Err36.2, Err37.0, Err37.1, or Err37.2, parameters cannot be initialized. "Error" is indicated.

(8) Unlock front panel

Unlock the front panel.

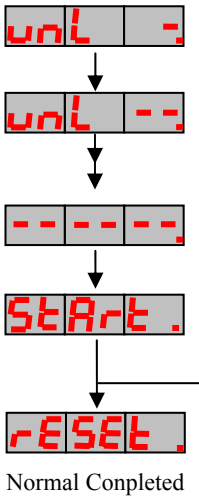
[Selection display]

[Execution display]

■ Press DATA to show the execution display of 

To execute the parameter initialization, hold down ▲ until the display changes to 

If ▲ is pressed (about 5 seconds), the number of bars increases as shown in the figure on the right.



Unlock front panel.

Completed

Normal Conpleted

Error has occurred.

(9) Auto-setup of linear motor

The parameters are initialized by the automatic operation according to the combination with the linear motor. It is two of the Pr3.26 "Reversal of direction of feedback scale" and Pr9.21 "CS phase setting" to be set automatically by this function. It is necessary to set other parameters beforehand correctly.
(Refer to 4-7 ” Basic setting of linear motor/feedback scale”)

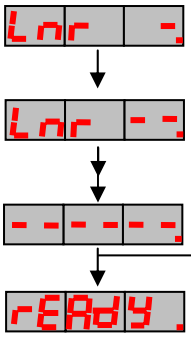
[Selection display]

[Execution display]

■ Push SET ,  and show the execution display.

If you exexute the auto-setup of linear motor, keep pushing ▲ until display changes to 

▲ Keep pushing (approx.5sec)
Then the cross-bar increasing as the right figure.

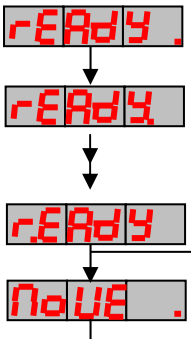


Preliminary step 1

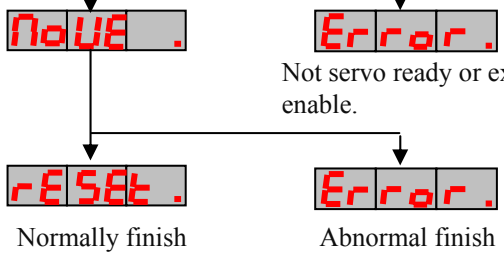
* In case of not servo-ready
(Alarm or main power-off state)
* In case of Pr9.20 is not 1 or 2.
(Not CS signal method or magnetic pole estimation method)

■ Next, keep pushing ◀ to change the display to 

◀ Keep pushing (approx.5sec)
Then the ‘.’ moves to the right as the right figure.



Preliminary step 2



Not servo ready or external servo-on signal is enable.

Normally finish

Abnormal finish

■ After the servo-on, the linear motor works to set a linear motor automatically.
When the automatic setting is completed, the drive will be servo off automatically.
Please reset the power supply of the servo drive at the end.

Note1) There is a possibility that the linear motor works at two cycles in an electric angle in the maximum in the linear motor auto-setup function.
Please execute it beforehand after set up the moving area.

Note2) This function might not operate normally when a vertical axis, load offset, and friction are large.
Moreover, when the load is installed, it is likely not to operate normally. Please remove the load in that case, and execute it only with the linear motor unit.

Note3) When a basic setting concerning the specification of a linear motor and the feedback scale is not correct, it is likely not to operate normally. Please set it correctly beforehand referring to 4-7 "Basic setting of linear motor/feedback scale". (In addition, Pr3.26 and Pr9.21 are set automatically by this function, the setting is unnecessary.)

Note4) If external SRV-ON is ON while executing linear motor auto-setup function, Err60.3 "Linear motor auto-setup error" is generated, and the linear motor auto-setup function is canceled.

Note5) While executing linear motor auto-setup function, it is operated with the current for the command value (%) set by Pr9.23 "Command thrust for estimating magnetic poles position" always impressed. When operation is slow, it is likely to be improved by enlarging a set value of Pr9.23. However, the upper bound of the impressed current is limited by current rating (100%). Please note that there is a possibility that the automatic setting value of Pr9.21 "CS phase setting" varies when there is irregularity at the speed under operation.
Moreover, in case of it uses with Pr5.12 "Over-load level setup" not equal to 0, when set value of Pr5.12 is smaller than a set value of Pr9.23, Err16.0 "Over-load protection" might be generated while executing linear motor auto-setup function. In that case, please set lower value of Pr9.23.

Note6) While executing linear motor auto-setup function, the stop judgment of the linear motor is done. Pr9.24 "Zero moving pulse width for estimating magnetic poles position" is used for the stop judgment condition. When this set value is too small, the stop judgment might not be done, and it become error. In that case, please enlarge a set value of Pr9.24.

Note7) In the caseof Pr9.20 "Magnetic poles detection method selection" =2(Magnetic poles position estimation method), the magnetic pole position estimation state returns to incomplete when the linear motor auto-setup function is executed while the magnetic pole position estimation is completed. Next, the magnetic pole position is estimated at the time of the Servo-On.

3-3 Monitor Signal Output

Various monitoring signals can be output as two types of analog signals from the analog monitor connectors of the front panel. The monitoring signals to output and their scaling (or the setting of the output gain) can be specified with parameters.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
4	16	Type of analog monitor 1	0~22	–	To select the monitoring signal for the analog monitor 1. Please also see the second table of this section.
4	17	Analog monitor 1 output gain	0~ 214748364	[Unit of monitor of Pr4.16]/V	To set the output gain for the analog monitor 1. When Pr4.16 "Motor speed" is set as 0, output is 1 V with the motor speed [mm/s] set in Pr4.17.
4	18	Type of analog monitor 2	0~22	–	To select the monitoring signal for the analog monitor 2. Please also see the second table of this section.
4	19	Analog monitor 2 output gain	0~ 214748364	[Unit of monitor of Pr4.18]/V	To set the output gain for the analog monitor 2. When Pr4.18 "Thrust command" is set as 3, output is 1 V with the thrust command [%] set in Pr4.19.
4	20	Type of digital monitor *[LA1] is not available	0~3	–	To select the monitoring signal for the digital monitor. 0: In-Position, 1: Command pulse ON/OFF, 2: Alarm ON/OFF, 3: Gain selection
4	21	Analog monitor output setup	0~2	–	To select the output type for the analog monitors. 0: Data output with sign -10 V - 10 V 1: Absolute data output 0 V - 10 V 2: Data output with offset 0 V - 10 V (with 5 V at center)

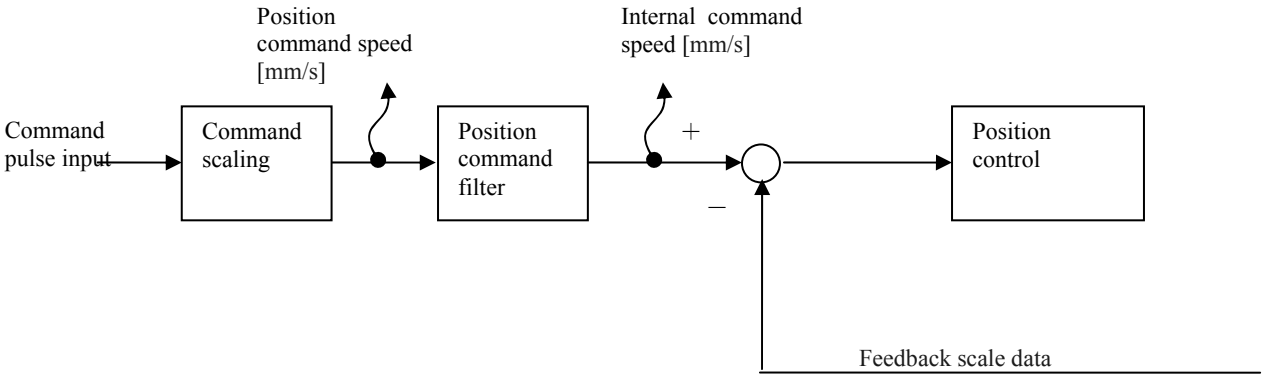
· The following table shows types of monitors set in Pr4.16 "Analog monitor 1 type" and Pr4.18 "Analog monitor 2 types." For Pr4.17 "Analog monitor 1 output gain" and Pr4.19 "Analog monitor 2 output gain," converting gain is set in response to the unit of each type. If these gain parameters are set to 0, the output gains shown at the right most column of the table will be automatically applied.

Pr4.16 / Pr4.18	Monitoring signal	Unit	Output gain when Pr4.17/Pr4.19 is set to 0
0	Motor speed	mm/s	500
1	Position command speed *3	mm/s	500
2	Internal position command speed *3	mm/s	500
3	Velocity control command	mm/s	500
4	Thrust command	%	33
5	Position command deviation *4	Pulse (command unit)	3000
6	Feedback scale deviation *4	Pulse (feedback scale unit)	3000
7	For use by the maker.	-	-
8	For use by the maker.	-	-
9	P-N voltage	V	80
10	Regenerative load factor	%	33
11	Overload factor	%	33
12	Positive thrust limit	%	33
13	Negative thrust limit	%	33
14	Speed limit	mm/s	500
15	Mass ratio	%	500
16	Analog input 1 *2	V	1
17	Analog input 2 *2	V	1
18	Analog input 3 *2	V	1
19	For use by the maker.	-	-
20	Drive temperature	°C	10
21	For use by the maker.	-	-
22	For use by the maker.	-	-

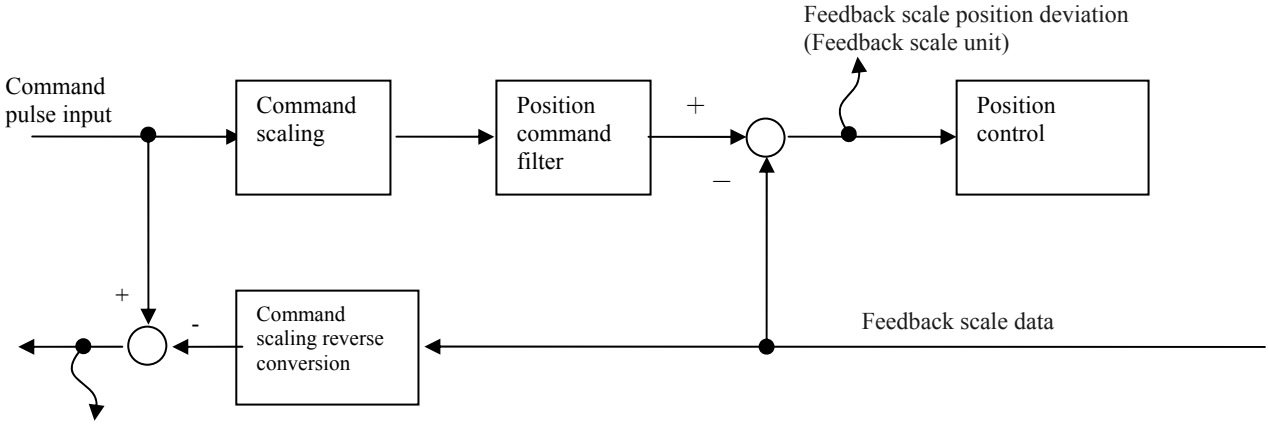
*1 Whether the direction is positive or negative depends on Pr0.00 "Operational direction setup" in principle. Note that the positive direction of single-rotation data of encoder is the direction of CCW. When using an incremental encoder, a normal value is output after the first pass of phase Z.

*2 Analog inputs 1 - 3 always output terminal voltage regardless of the use/nonuse of the analog input function.

*3 Position command speed / Internal command speed comes before/after the command filter (smoothing FIR filter) when inputting command pulses.



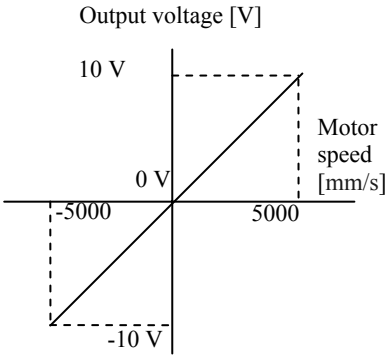
*4 Position command deviation is a deviation to command pulse input, and feedback scale position deviation is a deviation of the input part of position control. See the figure below for details.



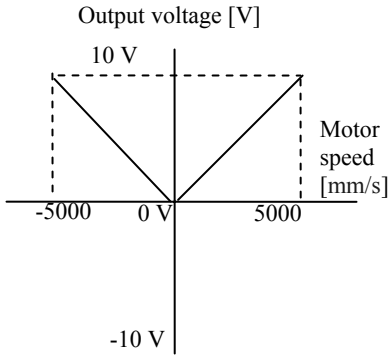
· Pr4.21 Analog monitor output setup

Specifications of output when Pr4.21 is set to 0, 1, and 2 are shown in the following figure.

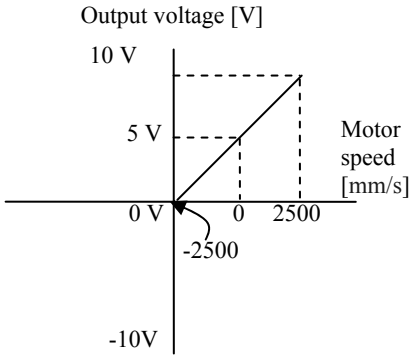
Pr4.21=0 Data output with sign (output range –10-10 V)



Pr4.21=1 Absolute data output (output range 0-10 V)



Pr4.21=2 Data output with offset (output range 0-10 V)



*In case of the motor speed with conversion gain at 500 (1 V=500 mm/s)

· Output status of digital monitor output [LA1] is not possible to use it.

Pr4.20	Monitor type	Digital signal output	
		L	H
0	In-position	Not In-position	In-position
1	Command pulse	No command pulse	Command pulse detected
2	Alarm	Alarm not detected	Alarm detected
3	Gain Selection	Select 1st gain	Select 2nd gain (or 3rd gain)

4. Basic Functions

4-1 Setting Operational Direction

The operation direction of the motor to the directions of position command, speed command, and thrust command can be switched.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	00	Operational direction setup	0~1	–	Specifies the relationship between the commanded direction and the count direction of feedback scale. 0 : Negative direction operation of feedback scale count for positive direction command 1 : Positive direction operation of feedback scale count for positive direction command

Please set Pr0.00 "Operational direction setup" by the following procedure.

[Procedure 1]

First of all, please set Pr3.26 "Feedback scale direction".

Please refer to 4-7-1-4 Feedback scale direction setting.

After set the parmeter, writes parameters in EEPROM, please turn on the power supply again.

[Procedure 2]

Sets to Pr0.00=1, write parameters in EEPROM, please turn on the power supply again.

(This procedure is unnecessary if the drive is shipping status because the default(shipping) setting is Pr0.00=1)

[Procedure 3]

In the state of an off servo (off the motor energizing), please move the motor in the direction to be assumed to be a positive direction as a device.

The direction where that time is counted the feedback scale is confirmed, and please set to Pr0.00=0 if the direction is a negative direction or set to Pr0.00=1 if it is a positive direction.

After set the parmeter, writes parameters in EEPROM, please turn on the power supply again.

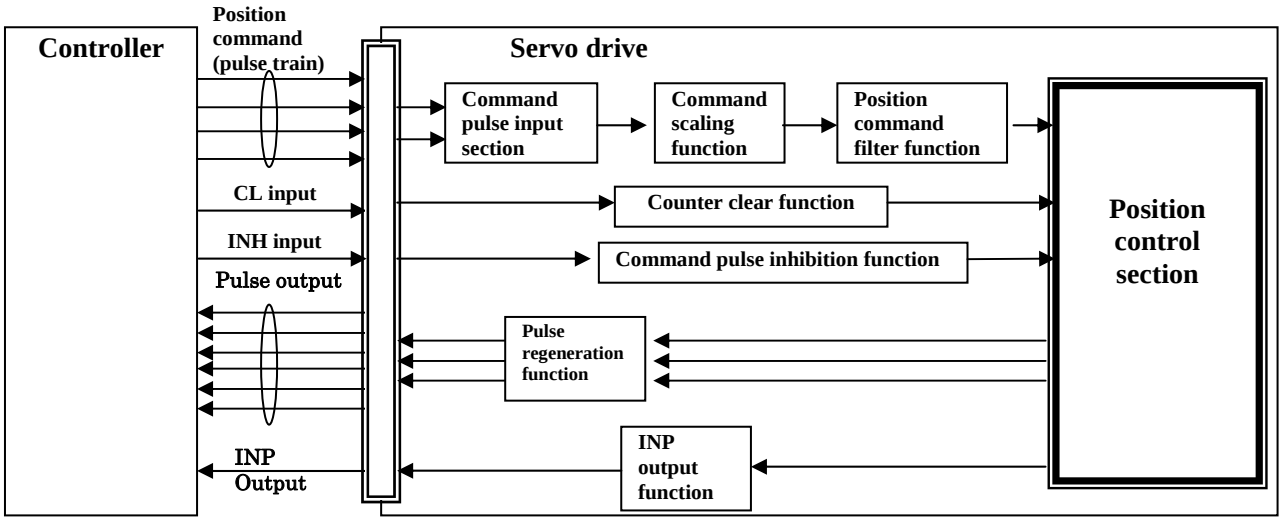
The count direction of the feedback scale can be confirmed in the direction changes where the value of the total of feedback scale pulse in a front monitor (3-2-1 Refer to (6)) or "Scale pulse sum total" of the monitor screen in PC software “PANATERM”.

The positive or negative direction referred to in this document indicates the direction as specified with this parameter. The table below shows the relationships with positive overtravel limit and negative overtravel limit as examples.

Pr0.00	Command direction	Direction of feedback scale	Positive overtravel limit	Negative overtravel limit
0	Positive	Negative direction	Enabled	–
0	Negative	Positive direction	–	Enabled
1	Positive	Positive direction	Enabled	–
1	Negative	Negative direction	–	Enabled

4-2 Position Control

Position control is performed based on a position command (pulse train) input from the controller. This section describes basic settings for position control.



4-2-1 Command Pulse Input

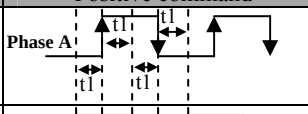
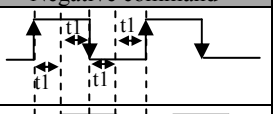
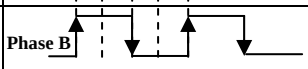
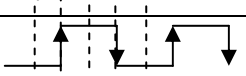
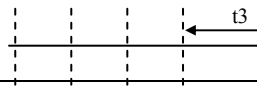
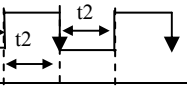
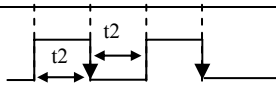
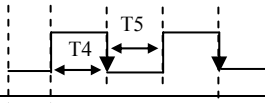
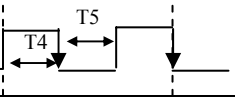
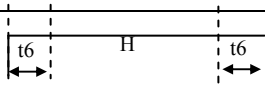
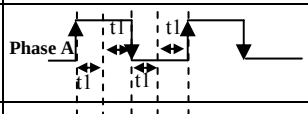
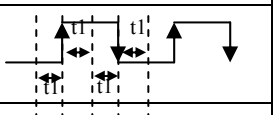
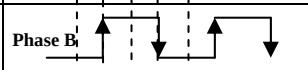
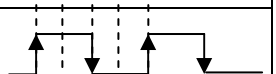
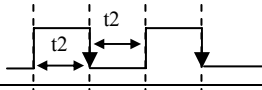
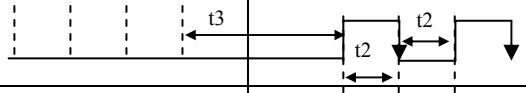
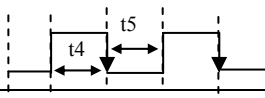
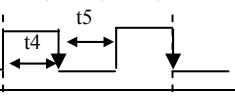
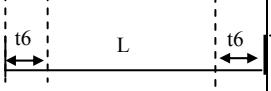
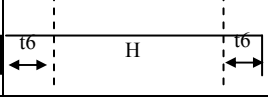
An input terminal for position command (pulse train) can be selected through Pr 0.05 "Selection of command pulse input" of two lines: one consists of PULSH1, PULSH2, SIGNH1, and SIGNH2 (hereafter "input 1"), and the other PULS1, PULS2, SIGN1, and SIGN2 (hereafter "input 2"). Use input 1 when the controller position command output is a line driver output and input 2 when it is an open collector output. Input 2 can also be used for a line driver output but input 1, which provides a higher maximum allowable input frequency, is recommended.

Three command pulse formats are supported: 2-phase pulse, positive pulse train/negative pulse train and pulse train + sign. The pulse format must be selected out of the three and the pulse counting direction must be specified according to the specifications of the controller and equipment installation condition.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	05 *	Selection of command pulse input	0~1	–	Selects whether to use optocoupler input or line driver dedicated input as the command pulse input. 0 : optocoupler input (PULS1, PULS2, SIGN1, SIGN2) 1 : line driver dedicated input (PULSH1, PULSH2, SIGNH1, SIGNH2)
0	06 *	Command pulse operational direction setup	0~1	–	Specifies the counting direction for command pulse input. See the table on the following page for the details.
0	07 *	Command pulse input mode setup	0~3	–	Specifies the counting mode for command pulse input. See the table on the following page for the details.

The following table shows the combinations of Pr0.06 "Command pulse operational direction setup" and Pr0.07 "Command pulse input mode setup".
Pulses are counted at the edges with arrows in the table.

Pr0.06	Pr0.07	Command pulse	Signal	Positive command	Negative command
0	0 or 2	2-phase pulse with 90° difference (Phase A + Phase B)	PULS		
			SIGN	 Phase B advanced by 90 deg from phase A	 Phase B delayed by 90 deg from phase A
	1	Positive pulse train + Negative pulse train	PULS		
			SIGN		
	3	Pulse train + Sign	PULS		
			SIGN		
1	0 or 2	2-phase pulse with 90° difference (Phase A + Phase B)	PULS		
			SIGN	 Phase B delayed by 90 deg from phase A	 Phase B advanced by 90 deg from phase A
	1	Positive pulse train + Negative pulse train	PULS		
			SIGN		
	3	Pulse train + Sign	PULS		
			SIGN		

PULS/SIGN signal		Max. allow-able input frequency	Minimum required time width [μs]					
			t1	t2	t3	t4	t5	t6
PULSH1, 2, SIGNH1, 2		4 Mpps	0.25	0.125	0.125	0.125	0.125	0.125
PULS1, 2, SIGN1, 2	Line driver	500 kpps	2	1	1	1	1	1
	Open collector	200 kpps	5	2.5	2.5	2.5	2.5	2.5

4-2-2 Command Scaling (Electronic Gear)

This function multiplies a pulse command value input from the controller by the specified scaling factor to use as a position command to the position control section. Using this function allows arbitrary setting of the motor revolution and distance per unit input command pulse and increase of a command pulse frequency when the required motor speed cannot be obtained due to the limit to the controller pulse output capability.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	09	1st numerator of electronic gear	1~ 1073741824	–	Specifies the numerator for scaling for a command pulse input.
0	10	Denominator of electronic gear	1~ 1073741824	–	Specifies the denominator for scaling for a command pulse input.

Pr0.09	Pr0.10	Command scaling
1~1073741824	1~1073741824	**Command pulse input** → [Set value of Pr0.09] / [Set value of Pr0.10] → **Position command**

4-2-3 Position Command Filter

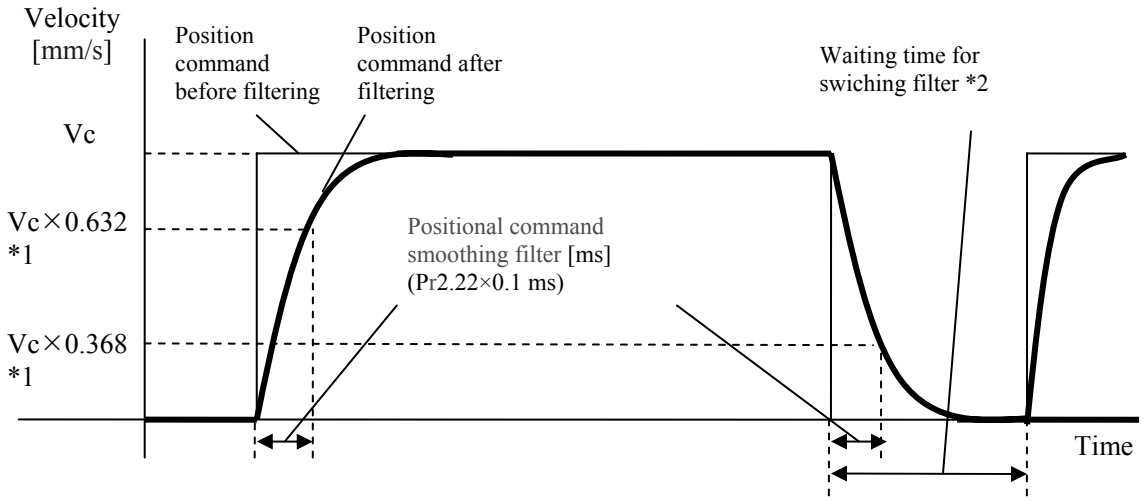
A command filter can be specified to smooth a position command after scaling (electric gear).

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
2	22	Position command smoothing filter	0~10000	0.1 ms	Specifies the first order filter time constant for a position command.
2	23	Position command FIR filter	0~10000	0.1 ms	Specifies the FIR filter time constant for a position command.

· Pr2.22 "Position command smoothing filter"

Specifies the first order filter time constant for a square wave command with a target velocity of Vc as shown in the figure below.

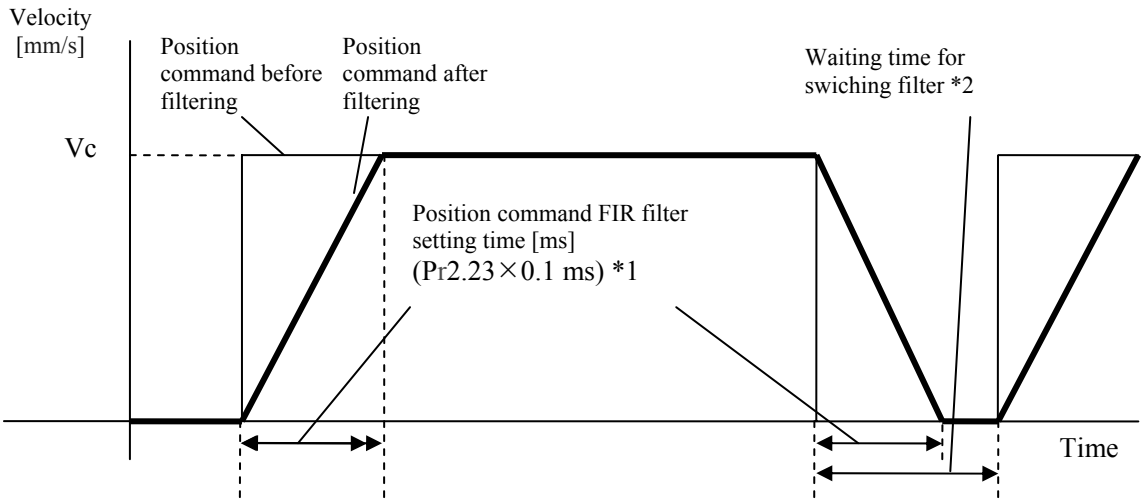


*1 Actual filter time constant contains absolute error of 0.4 ms maximum when the set value multiplied by 0.1 ms is less than 100 ms and relative error of 0.2% maximum when the set value multiplied by 0.1 ms is 20 ms or greater.

*2 Pr2.22 "Positional command smoothing filter" is switched when "in-position" is being output and when a command whose command pulse per time (0.166 ms) changes from 0 to any state except 0 is rising. Specifically when filter time constant is decreased and the in-position range is increased, the motor may temporarily rotates at a faster speed than the command speed if accumulated pulses—an area acquired by integrating the difference between the position command before filtering and the position command after filtering by time—are left in the filter at the point above. This is because accumulated pulses are rapidly cleared immediately after the switching and the motor goes back to the initial position. Use caution.

*3 There is a delay until the change in Pr2.22 "Positional command smoothing filter" is applied to internal calculation. If the switching timing described in *2 comes during the delay, the change may be suspended.

· Pr2.23 "Position command FIR filter"
Specifies the time required to reach Vc for a square wave command with a target velocity of Vc as shown in the figure below.



*1 Actual average travel times contains absolute error of 0.2 ms maximum when the set value multiplied by 0.1 ms is less than 10 ms and relative error of 1.6% maximum when the set value multiplied by 0.1 ms is 10 ms or greater.

*2 Before changing Pr2.23 "Position command FIR filter," stop the command pulse, and wait until the time for filter switching passes. The time for filter switching is as follows: the set value × 0.1 ms + 0.25 ms in the range of 10 ms or smaller, and the set value × 0.1 ms × 1.05 ms in the range of 10 ms or greater. When changing Pr2.23 "Position command FIR filter" during inputting a command pulse, the change is not updated immediately. It is updated when no command pulse is present during the time for filter switching.

*3 There is a delay until the change in Pr2.23 "Position command FIR filter" is applied to internal calculation. If the switching timing described in *2 comes during the delay, the change may be suspended.

4-2-4 Pulse Regeneration

A distance can be transmitted from the servo drive as phase A and phase B pulses signal to the controller. The phase Z signal of feedback scale is output, too. The output resolution, logic of the phase B signal can be specified with parameters.

4-2-4-1 Command Pulse Division

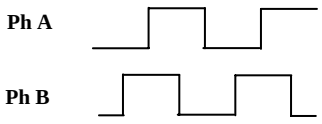
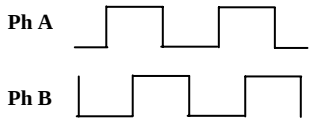
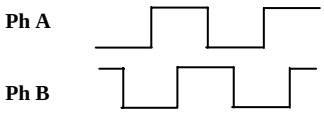
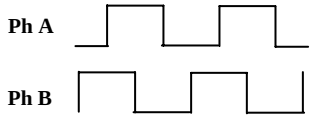
■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	11	Numerator of pulse output division	1~262144	P/r	It is set using a divider ratio with Pr0.11 as the numerator and Pr5.03 as the denominator. Accordingly, if the pulse count has been multiplied by 4, the equation below applies. Output pulse resolution per unit distance = (Set value of Pr0.11 / Set value of Pr5.03) × feedback scale resolution per unit distance
5	03	Denominator of pulse output division	1~262144	–	
0	12	Reversal of pulse output logic	0~3	–	Specifies the logic of the pulse output phase B signal and the output source. Reversing the phase B pulse logic allows the phase relation of phase B pulse with reference to phase A pulse. In the full-closed control mode, an encoder or external scale can be chosen as the output source. The output source must be an encoder in other than full-closed control modes.
5	33	Pulse regenerative output limit setup	0~1	–	Set the error detection function (Err28.0 "Limit of pulse replay error protection") as valid or invalid. 0: Invalid 1: Valid
6	20	Z-phase setup of feeback scale	0~400	μs	Set the regeneration range of phase Z of the feedback scale as time. In the event that width of the phase Z signal by travel from the feedback scale is too short to be detected, the phase Z signal is output for at least the set period.
6	21	Serial absolute feedback scale Z phase setup	0~ 268435456	EXSP	When using a serial absolute feedback scale, set the interval of output of phase Z as the number of output pulses (before quadruple) of phase A of the feedback scale. 0: Phase Z is output only when the workpiece is at point 0 of absolute position of the feedback scale. 1 - 268435456: Phase Z of the feedback scale is never output synchronously with phase A until the workpiece crosses point 0 of absolute position of the feedback scale for the first time after the control power supply of the drive is turned on. Then, Phase Z of the feedback scale is output at intervals of the phase A pulse that is set for this parameter.
6	22	A, B phase feedback scale pulse output method selection	0~1	–	Chooses a way of pulse regeneration of the ABZ parallel feedback scale. 0: Signals of the ABZ parallel feedback scale are directly output. 1: Signals of phase A and B from the ABZ parallel feedback scale are regenerated and output. * Signal of Z phase is always directly output from feedback scale.

The following table shows combinations of Pr0.11 " Numerator of pulse output division " and Pr5.03 "Denominator of pulse output division."

Pr0.11	Pr5.03	Pulse regeneration output processing
1~262144	1~262144	Feedback scale pulse [pulse] → [Set value of Pr0.11] / [Set value of Pr5.03] → Output pulse [pulse]

Details of Pr0.12 "Reversal of pulse output logic" are shown below.

Pr0.12	Ph B logic	Output source	For positive direction	For negative direction
0	Non-reversed	Feedback scale		
2				
1	Reverse	Feedback scale		
3				

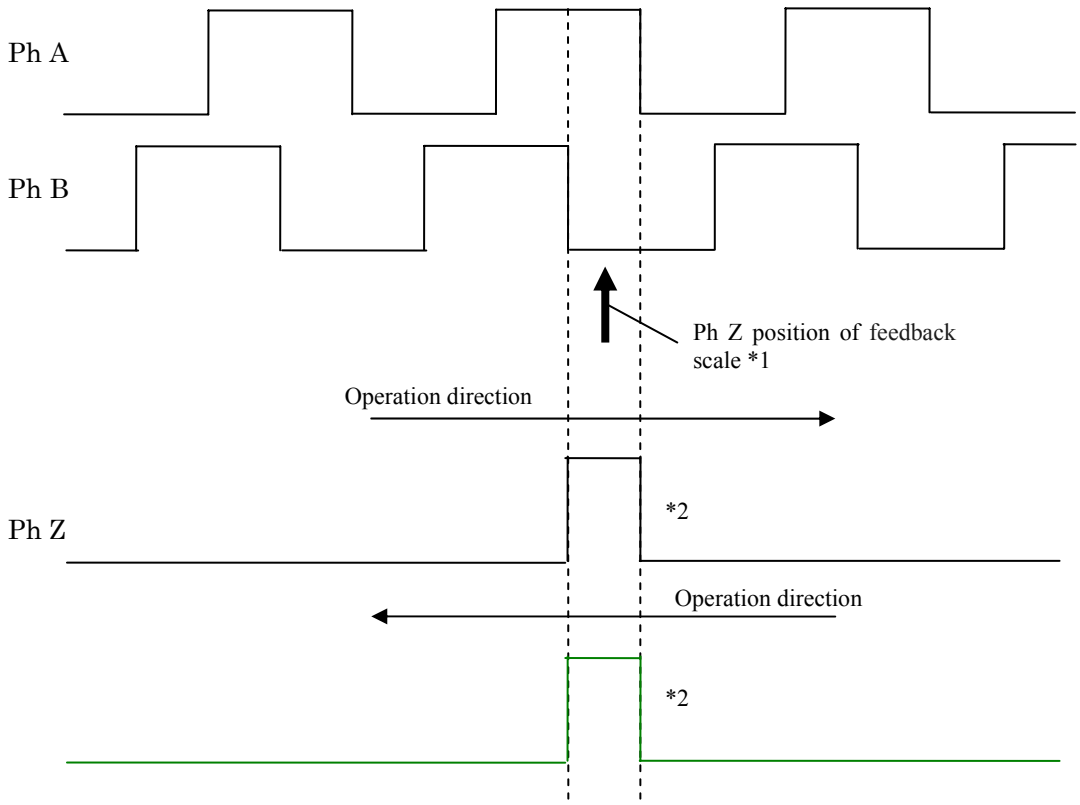
4-2-4-2 Pulse Regeneration of Feeback Scale

■ Serial absolute feeback scale

· Phase Z of the feeback scale is never output until the workpiece crosses point 0 of absolute position of the feeback scale for the first time after the control power supply of the drive is turned on. Phase Z is output at intervals of the phase A pulse set in Pr6.21 with point 0 of absolute position as a reference. Note that when Pr6.21 is set as 0, Phase Z is output only when the workpiece is at point 0 of absolute position of the feeback scale.

■ Serial incremental feeback scale (SR75, SR85 made by Magnescale Co.,Ltd.)

· Phase Z of the serial incremental feeback scale is directly output (not divided). Note that as shown in the following diagram, there are some differences according to the direction in which the workpiece has passed phase Z.



*1 The relationships between phase Z and phases A and B in position vary, depending on scale. The above diagram shows an example.

*2 Phase Z is regenerated for a pulse of original feedback scale. When the width is short, output time can be set longer in Pr6.20 "Z-phase setup of feedback scale".

*3 To use the Z phase as control signal, drop the speed below 15 Mpulse/s by using the feedback scale resolution standard (before the pulse scaling). When the speed is greater than or equal to 15 Mpulse/s, Z phase cannot be output correctly.

Example: When the feedback scale resolution is 0.1 μm, the speed [m/s] is as follows:
in case of 15 Mpulse/s:
15000000 [pulse/s]×0.1 μm = 1.5 m/s
Use the Z phase signals by dropping the speed to 1.5 m/s or less.

*4 When the power supply is turned on right above Z Phase, Z Phase is not output at a position as it is. It operates by one degree, and the scale side detects the edge of Z Phase and Z Phase is output.

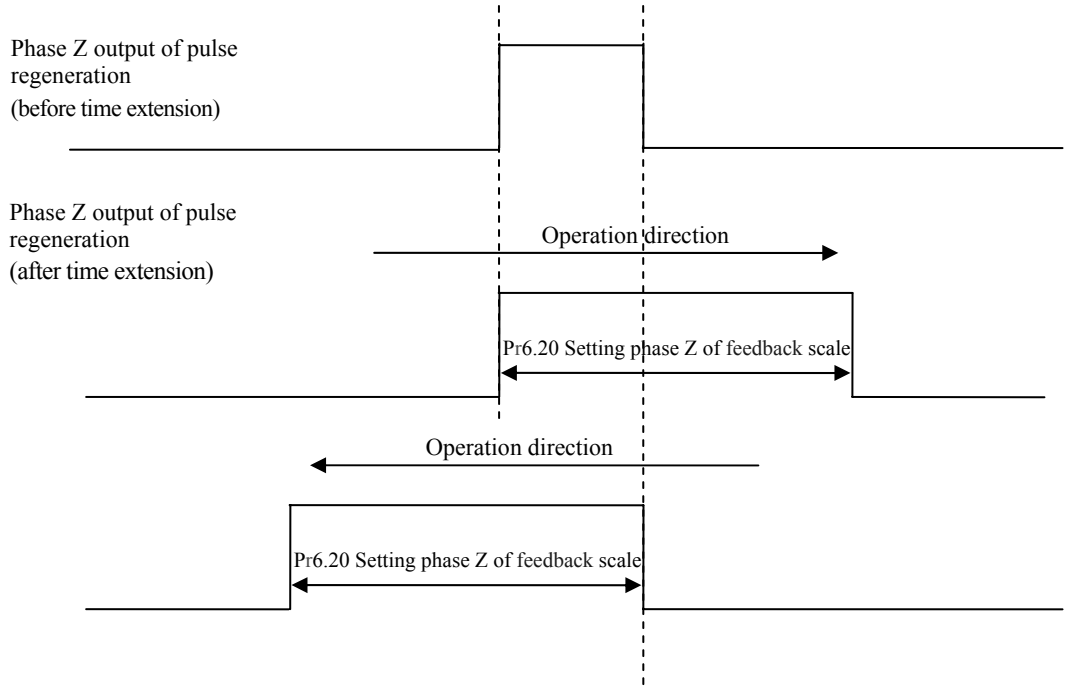
■ ABZ parallel feedback scale

· Phase Z directly outputs phase Z signals that are input using the ABZ parallel feedback scale. (Signals are not divided.)

· By setting Pr6.22 "A, B phase feedback scale pulse output method selection" as 1, signals of phases A and B can be taken into the drive and regenerated. Note that compared to setting Pr6.22 as 0, there is a delay in regenerating phases A and B signals.

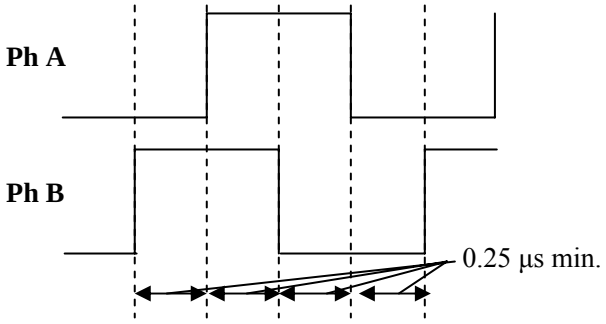
■ Items common to feedback scales

· In the event that width of the phase Z signal by travel from the feedback scale is too short to be detected, the phase Z signal is output for at least the period otherwise set in Pr6.20 "Z-phase setup of feedback scale". Note that output continues for the period counted from the rise of the phase Z signal, and accordingly width of the phase Z signal differs from the actual one. Also note that the direction of time extension varies depending on the operating direction as shown in the diagram below.



■ Notes on pulse regeneration function

· The maximum output frequency of pulse regeneration output is 4 Mpps (after multiplying by 4). Operation at a speed exceeding this may cause faulty functioning of regeneration leading to displacement.



By Pr5.33 "Pulse regenerative output limit setup", Err28.0 "Limit of pulse replay error protection" can be issued when reaching the limit of pulse regeneration. Note that this error message is issued by detecting the output limit of pulse regeneration, not using the maximum output frequency. The error message may be issued when frequency jumps instantaneously, depending on the rotational state of the motor such as operational fluctuation.

4-2-5 Counter Clear (CL)

This function allows the position deviation counter value in position control to be cleared to 0 by using a deviation counter clear input (CL).

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	17	Counter clear input mode	0~4	–	Selects the input mode of deviation counter clear input. 0: Invalid 1: Clear by level (without reading filter) 2: Clear by level (with reading filter) 3: Clear by edge (without reading filter) 4: Clear by edge (with reading filter)

For signal width and timing of deviation clear that need deviation counter clear input (CL), see the table below.

Pr5.17	CL signal width	Timing of clearing deviation
1	500 μs or longer	Continue to clear when the deviation counter clear input is ON*1.
2	1 ms min.	
3	100 μs or longer	Clear once at the edge*1 where the deviation counter clear input turns ON.
4	1 ms min.	

*1 The deviation counter clear input being OFF represents the input photocoupler being OFF, and the deviation counter clear input being ON represents the input photocoupler being ON.

4-2-6 In-position Output (INP)

Whether or not positioning has been completed can be checked with the In-position output (INP). This signal is turned on when the absolute value of the deviation counter value in position control is in the in-position range specified with the parameter. Settings such as including in the criteria whether or not a position command has been given are also available.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
4	31	Positioning complete (In-position) range	0~262144	Command unit	Set the threshold of position deviation that outputs the in-position signal (INP1). The unit is command by default, but it can be changed to encoder in Pr5.20 "Position setup unit select". Note that in that case, the unit of Pr0.14 "Position deviation excess setup" is also changed.
4	32	Positioning complete (In-position) output setup	0~4	—	Selects a condition to output the in-position signal (INP1). 0: The signal turns ON when the position deviation does not exceed Pr4.31 "Positioning complete (In-position) range". 1: The signal turns ON when there is no position command and the position deviation does not exceed Pr4.31 "Positioning complete (In-position) range". 2: The signal turns ON when there is no position command, the zero-speed detection signal is ON, and the position deviation does not exceed Pr4.31 "Positioning complete (In-position) range". 3: The signal turns ON when there is no position command and the position deviation does not exceed Pr4.31 "Positioning complete (In-position) range". Then, the signal remains turned ON until Pr4.33 "INP hold time" is over. After "INP hold time" is over, the INP output turns ON/OFF depending on the status of position command or position deviation. 4: The INP signal judgment begins after the delay time set with Pr4.33 passes from the change from command exist to none. the signal turns ON when there's no position command and the position deviation does not exceed Pr4.31.
4	33	INP hold time	0~30000	1 ms	Set the hold time for Pr4.32 "Positioning complete (In-position) output setup" being set as 3. 0: The hold time is infinite and the ON status is maintained until the next position command is given. 1 - 30000: The motor remains turned ON for the period set [ms]. Note that the motor is turned OFF when a position command is issued during the hold time. *At Pr4.32=4, this parameter becomes positioning judgment delay time. 0: The positioning judgment delay time becomes none, INP judgment begins immediately when position command is exit to none. 1 - 30000: The judgement delay for the set in [ms]. Note that when a position command is issued during the delay time the delay time becomes 0 and count-up again from position command is stopped.
4	42	2nd Positioning complete (In-position) range	0~262144	Command unit	Set the threshold of position deviation that outputs the in-position signal 2 (INP2). INP2 turns ON whenever the position deviation does not exceed the value set in this setting, regardless of Pr4.32 "Positioning complete (In-position) output setup". (The presence/absence of a position command is irrelevant.) The unit is command by default, but it can be changed to feedback scale in Pr5.20 "Position setup unit select". Note that in that case, the unit of Pr0.14 "Position deviation excess setup" is also changed.

· The presence/absence of a position command is judged by a command issued after the position command filter. For the position command filter, see Section 4-2-3 "Position Command Filter."

Note) In case of Pr9.20 " Magnetic poles detection method selection " =2(Magnetic poles position estimation method) and bit7=1 of Pr6.10 "Function expansion setup", both in-position signals 1(INP1) and in-position signals 2(INP2) are compulsorily turned off until the magnetic pole position estimation is completed.

4-2-7 Command Pulse Inhibition (INH)

The command pulse inhibition input signal (INH) can be used to force the command pulse input processing to stop. Turning the INH input on forces the servo drive to ignore the command pulse input and the pulse counting does not take place.

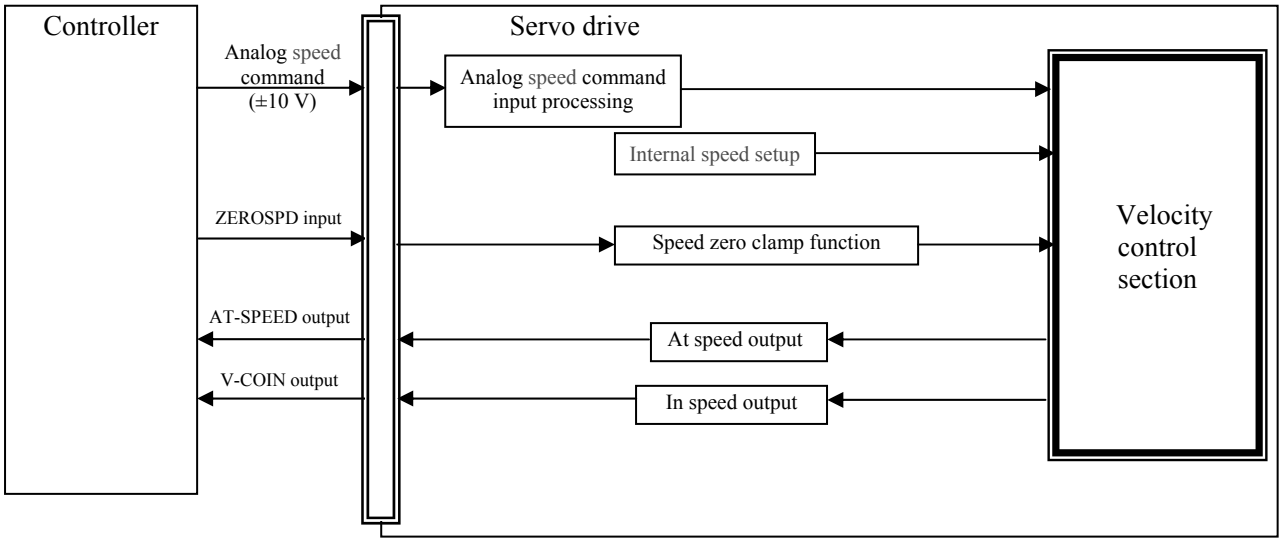
This function is disabled by the factory setting. Before use, change the setting of Pr5.18 "Invalidation of command pulse inhibit input".

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	18	Invalidation of command pulse inhibit input	0~1	–	Enables/disables the command pulse inhibition input. 0: Enable 1: Disable
5	19	Command pulse inhibit input reading setup	0~4	–	Selects the cycle of reading the signal of command pulse inhibition input. Updates the status of signal when it is periodically read and found the same twice or more. 0: 0.166 ms 1: 0.333 ms 2: 1 ms 3: 1.666 ms 4: 0.166 ms (when the signal is found the same twice or more) A prolonged cycle of reading decreases the likelihood of misoperation caused by noise, but it also reduces responsiveness to signal input.

4-3 Speed Control

The velocity is controlled based on an analog speed command input from the controller or preset speed command configured in the servo drive.



4-3-1 Speed Control by Analog Speed Command [LA1] is not possible to use it.

An analog speed command input (in voltage) is subjected to A/D conversion so that it can be captured as a digital value, which is in turn converted into a speed command value. This control allows noise filtering setting and offset adjustment.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	00	Speed setup, Internal/External switching	0~3	–	Selects the speed command input type in the velocity control mode. 0: Analog speed command (SPR) 1: Internal speed setup 1 - 4 2: Internal speed setup 1 - 3, Analog speed command (SPR) 3: Internal speed setup 1 - 8
3	01	Speed command rotational direction selection	0~1	–	Specifies the method of specification of the positive/negative direction of a speed command. 0: Specifies the direction with the sign of a speed command. Ex.) Speed command input "+": positive / "–": negative 1: Specifies the direction with the speed command sign (VC-SIGN) setting. OFF: positive / ON: negative
3	02	Input gain of speed command	10~2000	(mm/s) /V	Sets the gain for converting from the voltage applied to the analog speed command (SPR) to the motor command speed.
3	03	Reversal of speed command input	0~1	–	Specifies the polarity of the voltage applied to the analog speed command (SPR). 0: Non-reversed "+ voltage": positive direction / "– voltage": negative direction 1: Reversed "+ voltage": negative direction / "– voltage": positive direction
4	22	Analog input 1 (AI1) offset setup	-5578~ 5578	0.359 mV	Specifies the offset for the voltage applied to the analog input 1.
4	23	Analog input 1 (AI1) filter	0~6400	0.01 ms	To set up the time constant of the 1st delay filter for the voltage applied to the analog input 1.

The table below shows the relationship between the operation direction of the motor and combinations of parameter Pr3.00 "Speed setup, Internal/External switching," Pr3.01 "Speed command rotational direction selection", Pr3.03 "Reversal of speed command input", analog speed command (SPR) of I/F connectors, and selection of speed command sign (VC-SIGN), in addition to corresponding charts of conversion from input voltage of analog speed command to speed command.

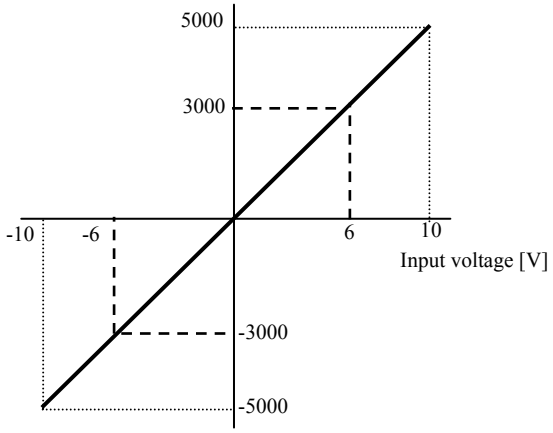
Pr3.00	Pr3.01	Pr3.03	Analog speed command (SPR)	Speed command sign (VC-SIGN)	Direction of motor operation	Conversion graph
0	0	0	+ voltage (0~10 V)	No effect	Positive	(a)
			- voltage (-10~0 V)	No effect	Negative	
		1	+ voltage (0~10 V)	No effect	Negative	(b)
			- voltage (-10~0 V)	No effect	Positive	
	1	No effect	+ voltage (0~10 V)	OFF	Positive	(c)
			- voltage (-10~0 V)			
			+ voltage (0~10 V)	ON	Negative	
			- voltage (-10~0 V)			

The conversion from an analog speed command input voltage [V] to a speed command to the motor [mm/s] can be in one of the three patterns shown in the "Conversion graph" column (a), (b) and (c), which are described below.

The slope in the chart is in the case where Pr3.02 is set as 500. The slope depends on the setting of Pr3.02.

Speed command [mm/s] = Pr3.02 setting × Input voltage [V]

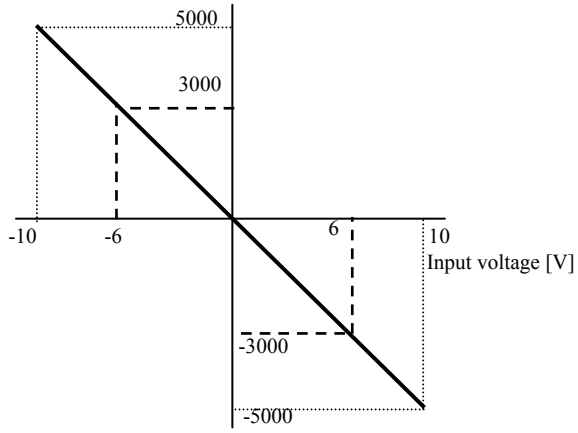
Speed command [mm/s]



Conversion (a)

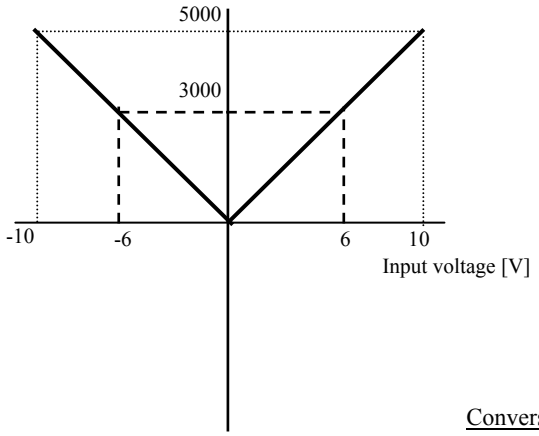
Speed command [mm/s] = – (Pr3.02 setting × Input voltage [V])

Speed command[mm/s]



Conversion (b)

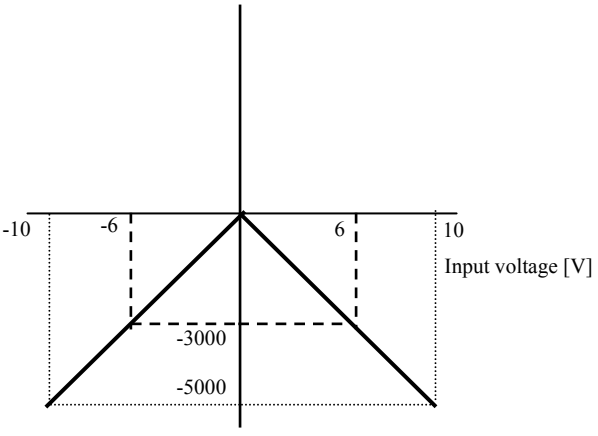
Speed command [mm/s]



VC-SIGN OFF

Conversion (c)

Speed command [mm/s]



VC-SIGN ON

4-3-2 Speed Control by Internal Speed Command

The velocity can be controlled according to the internal speed setup specified with a parameter. Using Input internal speed selection 1 - 3 (INTSPD1 - 3) allows selection of a speed out of up to 8 internal speed setup. The factory setting uses an analog speed command. Switch to internal speed using Pr3.00 "Speed setup, Internal/External switching".

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	00	Speed setup, Internal/External switching	0~3	–	Selects the velocity command input type in the velocity control mode. 0: Analog velocity command (SPR) 1: 1st – 4th speed of speed setup 2: 1st – 3rd speed of speed setup, Analog velocity command (SPR) 3: 1st – 8th speed of speed setup
3	01	Speed command operational direction selection	0~1	–	Specifies the method of specification of the positive/negative direction of a velocity command. 0: Specifies the direction with the sign of a velocity command. Ex.) Velocity command input "+": positive / "–": negative 1: Specifies the direction with the velocity command sign (VC-SIGN) setting.
3	04	1st speed of speed setup	-20000~ 20000	mm/s	Specifies the 1st speed.
3	05	2nd speed of speed setup			Specifies the 2nd speed .
3	06	3rd speed of speed setup			Specifies the 3rd speed .
3	07	4th speed of speed setup			Specifies the 4th speed.
3	08	5th speed of speed setup			Specifies the 5th speed .
3	09	6th speed of speed setup			Specifies the 6th speed.
3	10	7th speed of speed setup			Specifies the 7th speed .
3	11	8th speed of speed setup			Specifies the 8th speed .

· The relationship among Pr3.00 "Speed setup, Internal/External switching", states of speed setup 1 - 3, and selected speed command

Pr3.00	1st speed of speed setup (INTSPD1)	2nd speed of speed setup (INTSPD2)	3rd speed of speed setup (INTSPD3)	Speed command
1	OFF	OFF	No effect	Speed setup 1
	ON	OFF		Speed setup 2
	OFF	ON		Speed setup 3
	ON	ON		Speed setup 4
2	OFF	OFF	No effect	Speed setup 1
	ON	OFF		Speed setup 2
	OFF	ON		Speed setup 3
	ON	ON		Analog speed command
3	The same as Pr3.00 being set as 1		OFF	Speed setup 1 - 4
	OFF	OFF	ON	Speed setup 5
	ON	OFF	ON	Speed setup 6
	OFF	ON	ON	Speed setup 7
	ON	ON	ON	Speed setup 8

· The relationship between the setting of Pr3.01 "Speed command rotational direction selection" and the direction of speed command

Pr3.01	Internal speed setup (Speed 1 - 8)	Speed command sign (VC-SIGN) setting	Speed command direction
0	+	No effect	Positive
	–	No effect	Negative
1	Sign has no effect	OFF	Positive
	Sign has no effect	ON	Negative

4-3-3 Speed Zero Clamp (ZEROSPD)

Speed zero clamp can be used to force a speed command to 0.

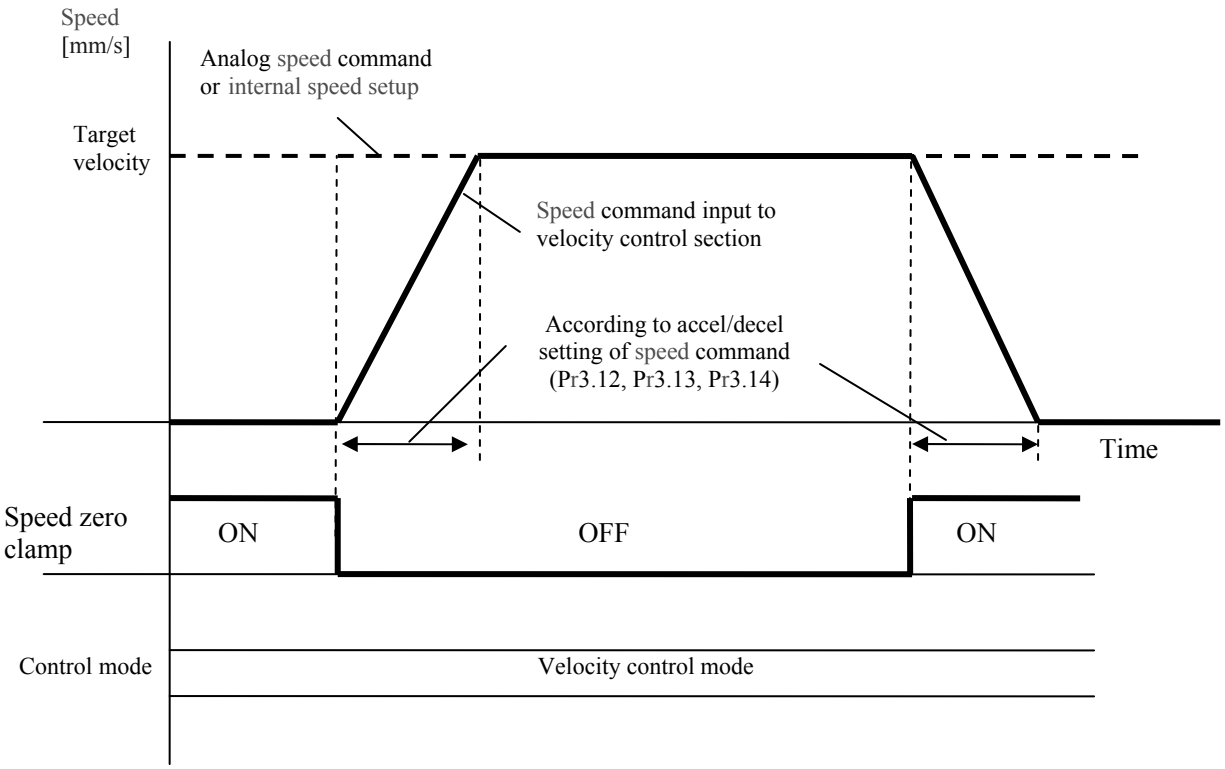
■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	15	Speed zero-clamp function selection	0~3	–	Configures settings for the speed zero clamp functions. 0: Disabled; speed zero clamp is ignored. 1: When the speed zero clamp is input, the speed command is 0. 2: When the speed zero clamp is input, the speed command is 0. At this time, if the actual speed does not exceed the setting of Pr3.16 "Speed zero clamp level", the motor is locked by position control. 3: When the speed zero clamp is input and the speed command does not exceed the setting of Pr3.16 "Speed zero clamp level", the motor is locked by position control.
3	16	Speed zero clamp level	10~20000	mm/s	Set the threshold to switch to the position control where Pr3.15 "Speed zero-clamp function selection" was set as 2 or 3. When Pr3.15 is set as 3, detection presents hysteresis of 10 mm/s.

· When Pr3.15 "Speed zero-clamp function selection" is set as 1

When the speed zero clamp (ZEROSPD) signal is input, the speed command is forced to be 0. To give a trapezoidal speed command, for example, the speed zero clamp signal can be turned on and an analog speed command or internal speed setup can be used to input the target velocity of the trapezoidal wave. Then, turning the zero clamp signal from on to off accelerates the speed command to the At-speed level and turning the signal from off to on decelerates the speed command to 0. Accordingly, turning the zero clamp signal on/off allows a speed command with acceleration/deceleration to be easily issued with a certain value specified as a speed command maintained.

Note that acceleration and deceleration can be set by Pr3.12 "Acceleration time setup", Pr3.13 "Deceleration time setup", and Pr3.14 "Sigmoid acceleration/ deceleration time setup". Note that all parameters are set as 0 by default, and therefore the speed command changes step-by-step.

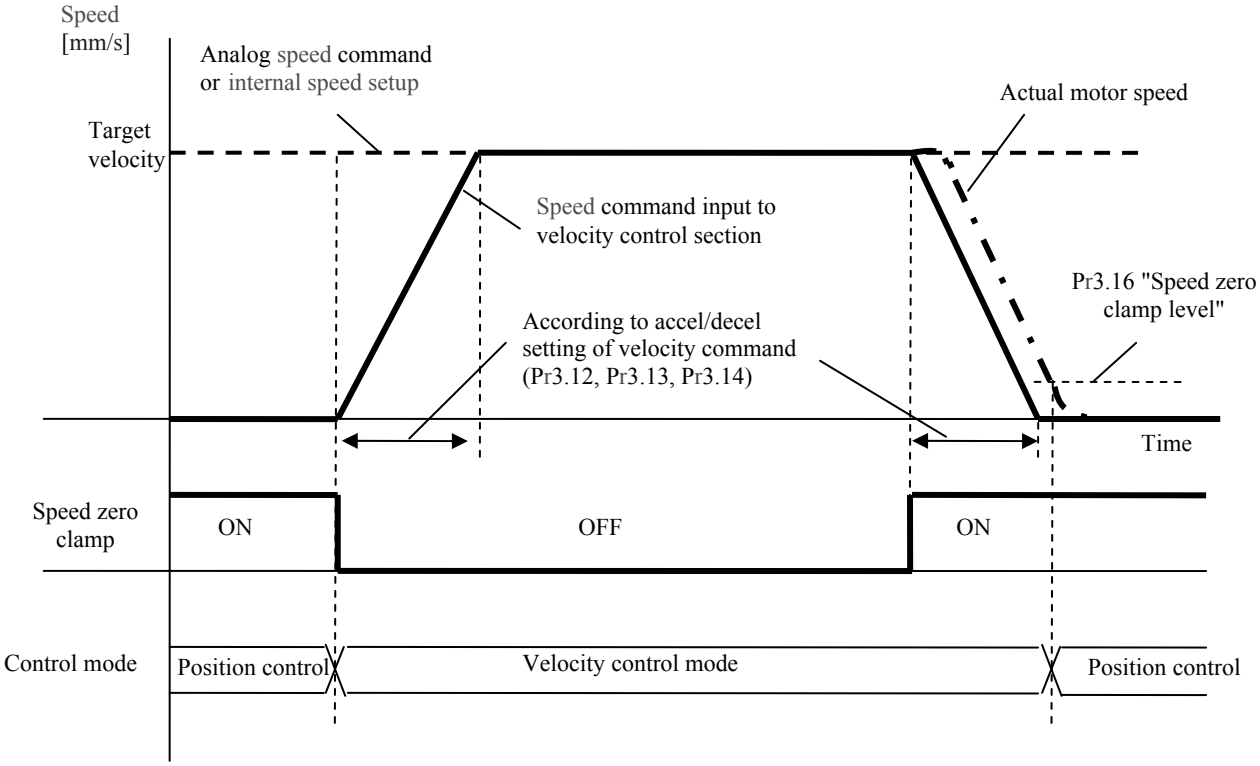


Note) Default setting of speed zero clamp signal is b-connect, “ON” signal in the above figure means input optocoupler is OFF, “OFF” signal means optocoupler is ON.

· When Pr3.15 "Speed zero-clamp function selection" is set as 2

The speed command is compulsorily changed to 0 when the speed zero clamp (ZEROSPD) input signal is ON. At this time, the motor is in the position control mode and servo-locked at the current position when the actual speed of the motor does not exceed the setting of Pr3.16 "Speed zero clamp level." The basic operation other than switching to position control is the same as with setting 1.

The shift from the speed control mode to the position control mode happens, as described above, when the speed zero clamp (ZEROSPD) input signal is ON and the actual speed of the motor does not exceed the setting of Pr3.16 "Speed zero clamp level." The shift from the position control mode to the speed control mode happens when the speed zero clamp (ZEROSPD) input signal is OFF. Once the motor is servo-locked in the position control mode, it remains locked while the speed zero clamp (ZEROSPD) remains ON, even if the actual speed exceeds the setting of Pr3.16 "Speed zero clamp level" by external force.

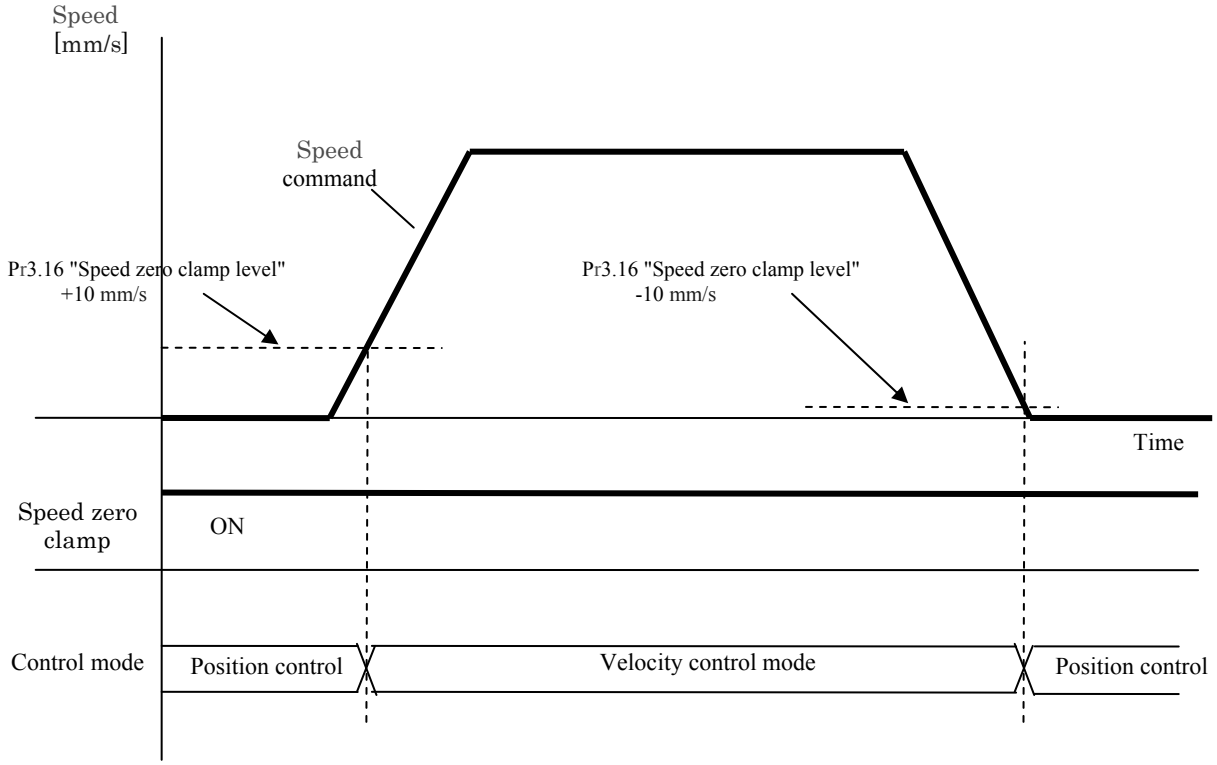


Note) The position command in position control as shown in the figure above is forced to be 0.
It operates as the normal position control during the position control. Properly set the position loop gain and various error detection functions. However, the control input signal is allocated according to the speed control.

Note) Set Pr0.01 "Control mode setup" as 1 (velocity control).
When simultaneously using the control mode switching in Pr0.01=3 or 4, the function may not operate normally.

· When Pr3.15 "Speed zero-clamp function selection" is set as 3

The motor is shifted to the position control mode and is servo-locked at the current position when the speed zero clamp (ZEROSPD) input signal is ON and the speed command does not exceed (the setting of Pr3.16 "Speed zero clamp level" - 10 r/min.). In this mode, the speed command is not forced to be 0 when the speed zero clamp (ZEROSPD) signal is input and the speed command must be varied.



Note) The position command in position control as shown in the figure above is forced to be 0.
It operates as the normal position control during the position control. Properly set the position loop gain and various error detection functions. However, the control input signal is allocated according to the speed control.

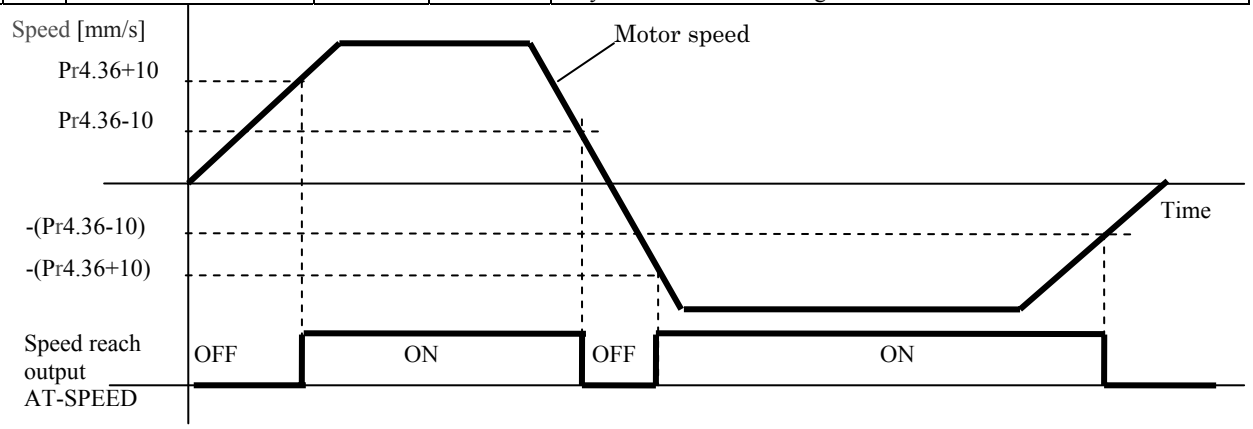
Note) Set Pr0.01 "Control mode setup" as 1 (velocity control).
When simultaneously using the control mode switching in Pr0.01=3 or 4, the function may not operate

4-3-4 Speed Reach Output (AT-SPEED)

The speed reach output (AT-SPEED) signal is output when the motor speed has reached the setting of Pr4.36 "At-speed."

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
4	36	At-speed (Speed arrival)	10~20000	mm/s	To set the threshold to detect the speed reach output (AT-SPEED). The speed reach output (AT-SPEED) is output when the motor speed has exceeded this setting. A hysteresis of 10 r/min is given for the detection.

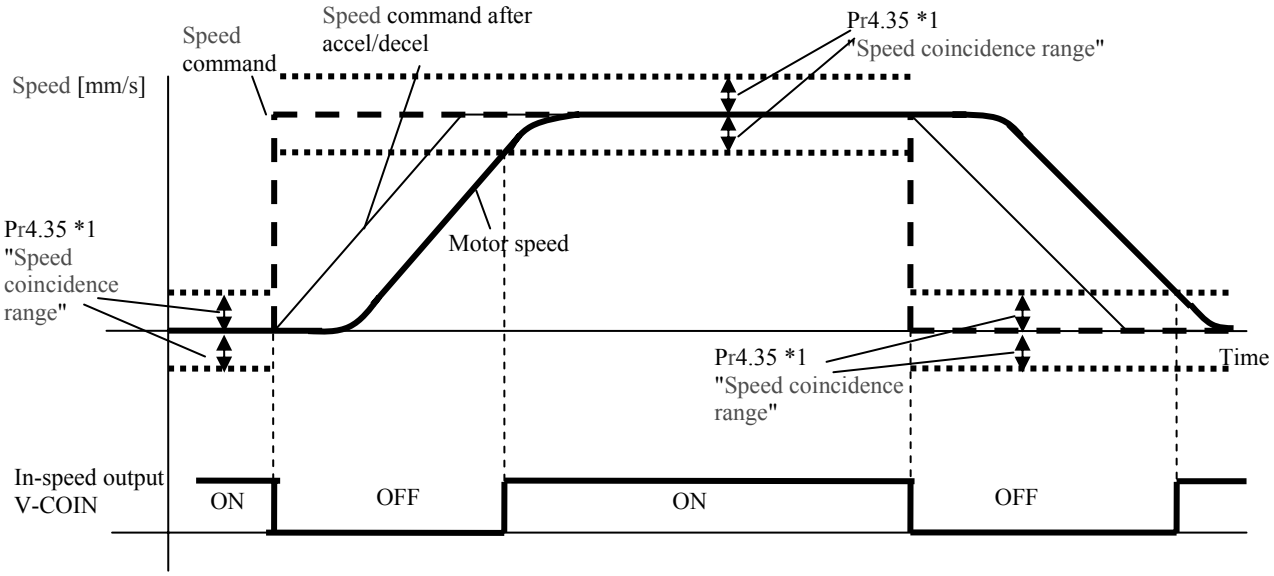


4-3-5 In-speed Output (V-COIN)

This signal is output when the speed command (before acceleration/deceleration) and the motor speed coincide with each other. The motor speed is judged as identical to the setting when the difference between the speed command before acceleration in the drive and the motor speed does not exceed the setting of Pr.4.35 "Speed coincidence range".

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
4	35	Speed coincidence range	10~20000	mm/s	Set the detection threshold of in-speed output (V-COIN). In-speed output (V-COIN) is output when the difference between the speed command and the motor speed does not exceed the setting of this parameter. A hysteresis of 10 mm/s is given to detection.



*1 A hysteresis of 10 mm/s is given for the in-speed detection and the actual detection width is as follows:
Threshold when in-speed output is turned ON: (Pr4.35-10) mm/s.
Threshold when in-speed output is turned OFF: (Pr4.35+10) mm/s.

4-3-6 Speed Command Acceleration/Deceleration Setting

For a speed command input, acceleration/deceleration can be internally added to use it as a speed command for velocity control.

This allows soft start for a step-shaped speed command or use with a internal speed setup. To reduce any shock due to acceleration variation, S-curve acceleration/deceleration function can be used.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	12	Acceleration time setup	0~10000	ms/ (1000 mm/s)	Sets the acceleration time for the speed command.
3	13	Deceleration time setup	0~10000	ms/ (1000 mm/s)	Sets the deceleration time for the speed command.
3	14	Sigmoid acceleration/ deceleration time setup	0~1000	ms	Sets the S-curve accel/decel time for the speed command.

Note) If a position loop is configured outside the drive, do not use the acceleration/deceleration time. Set 0 for the three above.

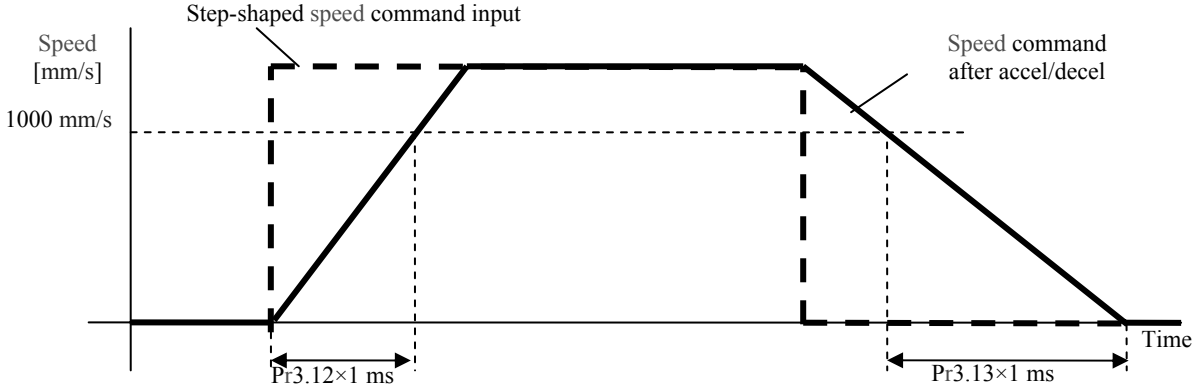
· Pr3.12 "Acceleration time setup" and Pr3.13 "Deceleration time setup"

Set Pr3.12 "Acceleration time setup" as the time that the speed command reaches 1000 mm/s. when a step-type speed command is input. Set Pr3.13 "Deceleration time setup" as the time that the speed command decreases from 1000 mm/s. to 0 mm/s.

When the target of the velocity command is represented as Vc [mm/s], the acceleration/deceleration time required can be calculated by using the equations below.

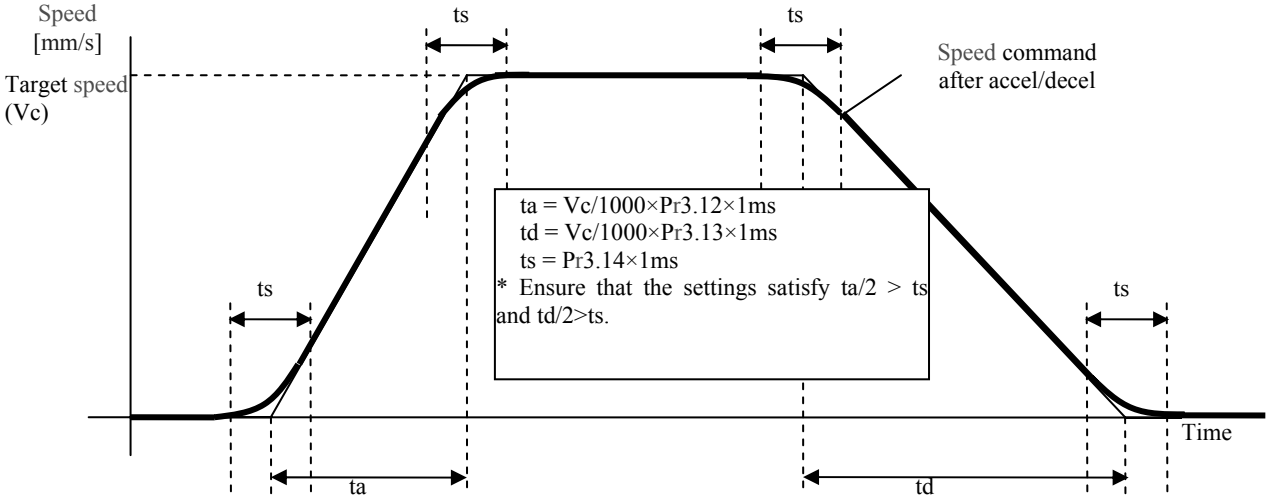
Acceleration time [ms] = Vc/1000 × Pr3.12 × 1 ms

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



· Pr3.14 "Sigmoid acceleration/ deceleration time setup"

Set the time of the S-curve as a time range with the inflection point of acceleration/deceleration made by the settings of Pr3.12 "Acceleration time setup" and Pr3.13 "Deceleration time setup" as its center.



4-4 Thrust Control [LA1] is not possible to use it.

The thrust is controlled based on the thrust command specified by an analog voltage. Thrust control requires a speed limit in addition to a thrust command, which controls to maintain the motor operation speed under the speed limit.

The A5 series provides two modes that are different from each other in issuing the thrust command and the speed limit. The differences are as shown in the table below.

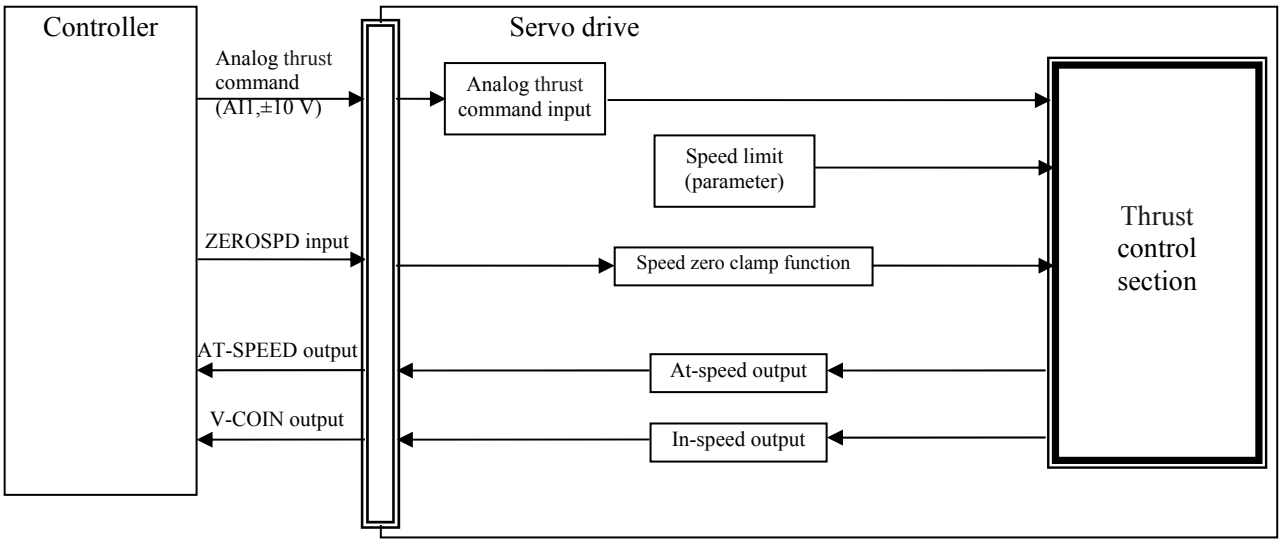
Selection of thrust command (Pr3.17)	Thrust command input	Speed limit input
0	Analog input 1 *1 (AI1; resolution: 16 bits)	Parameter value (Pr3.21)
1	Analog input 2 (AI2; resolution: 12 bits)	Analog input 1 (AI1; resolution: 16 bits)
2	Analog input 1 *1 (AI1; resolution: 16 bits)	Parameter value (Pr3.21, 3.22)

*1 When Pr0.01 "Control mode setup" is set as 5 (speed/ thrust control), the thrust command input is analog input 2 (AI2 with 12-bit resolution).

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	17	Selection of thrust command	0~2	–	Specifies how the thrust command and speed limit are input. 0: Thrust command selection 1 Thrust command: analog input 1 / Speed limit: 1 parameter 1: Thrust command selection 2 Thrust command: analog input 2 / Speed limit: analog input 1 2: Thrust command selection 3 Thrust command: analog input 1 / Speed limit: 2 parameters

4-4-1 Selection of Thrust Command 1&3 (Pr3.17=0, 2) [LA1] is not possible to use it.



* For the speed zero clamp function, see Section 4-4-1-2 “Speed Limit.”

The at-speed and in-speed outputs are the same as those in the velocity control mode.

4-4-1-1 Analog Thrust Command Input [LA1] is not possible to use it.

An analog thrust command input (voltage) is subjected to A/D conversion so that it can be captured as a digital value, which is in turn converted into a thrust command value. This control allows noise filtering setting and offset adjustment.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	18	Thrust command direction selection	0~1	—	Selects the method of specification of the positive/negative direction of a thrust command. 0: Specifies the direction with the sign of a thrust command. Ex.) Thrust command input "+": positive / "–": negative 1: Specifies the direction with the thrust command sign (TC-SIGN) setting. OFF: positive / ON: negative
3	19	Input gain of thrust command	10~100	0.1 V /100%	Sets the gain for converting from the voltage [V] applied to the analog thrust command (TRQR) to the thrust command [%]. Ex.) For setting the rated thrust (100%) for an input of 1 V, the setting = 10.
3	20	Input reversal of thrust command	0~1	—	Specifies the polarity of the voltage applied to the analog thrust command (TRQR). 0: Non-reversed "+ voltage": positive direction / "– voltage": negative direction 1: Reversed "+ voltage": negative direction / "– voltage": positive direction
4	22	Analog input 1 (AI1) Offset setting *1	-5578~ 5578	0.359 mV	Specifies the offset for the voltage applied to the analog input 1.
4	23	Analog input1 (AI1) Filter settings *1	0~6400	0.01 ms	To set up the time constant of the 1st delay filter for the voltage applied to the analog input 1.

*1 When Pr0.01 "Control mode setup" is set as 5 (speed/thrust control), the thrust command input is analog input 2 (AI2). Set Pr4.25 "Analog input 2 (AI2) offset setup" and Pr4.26 "Analog input 2 (AI2) filter".

The table below shows the relationship between the operation direction of the motor and combinations of parameter Pr3.17 "Selection of thrust command," Pr3.18 "Thrust command direction selection", Pr3.20 "Input reversal of thrust command", analog thrust command (TRQR) of I/F connectors, and selection of thrust command sign (TC-SIGN), in addition to corresponding charts of conversion from input voltage of analog thrust commands to thrust commands.

Pr3.17	Pr3.18	Pr3.20	Analog thrust command (TRQR)	Selection of thrust command sign (TC-SIGN)	Direction of motor operation	Conversion graph
0	0	0	+ voltage (0~10 V)	No effect	Positive	(a)
			- voltage (-10~0 V)	No effect	Negative	
		1	+ voltage (0~10 V)	No effect	Negative	(b)
			- voltage (-10~0 V)	No effect	Positive	
	1	No effect	+ voltage (0~10 V)	OFF	Positive	(c)
			- voltage (-10~0 V)			
			+ voltage (0~10 V)	ON	Negative	
			- voltage (-10~0 V)			

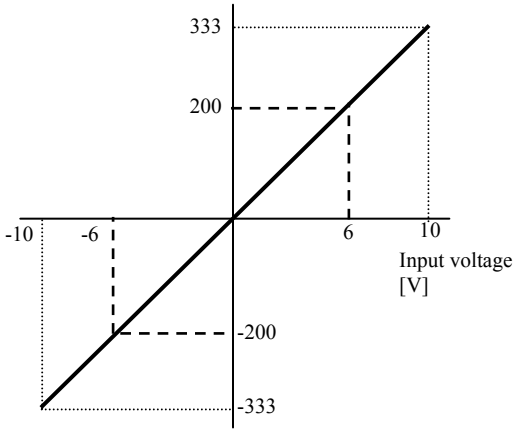
The conversion from an analog thrust command input voltage [V] to a thrust command to the motor [%] can be in one of the three patterns shown in the "Conversion graph" column (a), (b) and (c), which are described below.

The slope of charts is in the case where Pr3.19 is set as 30. The slope depends on the setting of Pr3.19.

Thrust command [%] =
100 × Input voltage [V] / (Setting of Pr3.19 × 0.1)

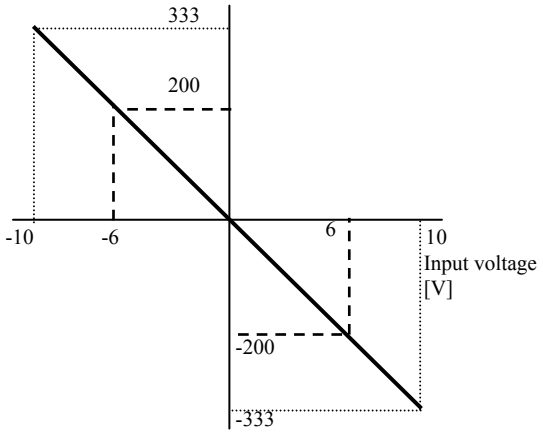
Thrust command [%] =
- (100 × Input voltage [V] / (Setting of Pr3.19 × 0.1))

Thrust command [%]



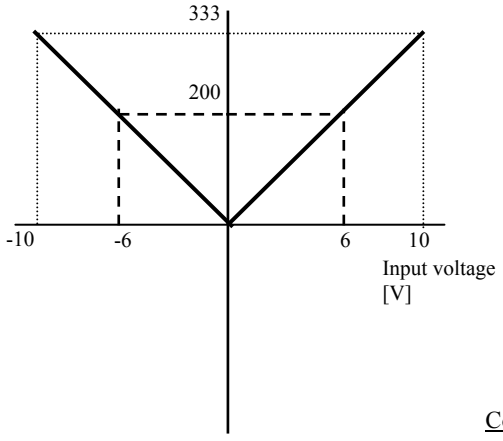
Conversion (a)

Thrust command [%]



Conversion (b)

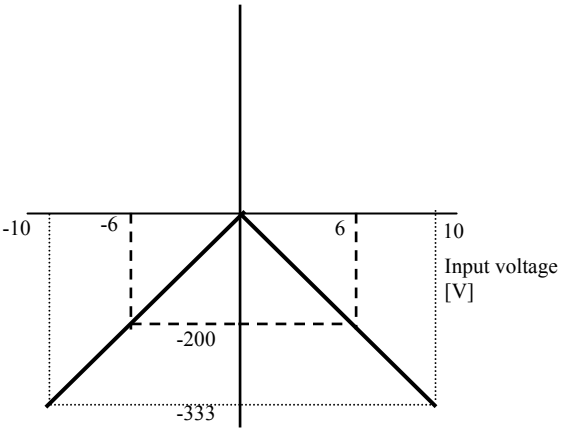
Thrust command [%]



TC-SIGN OFF

Conversion (c)

Thrust command [%]



TC-SIGN ON

4-4-1-2 Speed Limit [LA1] is not possible to use it.

Speed limiting is provided as a means of protection in thrust control.
Operation is controlled to maintain the speed under the speed limit in the thrust control mode.
Note) While operation is under the speed limit control, the thrust command to the motor may not follow the analog thrust command. The thrust command to the motor is the result of control to maintain the motor speed to under the speed limit.

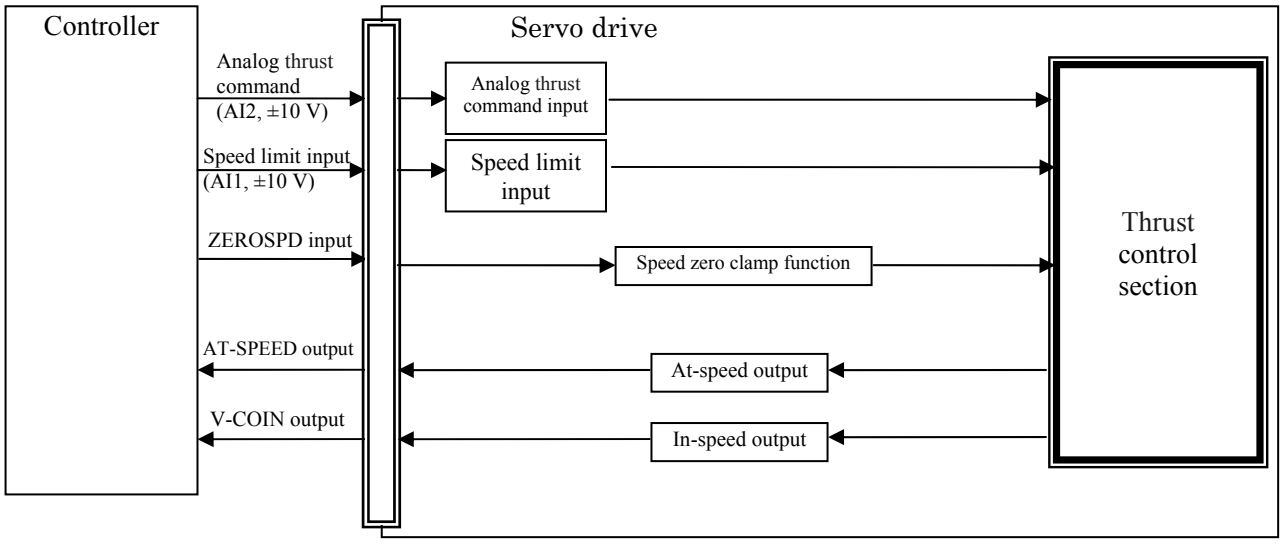
■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	21	Speed limit value 1	0~20000	mm/s	Specifies the speed limit in the thrust control mode. Control is given to maintain the speed under the speed limit in thrust control. Is identical to the speed limit of positive commands with Pr3.17 set as 2.
3	22	Speed limit value 2	0~20000	mm/s	Is identical to the speed limit of negative commands with Pr3.17 set as 2.
3	15	Speed zero-clamp function selection	0~3	–	Configures settings for the speed zero clamp functions. 0: Disabled; speed zero clamp is ignored. 1 - 3: When the speed zero clamp is input, speed limit = 0.

The table below shows combinations of Pr3.17 "Selection of thrust command," Pr3.21 "Speed limit value 1", Pr3.22 "Speed limit value 2", Pr3.15 "Speed zero-clamp function selection", the speed zero clamp input (ZEROSPD), and the direction of analog thrust command, in addition applicable speed limits.

Pr3.17	Pr3.21	Pr3.22	Pr3.15	Speed zero clamp (ZEROSPD)	Analog thrust command direction	Speed limit
0	0~20000	No effect	0	No effect	No effect	Set value of Pr3.21
			1~3	OFF		Set value of Pr3.21
				ON		0
2	0~20000	0~20000	0	No effect	Positive	Set value of Pr3.21
					Negative	Set value of Pr3.22
	0~20000	1~20000	1~3	OFF	Positive	Set value of Pr3.21
					Negative	Set value of Pr3.22
	0~20000	1~20000	1~3	ON	No effect	0

4-4-2 Selection of Thrust Command 2 (Pr3.17 = 1) [LA1] is not possible to use it.



* For the speed zero clamp function, see Section 4-4-2-2 Speed Limit.
The at-speed and in-speed outputs are the same as those in the velocity control mode.

4-4-2-1 Analog Thrust Command Input [LA1] is not possible to use it.

An analog thrust command input (voltage) is subjected to A/D conversion so that it can be captured as a digital value, which is in turn converted into a thrust command value. This control allows noise filtering setting and offset adjustment.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	18	Thrust command direction selection	0~1	–	Selects the method of specification of the positive/negative direction of a thrust command. 0: Specifies the direction with the sign of a thrust command. Ex.) Thrust command input "+": positive / "–": negative 1: Specifies the direction with the thrust command sign (TC-SIGN) setting. OFF: positive / ON: negative
3	19	Input gain of thrust command	10~100	0.1V /100%	Sets the gain for converting from the voltage [V] applied to the analog thrust command (TRQR) to the thrust command [%]. Example: To reach rated thrust (100%) when input voltage is 1 V, the set value is 10.
3	20	Input reversal of thrust command	0~1	–	Specifies the polarity of the voltage applied to the analog thrust command (TRQR). 0: Non-reversed "+ voltage": positive direction / "– voltage": negative direction 1: Reversed "+ voltage": negative direction / "– voltage": positive direction
4	25	Analog input 2 (AI2) offset setting	-342~342	5.86mV	Specifies the offset for the voltage applied to analog input 2.
4	26	Analog input 2 (AI2) filter setting	0~6400	0.01ms	To set up the time constant of the 1st delay filter for the voltage applied to the analog input 2.

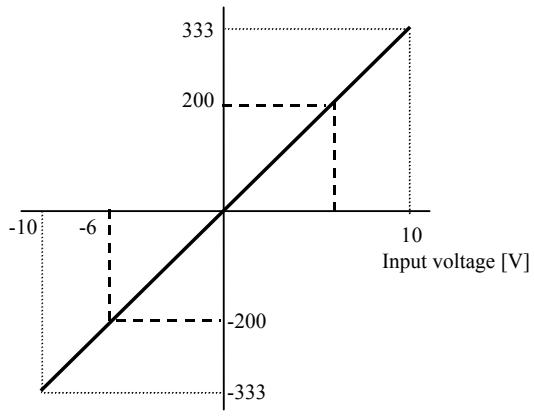
The table below shows the relationship between the opertion direction of the motor and combinations of parameter Pr3.17 "Selection of thrust command," Pr3.18 "Thrust command direction selection", Pr3.20 "Input reversal of thrust command", analog thrust command (TRQR) of I/F connectors, and selection of thrust command sign (TC-SIGN), in addition to corresponding charts of conversion from input voltage of analog thrust commands to thrust commands.

Pr3.17	Pr3.18	Pr3.20	Analog thrust command (TRQR)	Selection of thrust command sign (TC-SIGN)	Direction of motor operation	Conversion graph
0	0	0	+ voltage (0 ~ 10 V)	No effect	Positive	(a)
			- voltage (-10 ~ 0 V)	No effect	Negative	
		1	+ voltage (0 ~ 10 V)	No effect	Negative	(b)
			- voltage (-10 ~ 0 V)	No effect	Positive	
	1	No effect	+ voltage (0 ~ 10 V)	OFF	Positive	(c)
			- voltage (-10 ~ 0 V)			
			+ voltage (0 ~ 10 V)	ON	Negative	
			- voltage (-10 ~ 0 V)			

The conversion from an analog thrust command input voltage [V] to a thrust command to the motor [%] can be in one of the three patterns shown in the "Conversion graph" column (a), (b) and (c), which are described below.
The slope of charts is in the case where Pr3.19 is set as 30. The slope depends on the setting of Pr3.19.

Thrust command [%] =
100 × Input voltage [V] / (Setting of Pr3.19 × 0.1)

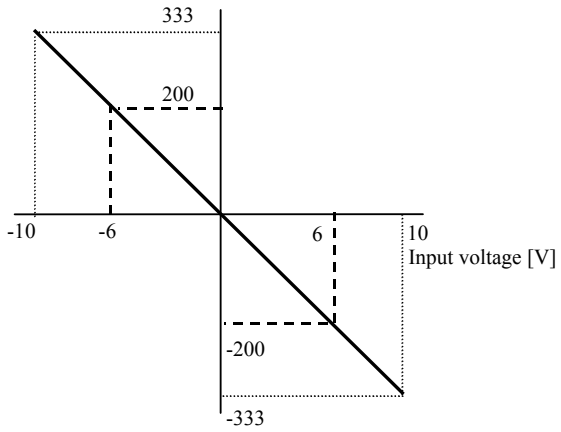
Thrust command [%]



Conversion (a)

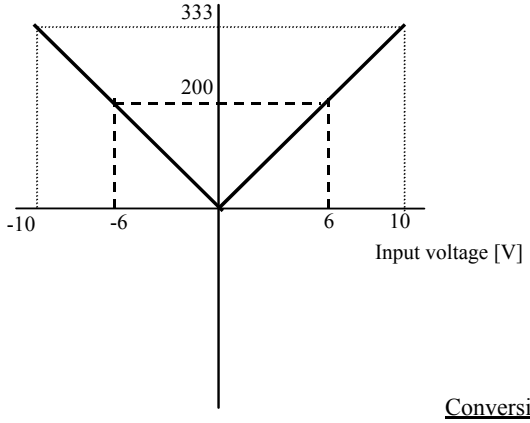
Thrust command [%] =
- (100 × Input voltage [V] / (Setting of Pr3.19 ×0.1))

Thrust command [%]



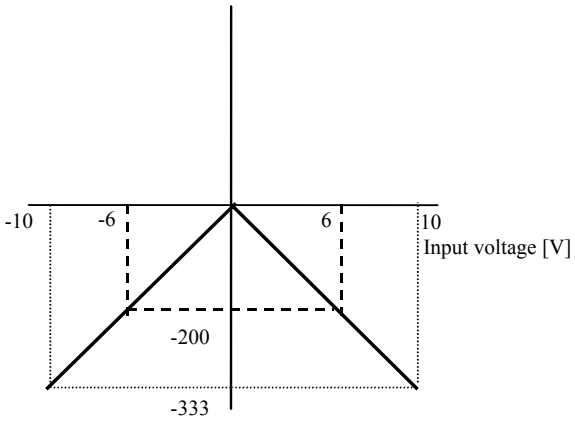
Conversion (b)

Thrust command [%]



TC-SIGN OFF

Thrust command [%]



TC-SIGN ON

Conversion (c)

4-4-2-2 Speed Limit [LA1] is not possible to use it.

Speed limiting is provided as a means of protection in thrust control. Operation is controlled to maintain the speed under the speed limit in the thrust control mode. When Pr3.17 "Selection of thrust command" is set as 1, use analog input 1 to input the speed limit.

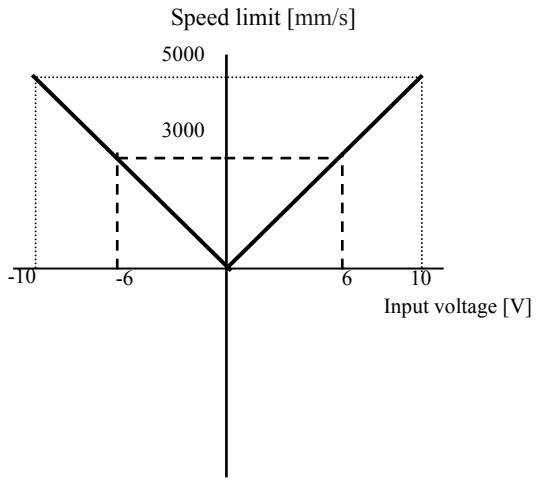
Note) While operation is under the speed limit control, the thrust command to the motor may not follow the analog thrust command. The thrust command to the motor is the result of control to maintain the motor speed to under the speed limit.

■ Related parameters

Category	No.	Parameter	Setup range	Unit	Function
3	02	Input gain of speed command	10~2000	(mm/s) /V	Sets the gain for converting from the voltage applied to the analog speed limit command input (SPL) to the speed limit.
4	22	Analog input 1 (AI1) offset setting	-5464~ 5464	0.366 mV	Specifies the offset for the voltage applied to analog input 1.
4	23	Analog input 1 (AI1) filter setting	0~6400	0.01 ms	To set up the time constant of the 1st delay filter for the voltage applied to the analog input 1.
3	15	Speed zero-clamp function selection	0~3	–	Configures settings for the speed zero clamp functions. 0: Disabled; speed zero clamp input is ignored. 1-3: When the speed zero clamp is input, speed limit = 0.

The conversion from an analog speed limit input voltage [V] to a speed limit [mm/s] is as shown below. The slope in the chart is in the case where Pr3.02 is set as 500. The slope depends on the setting of Pr3.02.

Speed limit [mm/s] = | Setting of Pr3.02 × Input voltage [V] |



4-5 Setting of Regenerative Resistor

This section describes the settings concerning the regenerative resistor.
For detailed specifications of the regenerative resistor.

■ Related parameters

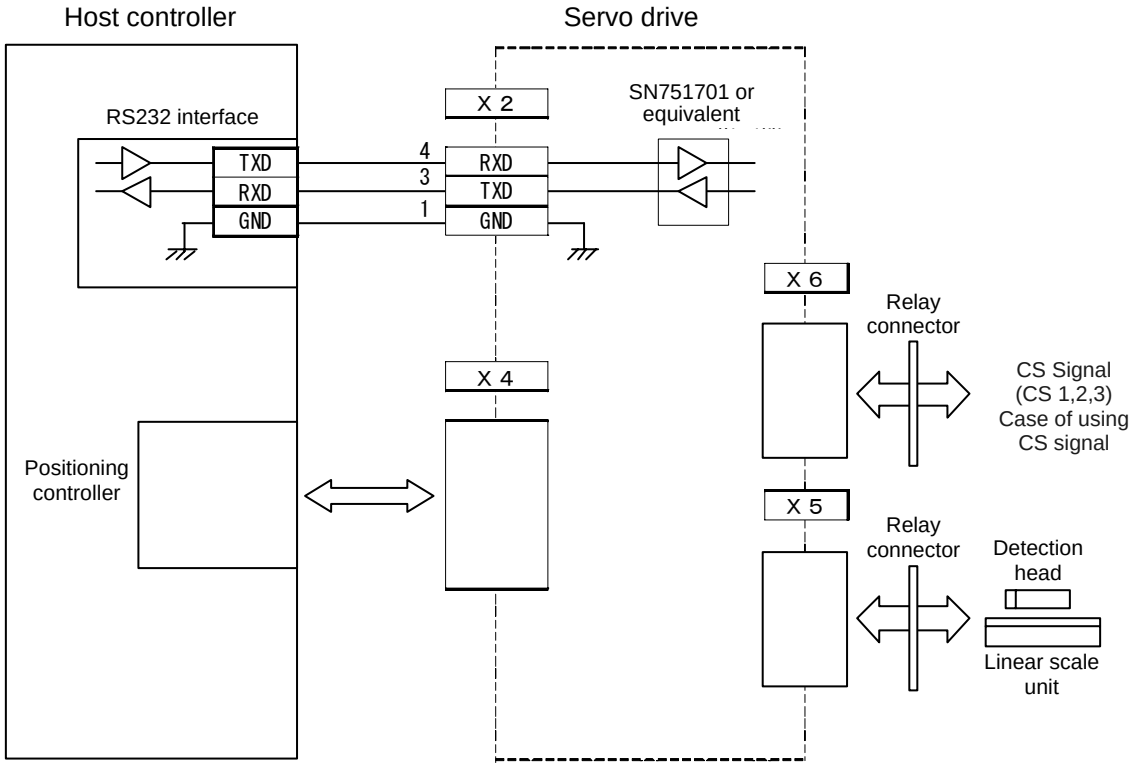
Category	No.	Parameter	Setup range	Unit	Function
0	16	External regenerative resistor setup	0~3	–	Set this parameter according to whether the built-in regenerative resistor is used as it is or the built-in resistor is isolated and an external regenerative resistor is provided. 0: Use the built-in resistor and provide regeneration over. 1: Use an external resistor and provide regeneration over. 2: Use an external resistor but not provide regeneration over. 3: Use with no regenerative resistor (no regeneration over).
0	17	Load factor of external regenerative resistor selection	0~4	–	Select a method of calculating a load factor of regenerative resistor when selecting an external regenerative resistor (Pr0.16=1, 2). 0: An operating factor of 10% for an external regenerative resistor corresponds to a regenerative load factor of 100%. (compatible with the A5 Series) 1 ~ 4: Reserved for the manufacturer's use (do not use).

4-6 Absolute Setting [LA1] is not possible to use it.
4-6-1 Feedback Scale [LA1] is not possible to use it.

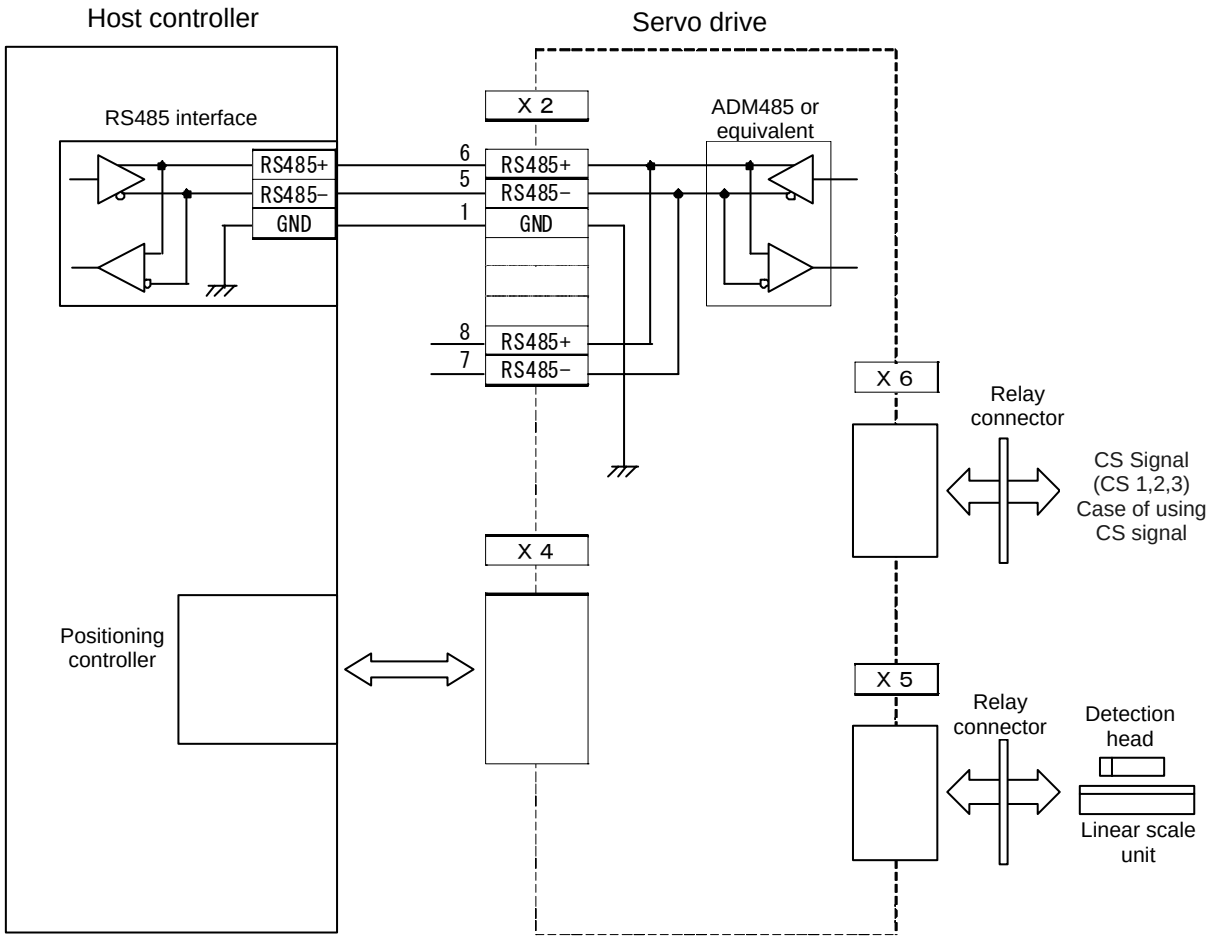
The absolute data of feedback scale is transferred to an upper controller by using the communication function of the servo drive (RS232 or RS485).

4-6-1-1 Configuration of Absolute FeedbackSystem [LA1] is not possible to use it.

Structure of absolute feedback scale system using RS232 interface



Configuration of the absolute feedback scale system using the RS485 interface



To use the RS485 interface, set Pr.5.31”Axis address” to "1" to "31".

4-6-1-2 Transfer of Absolute Data of FeedbackScale [LA1] is not possible to use it.

Send absolute data from the servo drive to the host controller, according to the following procedure.
Before sending absolute data, turn ON the power supply, and make sure that the servo ready output (S-RDY) are ON.

(1) Host controller serial communication interface setup

RS232

Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
Data length	8 bits
Parity	None
Start bit	1 bit
Stop bit	1 bit

The baud rate is defined by Pr. 5.29 “RS232 baud rate setup”

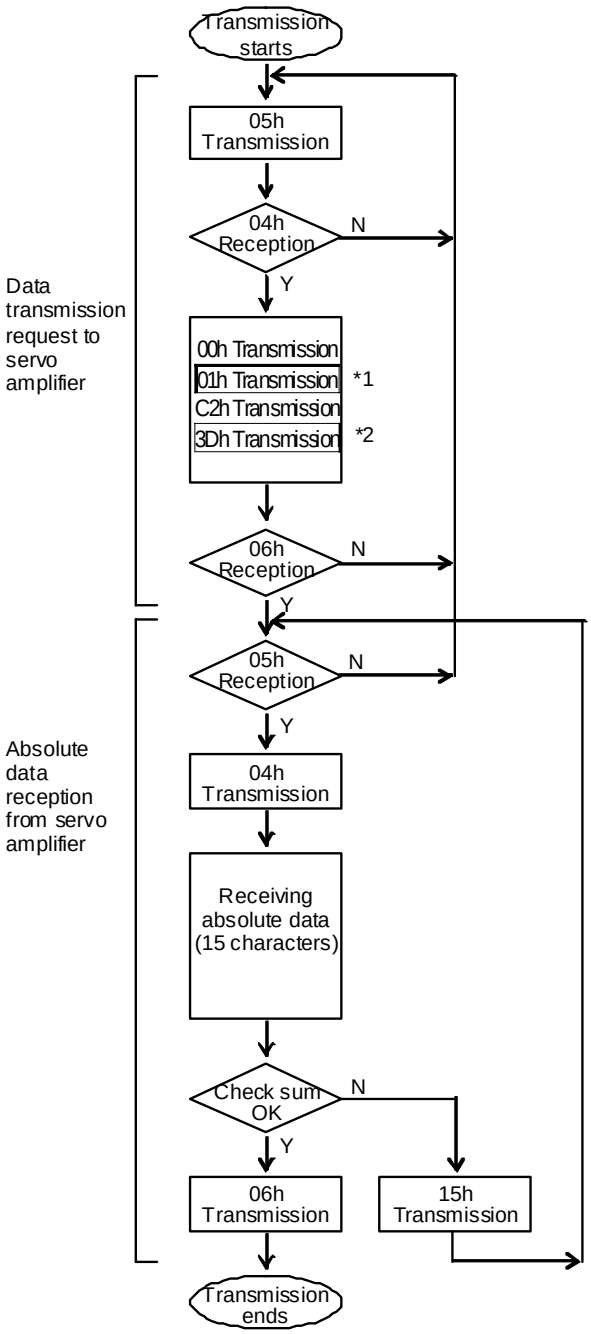
RS485

Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
Data length	8 bits
Parity	None
Start bit	1 bit
Stop bit	1 bit

The baud rate is defined by Pr. 5.30 “RS485 baud rate setup”

4-6-1-3 Procedure of Absolute Data of FeedbackScale [LA1] is not possible to use it.

RS232



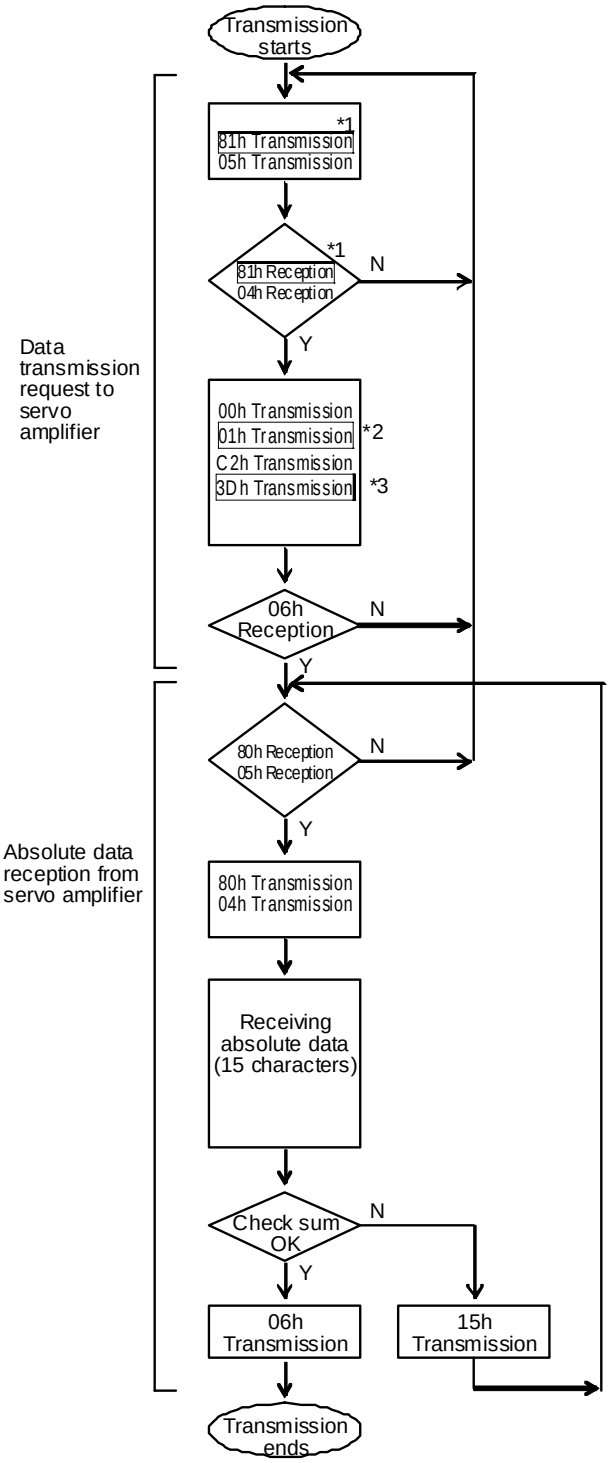
The data marked with * 1 and * 2 are defined by parameter setting Pr.5.31 “Axis address”.

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

If the low-order 8 bits of the sum of the received absolute data (15 characters) are "0", the check sum is judged acceptable.

* To avoid any operation error due to incidental noises, etc., it is recommended to repeat the above communication at least twice, and to make sure of the conformance of absolute data.

RS485



The data marked with * 1 and * 2 are defined by parameter setting Pr.5.31 “Axis address”.

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

If the low-order 8 bits of the sum of the received absolute data (15 characters) are "0", the check sum is judged acceptable.

* To avoid any operation error due to incidental noises, etc., it is recommended to repeat the above communication at least twice, and to make sure of the conformance of absolute data.

4-6-1-4 Configuration of Absolute Data [LA1] is not possible to use it.

Feedback scale position data consist of the data (15 characters) received through the RS232 or RS485 interface.

Received absolute data (15 characters)

0Bh
Axis address
C2h
FFh *1
31h *2
Feedback scale status (L)
Feedback scale status (H)
Absolute data (1)
Absolute data (2)
Absolute data (3)
Absolute data (4)
Absolute data (5)
Absolute data (6)
Error code
Check sum

←Set value of Pr5.31(Axis address)

The item marked with *1 is changeable.
The item marked with *2 depends on an external scale.
31h: AT573A
32h: ST770A, ST770AL
41h: SR77, SR88

←If data transmission is normally executed, the error code is "0". If it is not "0", re-load the absolute data from the drive.

Feedback scale absolute data ← Absolute data (6) x 10,000,000,000h + Absolute data (5) x 100,000,000h + Absolute data (4) x 1,000,000h + Absolute data (3) x 10,000h + Absolute data (2) x 100h + Absolute data (1)
Feedback scale absolute data is 48-bit (complement of negative value 2).

Feedback scale (In the case of 1, it causes an error.)

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

Err51.0 (Feedback scale status 0 error protection)
Err51.1 (Feedback scale status 1 error protection)
Err51.2 (Feedback scale status 2 error protection)
Err51.3 (Feedback scale status 3 error protection)
Err51.4 (Feedback scale status 4 error protection)
Err51.5 (Feedback scale status 5 error protection)
Warning A8 (Feedback scale abnormal warning)
Warning A8 (Feedback scale abnormal warning)

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

Logical addition of the bit 6 and 7 of the feedback scale status (L)
Logical addition of the bit 0 thru 5 of the feedback scale status (L)

As for the details of the feedback scale status, refer to the specification of the feedback scale.

- **Before sending absolute data, set the motor to the Servo-OFF status, and fix it with the brake.**

4-7 Basic setting of linear motor/feedback scale

A5L series need the basic setting according to the motor/feedback scale to be connected.

1) Setting for linear motor/feedback scale specification (4-7-1)
2) Detection method of magnetic poles position (4-7-2)

4-7-1 Setting for linear motor/feedback scale specification

Set up various parameters by referring to the specifications of linear motor to be connected.
A5L series support two motor types: linear and rotary.

4-7-1-1 Linear motor type

■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
9	00	Motor type selection	0 - 2	-	Selects the motor type to be connected. 1: Linear, 2: Rotary When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	01	Feedback scale resolution	0 - 16777216	0.001 μm	Sets up the resolution of feedback scale. When this setting is zero or 1000000 and over, Err60.0 (Motor setting error protection) occurs.
9	02	Magnetic pole pitch	0 - 32767	0.01 mm	Sets up the pitch of magnetic poles. When Pr9.00=1 (linear) and this setting value=0, Err60.0 (Motor setting error protection) occurs.
9	04	Weight of motor's movable section	0 - 32767	0.01 kg	Sets up the weight of motor's movable section. When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	05	Rated motor thrust	0 - 32767	0.1 N	Sets up the rated motor thrust. When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	06	Rated motor effective current	0 - 32767	0.1 Arms	Sets up the rated motor current. When this setting is zero, Err60.0 (Motor setting error protection) occurs. Also, when this setting exceeds allowable rated current of amplifier, Err60.1 (Motor combination error 1) occurs.
9	07	Maximum instantaneous motor current	0 - 32767	0.1 A	Sets up the maximum instantaneous current of the motor. When this setting is zero, Err60.0 (Motor setting error protection) occurs. Also, when this setting exceeds the maximum instantaneous current of amplifier, Err60.1 (Motor combination error 1) occurs.
9	08	Motor phase inductance	0 - 32767	0.01 mH	Sets up the motor phase inductance. When Pr9.12 (Automatic current response adjustment) ≠ 0 and this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	09	Motor phase resistance	0 - 32767	0.01 Ω	Sets up the motor phase resistance. When Pr9.12 (Automatic current response adjustment) ≠ 0 and this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	10	Overspeed level	0 - 20000	mm/s	Sets up the level to detect Err26.0 (Overspeed protection). When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	11	Carrier frequency selection	0 - 1	-	Selects the carrier frequency. 0:6 kHz 1:12 kHz * Applicable carrier frequency is judged based on the amplifier frame. Frame A: 12 kHz, Frames B-F: 6 kHz * When setting the carrier frequency to 12 kHz for frames B-F, the derating is required. For more information, refer to Delivery Specifications.
9	12	Automatic current response adjustment	0 - 100	%	Sets up the reference for current response when automatically setting Pr9.13 (Current proportional gain) and Pr9.14 (Current integrative gain). The larger the setting value, the higher the current response. But, higher response may cause unusual motion such as an oscillation, so set up an appropriate value in accordance with the operation state. Roughly speaking, set "40" for Pr9.11=0 (carrier: 6 kHz), set "80" for Pr9.11=1 (carrier: 12 kHz). When this setting is zero, Pr9.13 and Pr9.14 are not set up automatically. In such a case, set up Pr9.13 and Pr9.14 manually.
9	13	Current proportional gain	0 - 32767	-	Sets up the current proportional gain. In general, use the automatic setting value with Pr9.12.

Category	No.	Parameter Name	Scope	Unit	Description
9	14	Current integrative gain	0 - 32767	-	Sets up the current integrative gain. In general, use the automatic setting value with Pr9.12.
9	30	Pulse count between magnetic pole	0 – 327670000	Pulse	The magnetic pole setting of a linear motor can be set by the pulse count. Please set Pr9.02 "Magnetic pole pitch" to 0 when you do the magnetic pole setting by this parameter. Set value 512or more: A set value becomes a pulse count for each magnetic pole. Set value = magnetic pole pitch [mm] / scale resolution [um] * 1000 Note) The magnetic pole setting must use Pr9.02 "Magnetic pole pitch" basically. In that case, please set this parameter to 0. Please use this parameter when it is not possible to set it with Pr9.02 when it is special. This set value is effective only in Pr9.00 "Motor type selection 1(Linear type)".

4-7-1-2 Rotary motor type

■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
9	00	Motor type selection	0 - 2	-	Selects the motor type to be connected. 1: Linear, 2: Rotary When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	01	Number of scale pulses per rotation	0 - 16777216	pulse	Sets up the number of feedback scale pulses per rotation. The valid range is 10000 to 16777216. When this setting is out of range, Err60.0 (Motor setting error protection) occurs. Moreover, correspondence speed r/min changes depending on this set value. When the pulse number a unit second becomes 125Mpulse or more from the relation between Pr9.10 "Overspeed level" value and this set value, Err60.1 occurs. Ex) In case of Pr9.01=4194304(22bit) Correspondence speed[r/min] = 60*125000000 / 4194304 =1788.13 Then, Pr9.10 set to 1789 or more, Err60.1 occurs.
9	03	Number of pole pairs per rotation	0 - 255	Number of pole pairs	Sets up the number of pole pairs per rotation. When Pr9.00=2 (rotary) and this setting value=0, Err60.0 (Motor setting error protection) occurs.
9	04	Motor inertia	0 - 32767	0.00001 kgm^2	Sets up the motor inertia. When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	05	Rated motor torque	0 - 32767	0.1 Nm	Sets up the rated motor torque. When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	06	Rated motor effective current	0 - 32767	0.1 Arms	Sets up the rated motor current. When this setting is zero, Err60.0 (Motor setting error protection) occurs. Also, when this setting exceeds allowable rated current of amplifier, Err60.1 (Motor combination error 1) occurs.
9	07	Maximum instantaneous motor current	0 - 32767	0.1 A	Sets up the maximum instantaneous current of the motor. When this setting is zero, Err60.0 (Motor setting error protection) occurs. Also, when this setting exceeds the maximum instantaneous current of amplifier, Err60.1 (Motor combination error 1) occurs.
9	08	Motor phase inductance	0 - 32767	0.01 mH	Sets up the motor phase inductance. When Pr9.12 (Automatic current response adjustment) ≠ 0 and this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	09	Motor phase resistance	0 - 32767	0.01 Ω	Sets up the motor phase resistance. When Pr9.12 (Automatic current response adjustment) ≠ 0 and this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	10	Overspeed level	0 - 20000	r/min	Sets up the level to detect Err26.0 (Overspeed protection). When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	11	Carrier frequency selection	0 - 1	-	Select the carrier frequency. 0:6 kHz 1:12 kHz * Applicable carrier frequency is judged based on the amplifier frame. Frame A: 12 kHz, Frames B-F: 6 kHz * When setting the carrier frequency to 12 kHz for frames B-F, the derating is required. For more information, refer to Delivery Specifications.
9	12	Automatic current response adjustment	0 - 100	%	Sets up the reference for current response when automatically setting Pr9.13 (Current proportional gain) and Pr9.14 (Current integrative gain). The larger the setting value, the higher the current response. But, higher response may cause unusual motion such as an oscillation, so set up an appropriate value in accordance with the operation state. Roughly speaking, set "40" for Pr9.11=0 (carrier: 6 kHz), set "80" for Pr9.11=1 (carrier: 12 kHz). When this setting is zero, Pr9.13 and Pr9.14 are not set up automatically. In such a case, set up Pr9.13 and Pr9.14 manually.
9	13	Current proportional gain	0 - 32767	-	Sets up the current proportional gain. In general, use the automatic setting value with Pr9.12.
9	14	Current integrative gain	0 - 32767	-	Sets up the current integrative gain. In general, use the automatic setting value with Pr9.12.

4-7-1-3 Setting for feedback scale type

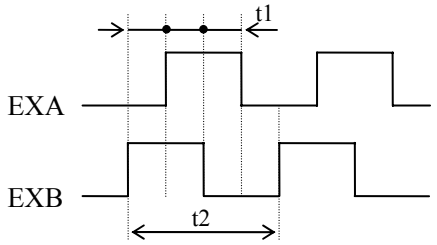
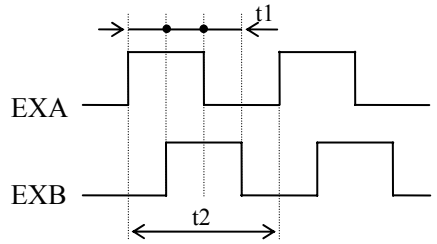
Select the feedback scale type to be used.

■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
3	23	Feedback scale type selection	0 - 2	-	Selects the feedback scale type. 0 : AB phase output type 1 : Serial communication type (incremental specification) 2 : Serial communication type (absolute specification) When this setting is set to 1 or 2 during connecting with AB phase output type, Err50.0 (Feedback scale connection error protection) occurs. Also, when this setting is set to 0 during connecting with serial communication type, Err55.0-2 (Phase A, B, or Z connection error protection) occurs.

Pr3.23	Feedback Scale Type	Supported Scale	Supported Speed *2
0	AB phase output type *1	Feedback scale for AB phase output type	Up to 8Mpps (after 4 edge evaluation)
1	Serial communication type (incremental specification)	Magnescale Co., Ltd. SR75, SR85, SL700/PL101-RP	Up to 400 Mpps
2	Serial communication type (absolute specification)	Mitutoyo Corporation AT573A, ST770A, ST770AL Magnescale Co., Ltd. SR77, SR87	Up to 400 Mpps

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

Count down direction	Count up direction
	
EXB is 90 degree ahead of EXA t1 > 0.125 μs t2 > 0.5 μs	EXB is 90 degree behind EXA t1 > 0.125 μs t2 > 0.5 μs

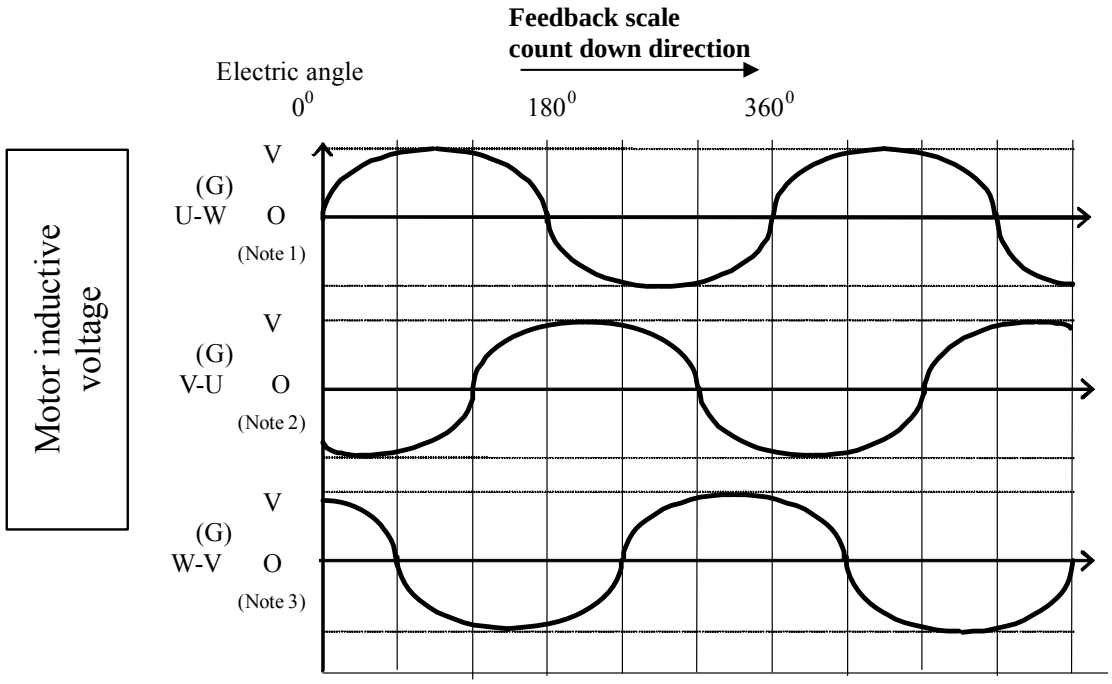
*2 The response speed indicates the feedback speed [pps] of feedback scale processable by the amplifier. For information on the supported scope of the scale, refer to the scale specifications.
For example, when using a feedback scale with the resolution 0.01 μm of serial communication type, the response speed is up to 4 m/s. Also, when using the response speed 5 m/s of serial communication type, select 0.0125 μm or less for the feedback scale resolution.

4-7-1-4 Feedback scale direction setting

■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
3	26	Feedback scale and CS direction inversion	0-3	-	Sets the inversion of feedback counter of feedback scale and CS signal. [Feedback scale] [CS signal] 0: Not inverted Not inverted 1: Inverted Not inverted 2: Not inverted Inverted 3: Inverted Inverted

Set up these parameters so that the relationship between the feedback scale count direction and motor's inductive voltage phase order meets the diagram below. Check the feedback scale count direction with "d05nPS" (total feedback scale pulses) in the front monitor by detaching the motor cable and manually rotating the motor's movable section. In addition, when checking the count direction, be sure to turn on again the power supply after setting Pr0.00 (Motor moving direction) to 1 and writing it into EEPROM.



Note 1: This waveform is that of inductive voltage of terminal U when the terminal W is set as GND.
Note 2: This waveform is that of inductive voltage of terminal V when the terminal U is set as GND.
Note 3: This waveform is that of inductive voltage of terminal W when the terminal V is set as GND.

4-7-2 Setting of detection method of magnetic poles position

There are three types of detection method of motor's magnetic poles position: "CS signal method" using CS signals, automatic estimation method ("Magnetic poles position estimation method"), and "Magnetic poles position restoration method" using the stored magnetic poles position.

4-7-2-1 CS signal method

This method detects the magnetic poles position by using CS signals (CS1, CS2, and CS3).

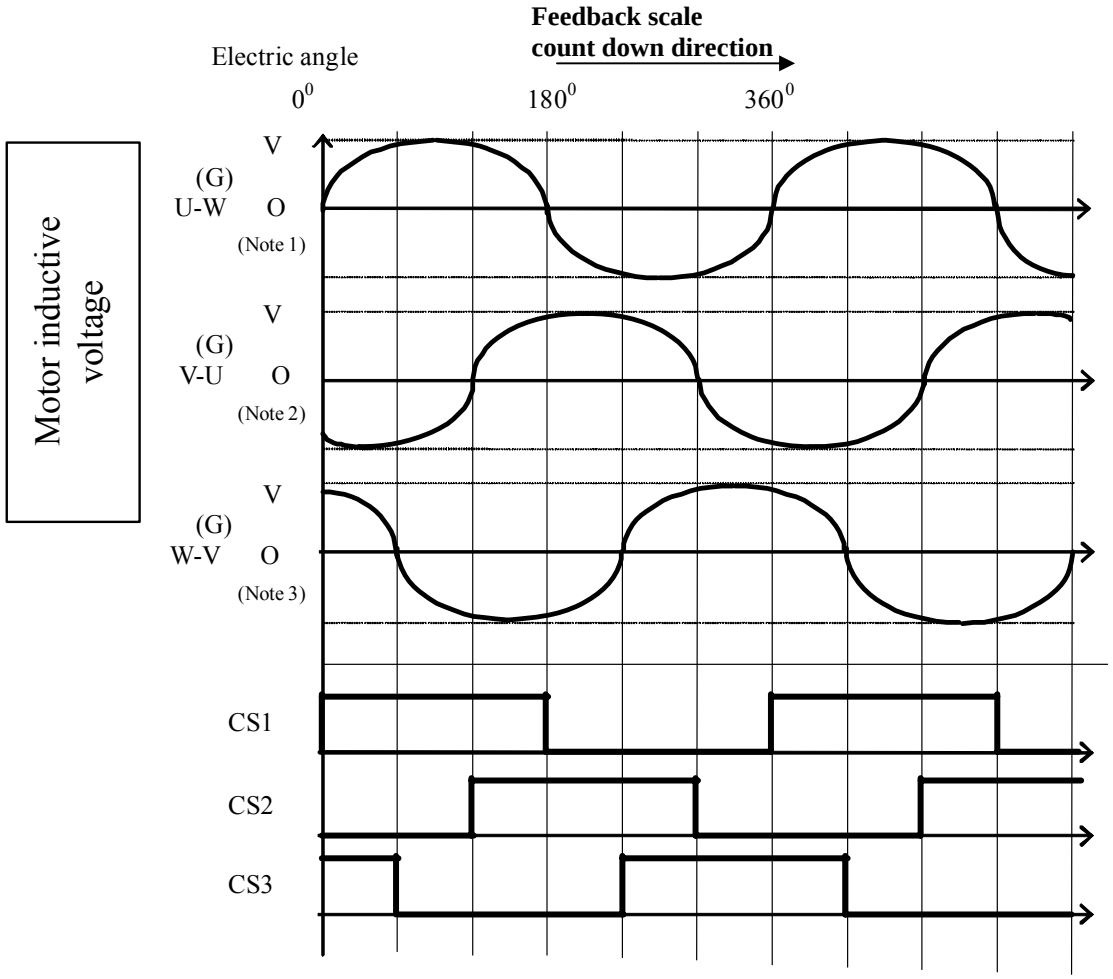
■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
9	20	Magnetic poles detection method selection	0 - 3	-	Selects the detection method of the magnetic poles position. 1 : CS signal method 2 : Magnetic poles position estimation method 3 : Magnetic poles position restoration method When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	21	CS phase setting	0 - 360	Electric angle (°)	Sets up the phase difference between motor's inductive voltage and CS signal. This setting is valid only when the CS signal method is selected (Pr9.20=1).
3	26	Feedback scale and CS direction inversion	0 - 3	-	Sets the inversion of feedback counter of feedback scale and CS signal. [Feedback scale] [CS signal] 0: Not inverted Not inverted 1: Inverted Not inverted 2: Not inverted Inverted 3: Inverted Inverted

Connect the components so that the relationship between motor's inductive voltage and CS 1, 2, 3 signals meets the diagram below.

Note that Pr9.21 “CS phase setting” can correct the phase difference. (Refer to the following page)

Moreover, the direction of the CS signal can be set by Pr3.26. (Refer to the CS signal direction setting the following description.)

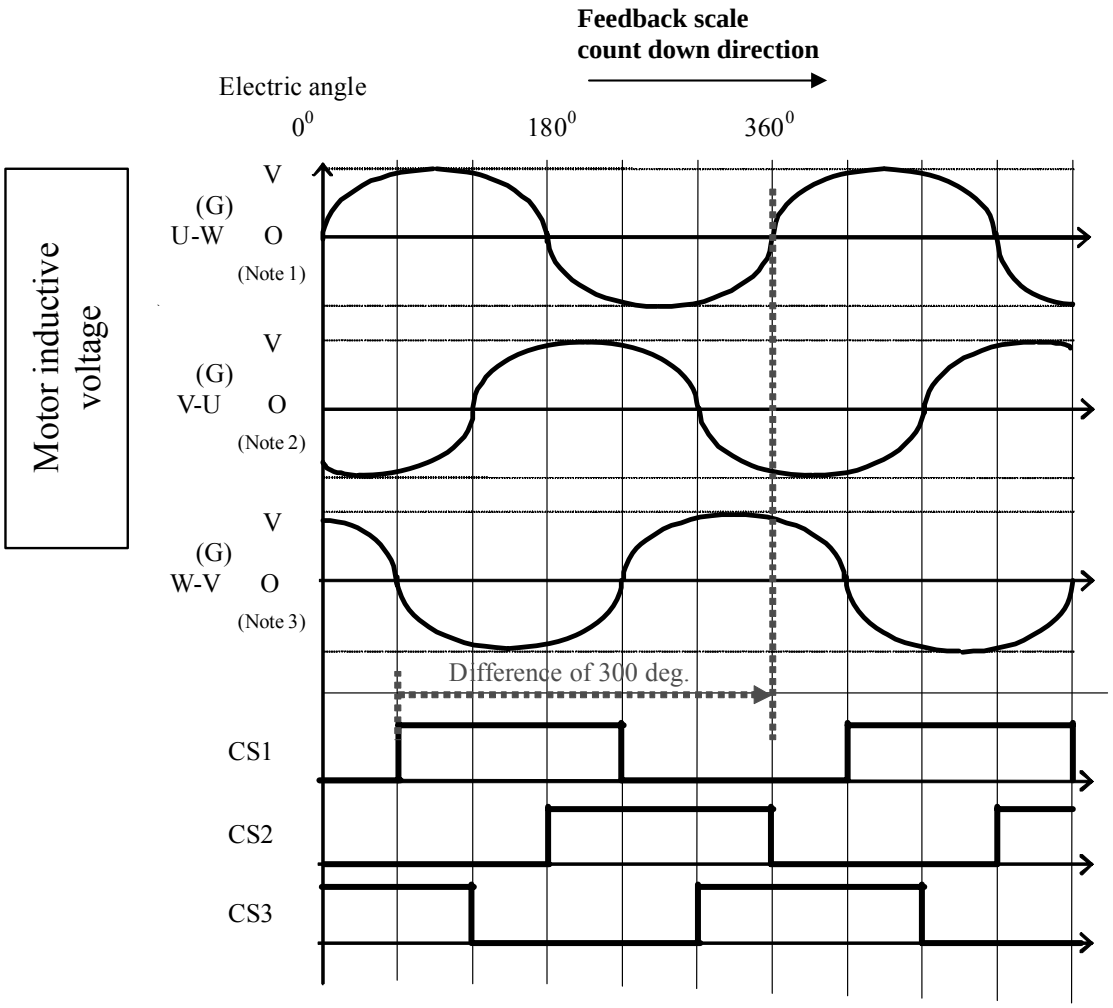


Note 1: This waveform is that of inductive voltage of terminal U when the terminal W is set as GND.
Note 2: This waveform is that of inductive voltage of terminal V when the terminal U is set as GND.
Note 3: This waveform is that of inductive voltage of terminal W when the terminal V is set as GND.

・ Phase difference setting method base on Pr9.21 “CS phase setting”

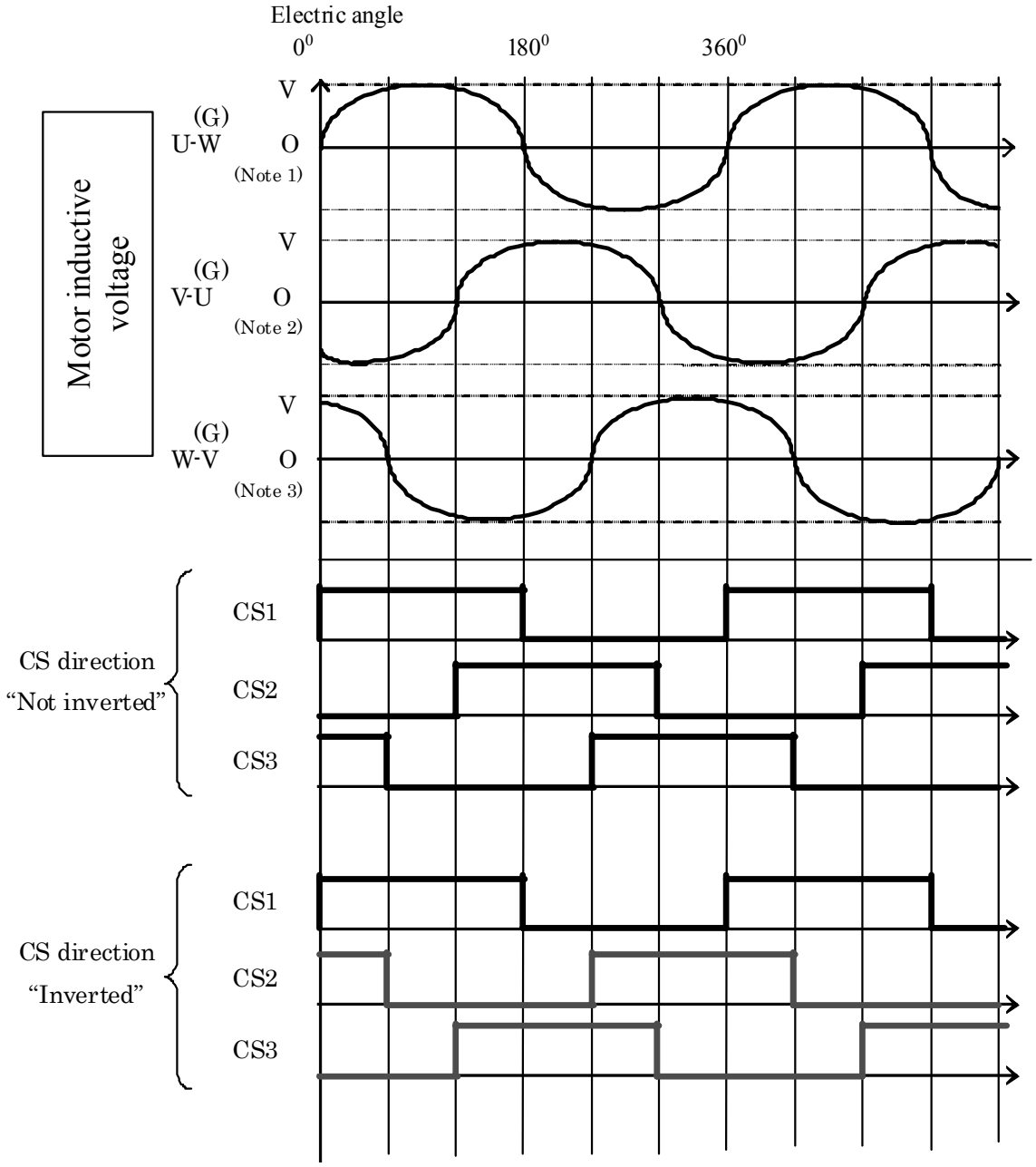
When it is difficult to match your cabling with the one shown in previous page, the phase difference can be corrected with the software based on Pr9.21 “CS phase setting”.

For example, when the relationship between inductive voltage and CS signal for the count down direction of feedback scale is the same as the diagram shown below, the difference between rising edges of inductive voltage between U and W and CS 1 signal is 300 degree, so set Pr9.21 to "300."



Note 1: This waveform is that of inductive voltage of terminal U when the terminal W is set as GND.
Note 2: This waveform is that of inductive voltage of terminal V when the terminal U is set as GND.
Note 3: This waveform is that of inductive voltage of terminal W when the terminal V is set as GND.

* CS signal direction setting by Pr3.26 ”Feedback scale and CS direction inversion”
There are 2 patterns for wiring the CS1, CS2, CS3 singal shown below. On above chart, CS1, CS2, CS3 is right wiring to the inductive voltage, therefore set Pr3.26 to “Not inverted”.
Meanwhile below chart, wiring of CS2 and CS3 is inverted as against the above chart. Therefore you need to set Pr3.26 to “Inverted”.
When the direction of CS signal is set to "Inverted", it comes to be able to operate it normally because CS2 and CS3 are replaced and used in the servo drive.



Note 1: This waveform is that of inductive voltage of terminal U when the terminal W is set as GND.
Note 2: This waveform is that of inductive voltage of terminal V when the terminal U is set as GND.
Note 3: This waveform is that of inductive voltage of terminal W when the terminal V is set as GND.

4-7-2-2 Magnetic poles position estimation method

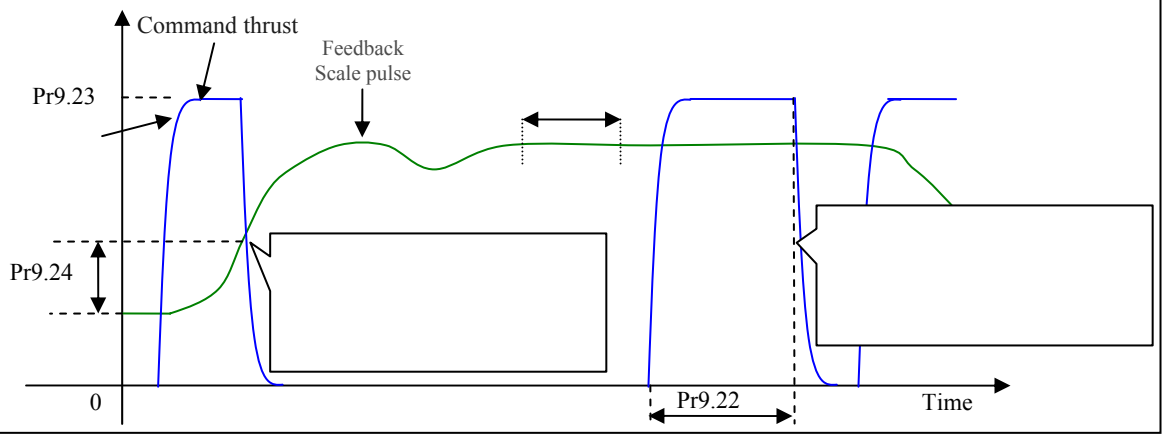
The magnetic poles position is estimated when the servo is turned on for the first time after power-on, without using CS signals. The estimated magnetic poles position is valid until the power is reset. After resetting the power supply, the magnetic poles position is estimated for the first time after the servo is turned on again.

■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
9	20	Magnetic poles detection method selection	0 - 3	-	Selects the detection method of the magnetic poles position. 1 : CS signal method 2 : Magnetic poles position estimation method 3 : Magnetic poles position restoration method When this setting is zero, Err60.0 (Motor setting error protection) occurs.
9	22	Thrust command time for estimating magnetic poles position	0 - 200	ms	• Sets up the application time of a command when estimating the magnetic poles position. • When the motor's number of moving pulses becomes the Pr9.24 setting value or more, the thrust command is stopped even if the application time is less than the specified time. • When this setting value is small, the motor cannot work sufficiently and the estimated accuracy is degraded. Or, a magnetic poles position estimation error may occur. • This setting is valid only when the magnetic poles position estimation method is selected (Pr9.20=2). Note: Actual application time of a command is approximately the setting value plus 4ms.
9	23	Command thrust for estimating magnetic poles position	0 - 300	%	• Sets up the thrust of a command when estimating the magnetic poles position. • When this setting value is small, the motor cannot work sufficiently and the estimated accuracy is degraded. Or, a magnetic poles position estimation error may occur. • This setting is valid only when the magnetic poles position estimation method is selected (Pr9.20=2). Note: Actual command thrust is limited by the motor's maximum allowable thrust.
9	24	Zero moving pulse width for estimating magnetic poles position	0 - 32767	pulse	• Sets up the pulse width for judging as a zero movement when estimating the magnetic poles position. • When the motor's moving pulse is less than this setting value even if the thrust is applied under the conditions Pr9.22 and Pr9.23, it is judged as a zero movement. • When this setting value is set small, the moving amount can be reduced during estimating the magnetic poles position. But, the estimated accuracy may be degraded. Roughly speaking, set up the number of pulses corresponding to one electric angle. • This setting is valid only when the magnetic poles position estimation method is selected (Pr9.20=2).
9	25	Number of pulses for judging as a motor stop when estimating magnetic poles position	0 - 32767	pulse	• Sets up the condition for judging as a motor stop when estimating the magnetic poles position. • When it continues for Pr9.26 [ms] that the number of motor moving pulses is Pr9.25 or less for 2 ms, the motor is judged to be stopped. Then, next thrust command is applied. • This setting is valid only when the magnetic poles position estimation method is selected (Pr9.20=2).
9	26	Time for judging as a motor stop when estimating magnetic poles position	0 - 32767	ms	
9	27	Time limit of motor stop for estimating magnetic poles position	0 - 32767	ms	• Sets up the time limit for judging as a motor stop when estimating the magnetic poles position. • When the motor is not judged as a stop even if this setting time elapsed, Err61.1 (Magnetic poles position estimation error 2) occurs. • This setting is valid only when the magnetic poles position estimation method is selected (Pr9.20=2).
9	28	Thrust command filter for estimating magnetic poles position	0 - 2500	0.01 ms	• Sets up the filter time constant for the thrust command when estimating the magnetic poles position. When this setting is zero, the filter is invalid and the command becomes a step command. • This setting is valid only when the magnetic poles position estimation method is selected (Pr9.20=2).

■ Points to note

- This function is performed when the servo is turned on for the first time after power-on. The motor works while estimating the magnetic poles position, so fully take care so as not to collide with the end of the unit.
- This function may not work properly when the vertical axis, uneven load, or friction is large.



4-7-2-3 Magnetic poles position restoration method

Once the magnetic poles position is estimated with the magnetic poles position estimation method (4-7-2-2) and stored, the magnetic poles position can be used to control the motor after resetting the power supply. Base on this method, only one estimation of the magnetic poles position suffices in the beginning. After that, it does not need to estimate the magnetic poles position regardless of whether the power supply is reset.

This method is supported only when using the feedback scale of absolute type.

■ Relevant parameters

Category	No.	Parameter Name	Scope	Unit	Description
9	20	Magnetic poles detection method selection	0 - 3	-	Selects the detection method of the magnetic poles position. 1 : CS signal method 2 : Magnetic poles position estimation method 3 : Magnetic poles position restoration method When this setting is zero, Err60.0 (Motor setting error protection) occurs.

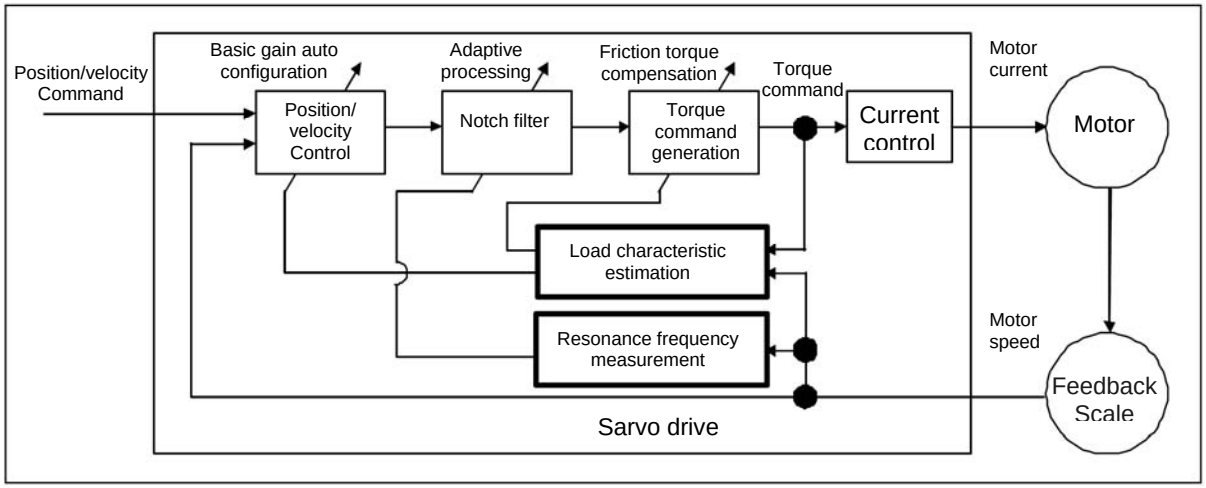
■ Points to note

- When this method is selected while the magnetic poles position is not estimated at all or while the estimation result of the magnetic poles position is cleared, Err61.2 (Magnetic poles position estimation error 3) occurs.
  The estimation result of the magnetic poles position is cleared when the detection method of magnetic poles position is not specified (Pr9.20=0).
  However, EEPROM relevant alarms (Err36.0 - 2, Err37.0 - 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 (Magnetic poles position estimation error 3) occurs.
- The estimation result of the magnetic poles 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 magnetic poles position may change, thereby disabling you to control the motor properly. When one of components above is exchanged at least, set Pr9.20=2 once. Then, estimate the magnetic poles position and set Pr9.20=3 again.

5. Gain Adjustment / Damping Control Functions

5-1 Automatic Adjusting Function

The following figure shows an overview of automatic adjustment function of A5 series.



1) Real-time auto tuning

This function estimates load characteristic using motor speed and thrust command, and automatically specifies basic gain with regard to position control and speed control on the basis of mass estimation value. At the same time, setting time for positioning is reduced by adding an estimated friction thrust to a thrust command in advance.

2) Adaptive filter

Estimating a resonance frequency using a motor speed and removing the frequency components from a thrust command suppresses vibrations caused by resonance.

5-1-1 Real-time Auto Tuning

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

1) Scope of application

This function is enabled under the following conditions:

	Conditions for real-time auto tuning
Control mode	Valid real-time auto tuning modes change depending on control modes. Refer to descriptions about parameter Pr0.02 "Real-time auto-gain tuning setup" for details.
Other	· In Servo On status. · Parameters for other functions than control, such as deviation counter clearing, input signals such as command input prohibition, and thrust limit settings, must be specified appropriately and normal rotation of motor must have no problems. · The mass ratio estimation is not working while executing the magnetic pole position estimation.

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 [rmm/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 thrust is small with reference to the uneven load/ viscous friction thrust.

3) Parameters controlling operation of real-time auto tuning

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

<table>
<tr><th>Category</th><th>No.</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td>0</td><td>02</td><td>Real-time auto-gain tuning setup</td><td>0~6</td><td>–</td><td>Specifies the operation mode of real-time auto tuning.
<table>
<tr><th>Setting</th><th>Mode</th><th>Description</th></tr>
<tr><td>0</td><td>Invalid</td><td>The real-time auto tuning function is disabled.</td></tr>
<tr><td>1</td><td>Standard</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>Positioning
*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>Vertical axis
*2</td><td>In addition positioning mode, compensation against biased load on vertical axis is made to reduce variations in settling time of positioning.</td></tr>
<tr><td>4</td><td>Friction compensation
*3</td><td>In addition to the vertical axis mode, settling time of positioning is reduced for belt-drive axis 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>
<tr><td>6</td><td>Customize
*4</td><td>Combination of real-time auto tuning functions is specified in detail in Pr6.32 "Real time auto tuning custom setup" allows customization in accordance with applications.</td></tr>
</table>
*1 Speed and thrust controls are the same as in standard mode.
*2 Thrust control is the same as in standard mode.
*3 Speed control is the same as in standard mode. Thrust control is the same as in standard mode.
*4 Some functions are not available depending on control modes. Refer to descriptions of Pr6.32.</td></tr>
<tr><td>0</td><td>03</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)

<table>
<tr><th>Category</th><th>No.</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>31</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>Real time auto tuning custom setup
(Continued)</td><td>-32768~ 32767</td><td>–</td><td>If customized mode is selected for an operation mode of real-time auto tuning, detailed settings of automatic adjustment function (Pr0.02=6) must be specified.
<table>
<tr><th>Bit</th><th>Item</th><th>Description</th></tr>
<tr><td>1~0</td><td>Load characteristic estimation
*</td><td>Specify valid/invalid setting of load characteristic estimation function.
Setting value = 0: Invalid
Setting value = 1: Valid</td></tr>
<tr><td>3~2</td><td>Updating mass ratio</td><td>Specify updating Pr0.04 "Mass ratio" by load characteristic estimation result.
Setting value= 0: Current setting is used.
Setting value = 1: Updated by estimated value.</td></tr>
<tr><td>6~4</td><td>Thrust compensation</td><td>Specify updating Pr6.07 "Thrust command additional value", Pr6.08 " Positive direction thrust compensation value ", and Pr6.09 "Negative direction thrust compensation value" by load characteristic estimation result.
Setting value = 0: Current setting is used.
Setting value = 1: Thrust compensation invalid
Clear parameter above to zero.
Setting value = 2: Vertical axis mode
Update Pr6.07. Clear Pr6.08 and Pr6.09 to zero.
Setting value = 3: Friction compensation (weak)
Update Pr6.07. Weak compensation is specified for Pr6.08 and Pr6.09.
Setting value = 4: Friction compensation (medium)
Medium-level compensation is specified for Pr6.08 and Pr6.09.
Setting value = 5: Friction compensation (strong)
Strong compensation is specified for Pr6.08 and Pr6.09.</td></tr>
</table>
* If load characteristic estimation is invalid, updating mass ratio by estimated value does notchange current settings. Updating thrust compensation by estimated value results in clearing to zero (Invalid).</td></tr>
</table>

<table>
<tr><th>Category</th><th>No.</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td>6</td><td>32</td><td>Real time auto tuning custom setup (Continued)</td><td>-32768~ 32767</td><td>–</td><td>
<table>
<tr><th>Bit</th><th>Item</th><th>Description</th></tr>
<tr><td>7</td><td>Stiffness setting</td><td>Valid/invalid setting of basic gain is specified by Pr0.03 "Selection of machine stiffness at realtime auto-gain tuning".
Setting value = 0: Invalid
Setting value = 1: Valid</td></tr>
<tr><td>8</td><td>Fixed parameter setting</td><td>Permission/no permission of fixed parameters, which are usually fixed, is specified.
Setting value = 0: Current setting is used.
Setting value = 1: Set to fixed value.</td></tr>
<tr><td>10~9</td><td>Gain switching setting</td><td>Setting method is selected for gain switching related parameters with real-time auto tuning valid.
Setting value = 0: Current setting is used.
Setting value = 1: Gain switching invalid
Setting value = 2: Gain switching valid</td></tr>
</table>
Note) This parameter must be specified on the basis of bits. Since operations are not guaranteed with wrong settings specified, use of setup support software is recommended in parameter editing.

* Setting method of bit-basis parameters.
To specify a value other than "0" for the settings, calculate a Pr6.32 setting value by the following procedures:
1) Verify the least significant bit of each setting.
Example: The least significant bit of thrust compensation function is "4."
2) Multiply a (the least significant bit) the power of 2 by a setting value.
Example: To specify friction compensation (medium) for thrust compensation function, a value is "$2^4 \times 4 = 64$."
3) Calculate 1) and 2) for all settings and specify a value found by summing up all values as a Pr6.32 setting value.
Example: For settings such as Load characteristic measurement = Valid, Mass ratio updating = Valid, Thrust compensation = Friction compensation (medium), Hardness setting = Valid, Fixed parameter = Set to fixed value, and Gain switching setting=Valid, a value is calculated as
$2^0 \times 1 + 2^2 \times 1 + 2^4 \times 4 + 2^7 \times 1 + 2^8 \times 1 + 2^9 \times 2 = 1477$
</td></tr>
</table>

4) Parameter changed by real-time auto tuning

The real-time auto tuning function updates the following parameters using load characteristic values, in accordance with Pr0.02 "Real-time auto-gain tuning setup"and Pr6.32 " Real time auto tuning custom setup".

Category	No.	Parameter	Setup range	Unit	Function
0	04	Mass ratio	0~10000	%	This parameter is updated if updating mass ratio of real-time auto tuning is valid.
6	07	Thrust command additional value	-100~100	%	This parameter is updated if vertical axis mode of real-time auto tuning is valid.
6	08	Positive direction thrust compensation value	-100~100	%	This parameter is updated if friction compensation mode of real-time auto tuning is valid.
6	09	Negative direction thrust compensation value	-100~100	%	This parameter is updated if friction compensation mode 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.	Parameter	Setup range	Unit	Function
1	00	1st gain of position loop	0~30000	0.1/s	If hardness setting is valid, update the setting values in accordance with hardness.
1	01	1st gain of velocity loop	1~32767	0.1 Hz	If hardness setting is valid, update the setting values in accordance with hardness.
1	02	1st time constant of velocity loop integration	1~10000	0.1 ms	If hardness setting is valid, update the setting values in accordance with hardness.
1	04	1st time constant of thrust filter	0~2500	0.01 ms	If hardness setting is valid, update the setting values in accordance with hardness.
1	05	2nd gain of position loop	0~30000	0.1/s	If hardness setting is valid, update the setting values in accordance with hardness.
1	06	Velocity loop gain 2	1~32767	0.1 Hz	If hardness setting is valid, update the setting values in accordance with hardness.
1	07	2nd time constant of velocity loop integration	1~10000	0.1 ms	If hardness setting is valid, update the setting values in accordance with hardness.
1	09	Thrust filter time constant 2	0~2500	0.01 ms	If hardness setting is valid, update the setting values in accordance with hardness.

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

Category	No.	Parameter	Setup range	Unit	Function
1	03	1st filter of speed detection	0~5	–	If fixed parameter setting is valid, specify "0."
1	08	2nd filter of speed detection	0~5	–	If fixed parameter setting is valid, specify "0."
1	10	Velocity feed forward gain	0~1000	0.1%	If fixed parameter setting is valid, specify "300" (30%).
1	11	Velocity feed forward filter time constant	1~6400	0.01 ms	If fixed parameter setting is valid, set "50" (0.5 ms).
1	12	Thrust feed forward gain	0~1000	0.1%	If fixed parameter setting is valid, specify "0."
1	13	Thrust feed forward time constant	0~6400	0.01 ms	If fixed parameter setting is valid, specify "0."

(Continued)

Specify the following parameters for real-time auto tuning in accordance with gain switching settings.

Category	No.	Parameter	Setup range	Unit	Function
1	14	2nd gain setup	0~1	–	Specify "0" for other cases than maintaining current settings.
1	15	Mode of position control switching	0~10	–	If gain switching is valid, specify "10." If gain switching is invalid, specify "0."
1	16	Delay time of position control switching	0~10000	0.1 ms	Specify "50" for other cases than maintaining current settings.
1	17	Level of position control switching	0~20000	–	Specify "50" for other cases than maintaining current settings.
1	18	Hysteresis at position control switching	0~20000	–	Specify "33" for other cases than maintaining current settings.
1	19	Position gain switching time	0~10000	0.1 ms	Specify "33" for other cases than maintaining current settings.
1	20	Mode of velocity control switching	0~5	–	Specify "0" for other cases than maintaining current settings.
1	21	Delay time of velocity control switching	0~10000	0.1 ms	Specify "0" for other cases than maintaining current settings.
1	22	Level of velocity control switching	0~20000	–	Specify "0" for other cases than maintaining current settings.
1	23	Hysteresis at velocity control switching	0~20000	–	Specify "0" for other cases than maintaining current settings.
1	24	Mode of thrust control switching	0~3	–	Specify "0" for other cases than maintaining current settings.
1	25	Delay time of thrust control switching	0~10000	0.1 ms	Specify "0" for other cases than maintaining current settings.
1	26	Level of thrust control switching	0~20000	–	Specify "0" for other cases than maintaining current settings.
1	27	Hysteresis at thrust control switching	0~20000	–	Specify "0" for other cases than maintaining current settings.

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.	Parameter	Setup range	Unit	Function
6	10	Function permission flag	0~63	–	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	13	2nd Mass ratio	0~10000	%	Parameter settings may be changed, but mass ratio switching function is made invalid.
6	23	Disturbance thrust compensation gain	-100~100	%	Parameter settings may be changed, but disturbance observer compensation function is made invalid.
6	24	Disturbance observer filter	10~2500	0.01 ms	Parameter settings may be changed, but disturbance observer compensation function is made invalid.

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 "Thrust command additional value", Pr6.08 "Positive direction thrust compensation value", and Pr6.09 "Negative direction thrust compensation value".

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 "Thrust command additional value", Pr6.08 "Positive direction thrust compensation value", and Pr6.09 "Negative direction thrust compensation value".
2) After occurrence of strange noises or vibrations, values of Pr0.04 " Mass ratio," Pr6.07 "Thrust command additional value", Pr6.08 "Positive direction thrust compensation value", or Pr6.09 "Negative direction thrust compensation value" 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 "Thrust command additional value", Pr6.08 "Positive direction thrust compensation value", and Pr6.09 "Negative direction thrust compensation value" 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.

7) Basic gain parameter settings table

Stiffness	Gain 1				Gain 2				A4 Series stiffness setting (Reference) *1
	Pr1.00	Pr1.01	Pr1.02	Pr1.04	Pr1.05	Pr1.06	Pr1.07	Pr1.09	
	Position [0.1/s]	Speed [0.1 Hz]	Velocity integral [0.1 ms]	Thrust [0.01 ms]	Position [0.1/s]	Speed [0.1 Hz]	Velocity integral [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 Hardness settings of A4 series refers to the setting values (0 to 15) of A4 series parameter Pr22 "Real-time auto tuning machine hardness selection."

5-1-2 Adaptive Filter

Vibrations are reduced by estimating resonance frequency on the basis of vibration components appearing in motor speeds under actual operations, and by removing the resonance components from thrust command.

1) Scope of application

This function is enabled under the following conditions

	Conditions for the functioning of adaptive filter
Control mode	Control mode must be that other than thrust control mode.
Other	· In servo On status. · Factors other than control parameters, such as prohibition of deviation counter clearing command input and thrust limiter, are appropriately specified and normal motor rotation is possible with no problems. · The adaptive function is not working while executing the magnetic pole position estimation.

2) Cautions

The adaptive filter may not function normally in the following conditions. If that happens, manually configure the notch filters for suppressing resonance.

	Conditions that interfere with operations of adaptable filter
Resonance point	· When a resonance frequency is lower than 3 times as high as speed responding frequency [Hz]. · The resonance peak is low or control gain is low and its effect is not observed in the motor speed. · Three or more resonance points exist.
Load	· Motor speed variation including a high-frequency component is generated due to any nonlinear factor such as backlash.
Command pattern	· Acceleration/deceleration is rapid at 30000 [mm/s] in 1 [s] or higher.

3) Related parameters

The operation of the adaptive filter can be specified by using the following parameters.

Category	No.	Parameter	Setup range	Unit	Function
2	00	Adaptive filter mode setup	0~4	–	Operating mode of adaptive filter is specified. Setting value 0: Adaptive filter invalid Adaptive filter is Invalid. Current values are retained for parameters related to 3rd and 4th Notch filter. Setting value 1: One adaptive filter is valid. One adaptive filter is made valid. Update parameters related with 3rd Notch filter in accordance with adapting results. Setting value 2: Two adaptive filters are valid. Two adaptive filters are valid. Update parameters related with 3rd and 4th Notch filter in accordance with adapting results. Setting value 3: Resonance frequency measurement mode Resonance frequency is measured. Measurement results are verified on PANATERM. Current values are retained for parameters related to 3rd and 4th Notch filter. Setting value 4: Clearing adapting results. Parameters related to 3rd and 4th Notch filter are made invalid and adapting results are cleared.

(Continued)

The adaptive filter function automatically specifies the following parameters.

Category	No.	Parameter	Setup range	Unit	Function
2	07	3rd Notch frequency	50~5000	Hz	Automatically specifies the first resonance frequency estimated by the adaptive filter function. If no resonance point is found, 5000 is specified.
2	08	3rd notch width selection	0~20	-	This is automatically specified when adaptive filter is valid.
2	09	3rd notch depth selection	0~99	-	This is automatically specified when adaptive filter is valid.
2	10	4th Notch frequency	50~5000	Hz	Automatically specifies the second resonance frequency estimated by the adaptive filter function. If no resonance point is found, 5000 is specified.
2	11	4th notch width selection	0~20	-	This is automatically specified when two adaptive filters are valid.
2	12	4th notch depth selection	0~99	-	This is automatically specified when two adaptive filters are valid.

4) Usage

Input an operating command with a value other than "0" specified for Pr2.00 "Adaptive filter mode setup". If any effect of the resonance point is observed in the motor speed, the parameters for the third and/or fourth notch filters are automatically specified according to the number of adaptive filters.

5) Other cautions

1) Abnormal noise or oscillation may be generated immediately after the first Servo On after power-up or after increasing the stiffness setting when real-time auto tuning is enabled until the load characteristics estimation has been stabilized. This is normal if the condition is stabilized soon. If oscillation or continued generation of abnormal noise through three or more reciprocating movements often occurs, take the following steps.

   1) Write the parameters with which normal operation has been observed to the EEPROM.
   2) Reduce value of Pr0.03 "Selection of machine stiffness at realtime auto-gain tuning".
   3) Specify "0" for Pr2.00 "Adaptive filter mode setup" and make adaptive invalid.
   4) Manually specify the notch filters.

2) After any abnormal noise or oscillation has occurred, the third and fourth notch filter settings may be modified to an extreme value. In that case, make adaptive filter invalid by the procedures of 3) above and specify a setting value "5000" (Invalid) for Pr2.07 "3rd Notch frequency" and Pr2.10 "4th Notch frequency." Then make the adaptive filter valid again.

3) 3rd Notch filter frequency (Pr2.07) and 4th Notch filter frequency (Pr2.10) are written in EEPROM every 30 minutes. The data are used as the initial values for adaptive processing at the next power-up.

5-2 Manual Adjustment

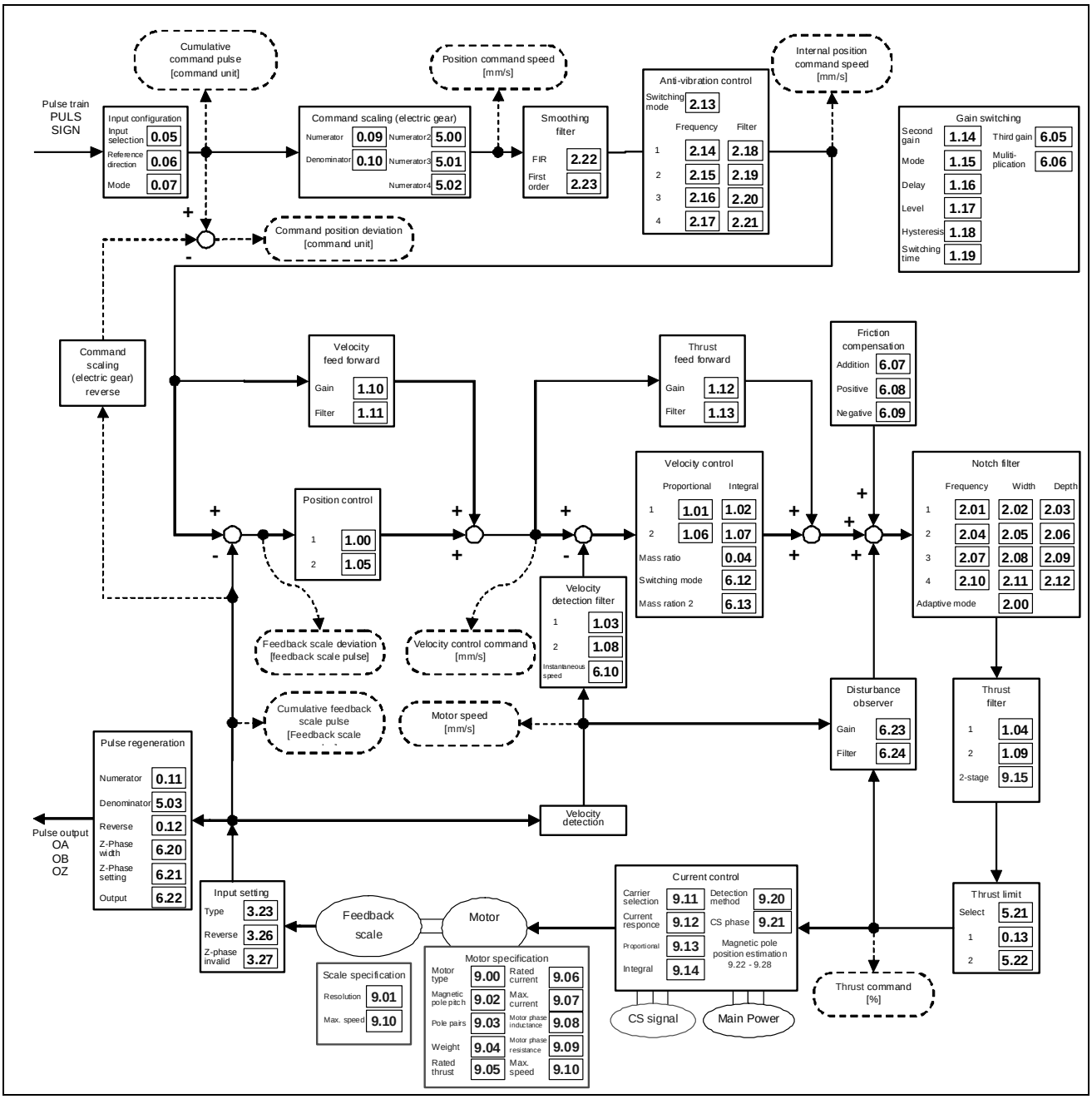
The A5 series the automatic adjustment function described above. However, if the function is not available due to load conditions or restrictions of operating patterns, or if best responses and stability is needed suitable for device characteristics, manual readjustment may be required.

This section describes the manual tuning function with different subsections for the individual control modes and functions as shown below.

1) Position control mode block diagram (5-2-1)
2) Speed control mode block diagram (5-2-2)
3) Thrust control mode block diagram (5-2-3)
4) Gain switching function (5-2-4)
5) Notch filter (5-2-5)
6) Vibration suppression control (5-2-6)
7) Feed forward function (5-2-7)
8) Instantaneous speed 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) Mass ratio switching function (5-2-12)
13) Two-Stage Thrust Filter Function (5-2-13)

5-2-1 Block Diagram of Position Control Mode

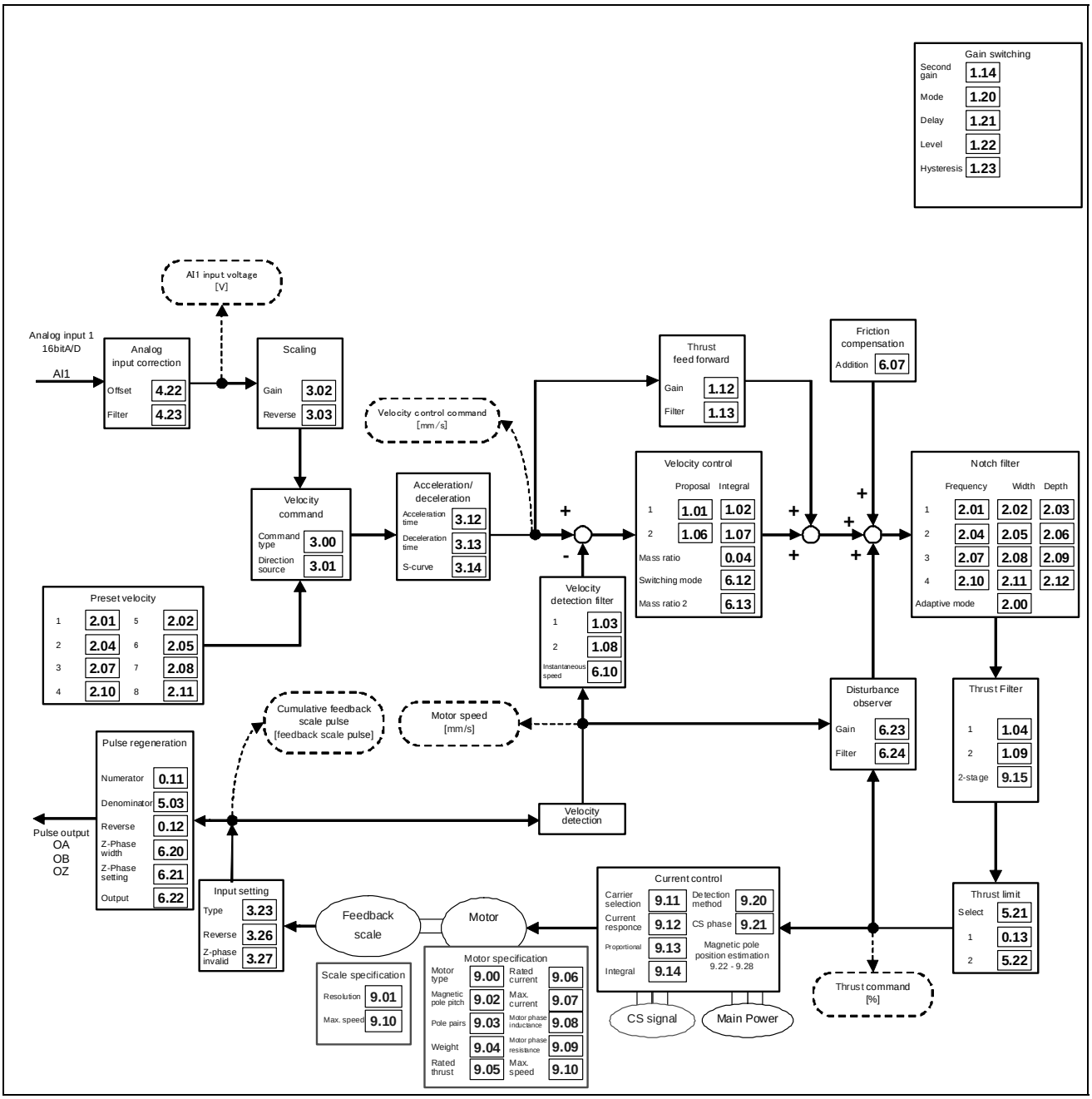
A5 series position control has a structure shown in the following block diagram.



Position control block diagram

5-2-2 Block Diagram of Speed Control Mode [LA1] can use only internal speed.

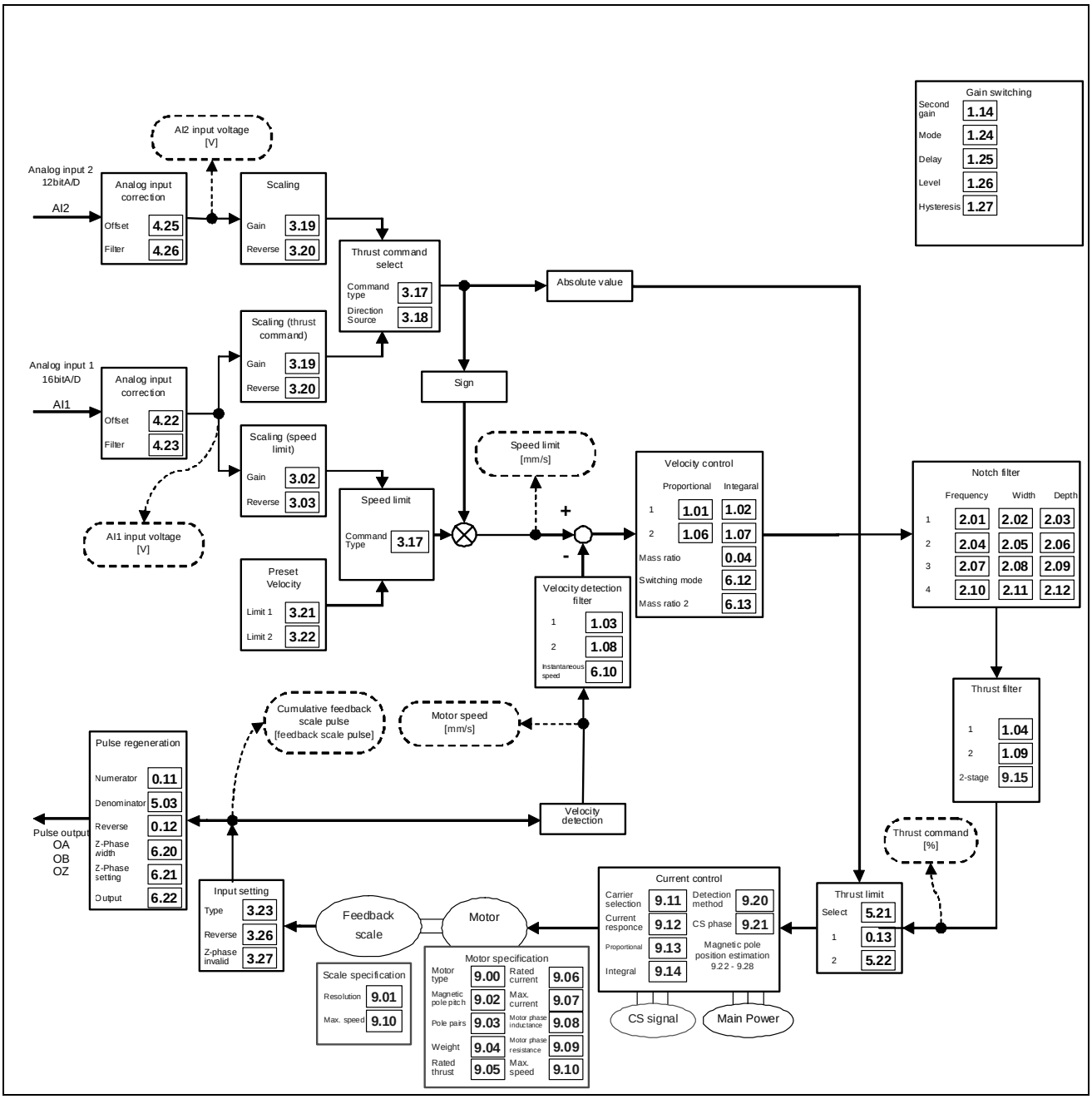
A5 series speed control has a structure shown in the following block diagram.



Velocity control block diagram

5-2-3 Block Diagram of Thrust Control Mode [LA1] is not possible to use it.

A5 series thrust control has a structure shown in the following block diagram.



Thrust control block diagram

5-2-4 Gain Switching Function

Gain switching by internal data or external signals provides the following effects.

- Decreased gain during stop (servo lock) for reducing vibration.
- Increased gain during stop (stabilization) for reducing the stabilization time.
- Increased gain during operation for faster follow-up to command.
- Gain is switched by external signals in accordance with device conditions.

1) Related parameters

The gain switching function can be specified by the following parameters:

<table>
<tr><th>Category</th><th>No.</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td>1</td><td>14</td><td>2nd gain setup</td><td>0~1</td><td>-</td><td>Specified for optimum tuning by using the gain switching function.
0: Fixed at first gain. The gain switch input (GAIN) is used to switch the speed loop operation between PI and P operations.
From GAIN input photocoupler OFF to PI operation
From GAIN input photocoupler ON to P operation
* The above is the case when the logic setting of GAIN input is connect A. When the logic setting is connect B, OFF and ON are reversed.
1: Gain switching of 1st gain (Pr1.00 to Pr1.04) and 2nd gain (Pr1.05 to Pr1.09) is made valid.</td></tr>
<tr><td>1</td><td>15</td><td>Mode of position control switching</td><td>0~10</td><td>-</td><td>Specifies the trigger condition for gain switching in position control.
<table>
<tr><th>Setting</th><th>Condition of switching</th></tr>
<tr><td>0</td><td>Fixed to the first gain</td></tr>
<tr><td>1</td><td>Fixed to the second gain</td></tr>
<tr><td>2</td><td>Gain switch</td></tr>
<tr><td>3</td><td>Thrust command</td></tr>
<tr><td>4</td><td>Disabled (fixed to the first gain)</td></tr>
<tr><td>5</td><td>Speed command</td></tr>
<tr><td>6</td><td>Position deviation</td></tr>
<tr><td>7</td><td>Position command</td></tr>
<tr><td>8</td><td>Not in-position</td></tr>
<tr><td>9</td><td>Actual speed</td></tr>
<tr><td>10</td><td>Position command + actual speed</td></tr>
</table></td></tr>
<tr><td>1</td><td>16</td><td>Delay time of position control switching</td><td>0~10000</td><td>0.1 ms</td><td>Specifies the time between trigger detection and actual gain switching from the second to the first gain when the switching mode is 3 or any of 5 - 10 in position control.</td></tr>
<tr><td>1</td><td>17</td><td>Level of position control switching</td><td>0~20000</td><td>Depends on the mode</td><td>Specifies the level of the trigger when the switching mode is 3, 5, 6, 9 or 10 in position control.
The unit depends on the switching mode setting.
Note) Specify a level ≥ Hysteresis.</td></tr>
<tr><td>1</td><td>18</td><td>Hysteresis at position control switching</td><td>0~20000</td><td>Depends on the mode</td><td>Specifies the hysteresis for the trigger when the switching mode is 3, 5, 6, 9 or 10 in position control.
The unit depends on the switching mode setting.
Note) If a level is lower than hysteresis, hysteresis is set to be the same as level internally.</td></tr>
<tr><td>1</td><td>19</td><td>Position gain switching time</td><td>0~10000</td><td>0.1 ms</td><td>Under position control, if a difference between Pr1.00 “1st gain of position loop” and Pr1.05 “2nd gain of position loop“ is large, a sudden increase of position loop gain may be suppressed.
When position loop gain increases, gains change taking time specified by a setting value.</td></tr>
</table>

(Continued)

<table>
<tr><th>Category</th><th>No.</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td>1</td><td>20</td><td>Mode of velocity control switching</td><td>0~5</td><td>-</td><td>Specifies the trigger condition for gain switching in velocity control.<table><tr><th>Setting</th><th>Condition of switching</th></tr><tr><td>0</td><td>Fixed to the first gain</td></tr><tr><td>1</td><td>Fixed to the second gain</td></tr><tr><td>2</td><td>Gain switch</td></tr><tr><td>3</td><td>Thrust command</td></tr><tr><td>4</td><td>Speed command variation</td></tr><tr><td>5</td><td>Speed command</td></tr></table></td></tr>
<tr><td>1</td><td>21</td><td>Delay time of velocity control switching</td><td>0~10000</td><td>0.1 ms</td><td>Specifies the time between trigger detection and actual gain switching from the second to the first gain when the switching mode is any of 3 - 5 in velocity control.</td></tr>
<tr><td>1</td><td>22</td><td>Level of velocity control switching</td><td>0~20000</td><td>Depends on the mode</td><td>Specifies the level of the trigger when the switching mode is any of 3 - 5 in velocity control.
The unit depends on the switching mode setting.
Note) Specify a level ≥ Hysteresis.</td></tr>
<tr><td>1</td><td>23</td><td>Hysteresis at velocity control switching</td><td>0~20000</td><td>Depends on the mode</td><td>Specifies the hysteresis for the trigger when the switching mode is any of 3 - 5 in velocity control.
The unit depends on the switching mode setting.
Note) If a level is lower than hysteresis, hysteresis is set to be the same as level internally.</td></tr>
<tr><td>1</td><td>24</td><td>Mode of thrust control switching</td><td>0~3</td><td>-</td><td>Specifies the trigger condition for gain switching in thrust control.<table><tr><th>Setting</th><th>Condition of switching</th></tr><tr><td>0</td><td>Fixed to the first gain</td></tr><tr><td>1</td><td>Fixed to the second gain</td></tr><tr><td>2</td><td>Gain switch</td></tr><tr><td>3</td><td>Thrust command</td></tr></table></td></tr>
<tr><td>1</td><td>25</td><td>Delay time of thrust control switching</td><td>0~10000</td><td>0.1 ms</td><td>Under thrust control and switching mode "3," specify actual time of period between trigger detection and switching gain for switching from 2nd gain to 1st gain.</td></tr>
<tr><td>1</td><td>26</td><td>Level of thrust control switching</td><td>0~20000</td><td>Depends on the mode</td><td>Under thrust control and switching mode "3," specify a level for trigger assessment.
The unit depends on the switching mode setting.
Note) Specify a level ≥ Hysteresis.</td></tr>
<tr><td>1</td><td>27</td><td>Hysteresis at thrust control switching</td><td>0~20000</td><td>Depends on the mode</td><td>Under thrust control, and switching mode "3," specify hysteresis for trigger assessment
The unit depends on the switching mode setting.
Note) If a level is lower than hysteresis, hysteresis is set to be the same as level internally.</td></tr>
</table>

2) Usage

After a gain switching mode for each control mode to use, and make gain switching function valid (Pr1.14=1) by Pr1.14 "2nd gain setup" to use.

Switching mode setting	Condition of switching	Description of gain switching
0	Fixed to the first gain	Fixed to 1st gain (Pr1.00 to Pr1.04).
1	Fixed to the second gain	Fixed to 2nd gain (Pr1.05 to Pr1.09).
2	Gain switch	The first gain is used when Gain switch (GAIN) is open. The second gain is used when Gain switch (GAIN) is connected to COM-. * If Gain switch (GAIN) is not assigned to any input signal, the first gain is always used.
3	Thrust command	If the previously used first gain has caused the absolute value of the thrust command to exceed "Level + Hysteresis" [%], the second gain is used. If the previously used second gain has caused the absolute value of the thrust command to stay below "Level – Hysteresis" [%] for the delay time, the first gain is used again.
4	Speed command variation	Enabled only in velocity control. If the previously used first gain has caused the absolute value of the speed command variation to exceed "Level + Hysteresis" [10 mm/s], the second gain is used. If the previously used second gain has caused the absolute value of the speed command variation to stay below "Level – Hysteresis" [10 mm/s] for the delay time, the first gain is used again. * The first gain is always used for control other than velocity control.
5	Speed command	Enabled in position/velocity/full-closed control. If the previously used first gain has caused the absolute value of the speed command to exceed "Level + Hysteresis" [mm/s], the second gain is used. If the previously used second gain has caused the absolute value of the speed command to stay below "Level – Hysteresis" [mm/s] for the delay time, the first gain is used again.
6	Command position deviation	Enabled in position control. If the previously used first gain has caused the absolute value of the position deviation to exceed "Level + Hysteresis" [pulses], the second gain is used. If the previously used second gain has caused the absolute value of the position deviation to stay below "Level – Hysteresis" [pulses] for the delay time, the first gain is used again. * The unit of level and hysteresis [pulses] is based on the feedback scale resolution.

(Continued)

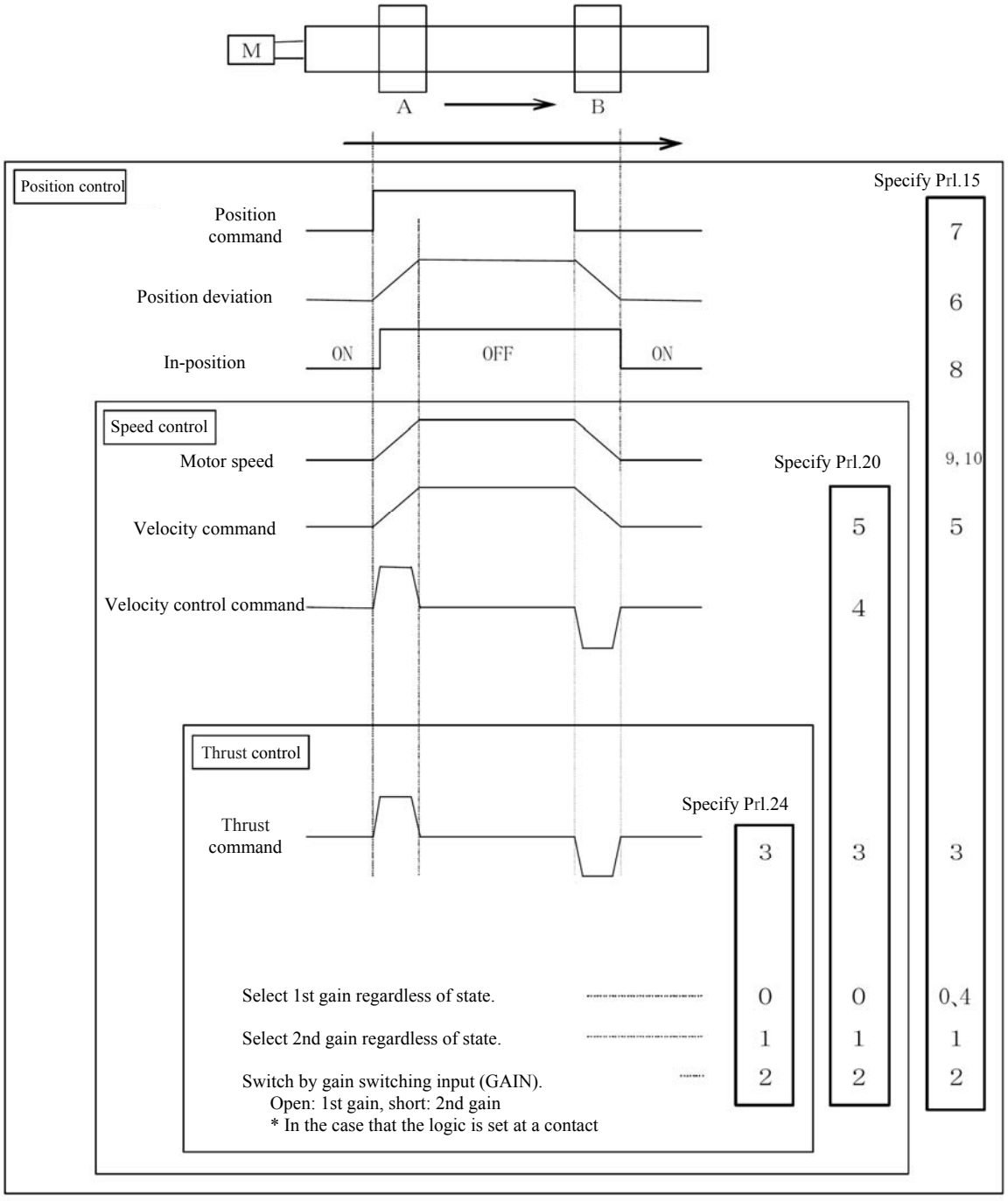
Switching mode setting	Condition of switching	Description of gain switching
7	Position command	Enabled in position control. If the first gain has been previously used and the position command is not 0, the second gain is used. If the second gain has been previously used and the position command has stayed 0 for the delay time, the first gain is used again.
8	Not in-position	Enabled in position control. If the previously used first gain has caused incomplete positioning, the second gain is used. If the previously used second gain has caused in-position state to be maintained for the delay time, the first gain is used again.
9	Actual speed	Enabled in position control. If the previously used first gain has caused the absolute value of the actual speed to exceed "Level + Hysteresis" [mm/s], the second gain is used. If the previously used second gain has caused the absolute value of the actual speed to stay below "Level – Hysteresis" [mm/s] for the delay time, the first gain is used again.
10	Position command + actual speed	Enabled in position control. If the first gain has been previously used and the position command is not 0, the second gain is used. If the second gain has been previously used, the position command has stayed 0 for the delay time and the absolute value of the actual speed is below "Level – Hysteresis" [mm/s], the first gain is used again.

3) Setting procedures

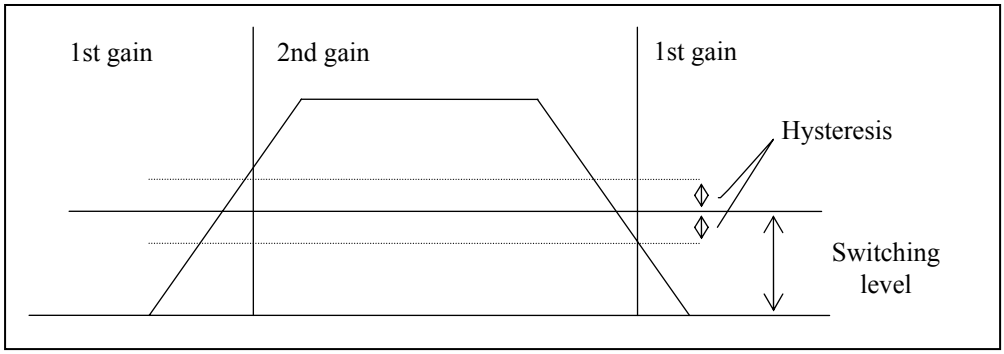
For example, assume that conditions inside the servo drive changed as shown in the following figure, when the load moved from A position to B position. The following describes the procedures for specifying related parameters when using the gain switching function under those conditions.

1) Specify the conditions of switching gains with the following parameters:

Pr1.15 "Mode of position control switching"
Pr1.20 "Mode of velocity control switching"
Pr1.24 "Mode of thrust control switching"

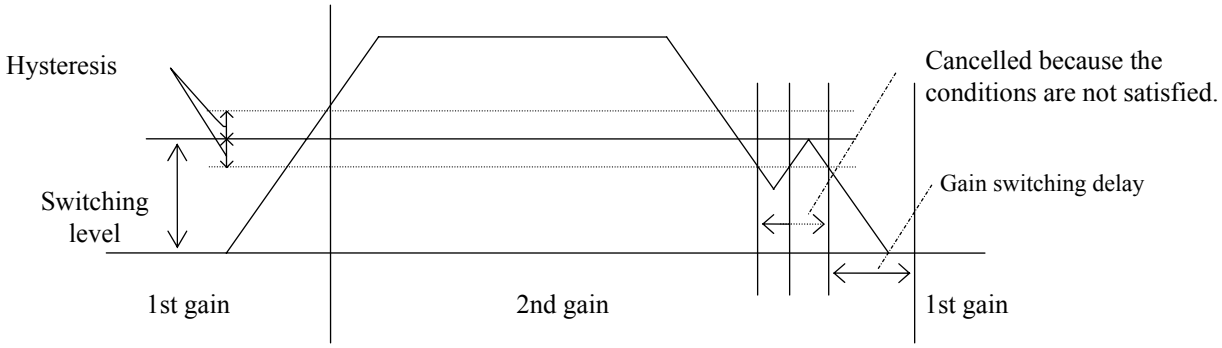


2) Specify switching level and hysteresis in accordance with switching conditions.



3) Specify switching delay time

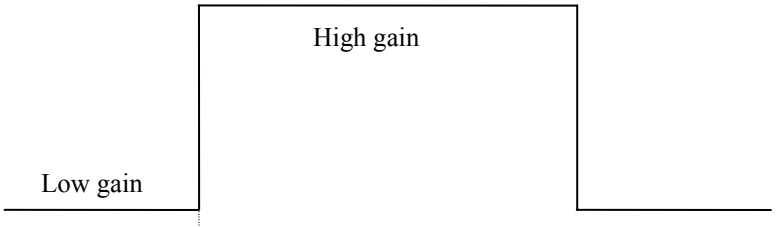
The switching delay time specifies a period of delay time for switching from 2nd gain to 1st gain.
When switching from 2nd gain to 1st gain, the switching conditions must be satisfied during a period of switching delay time.



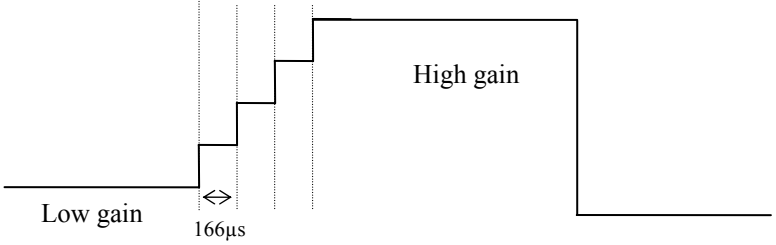
4) Specify position gain switching time.

When switching gains, velocity loop gain, speed integration constant, speed detection filter, and thrust filtering constant are switched instantaneously. However, position loop gain can be gradually switched to avoid problems caused by sudden change to a high gain.

When "0" is specified for Pr1.19 "Position gain switching time.



When "5" is specified for Pr1.19 "Position gain switching time



5-2-5 Notch Filter

When the mechanical stiffness is low, resonance due to axis distortion, etc. may generate vibration or noise, in which case a high gain cannot be specified. In that case, specifying a higher gain or reducing vibrations is made possible by suppressing a resonance peak with the notch filter.

1) Related parameter

A5 series allows use of four notch filters that can adjust frequency, width, and depth.

Category	No.	Parameter	Setup range	Unit	Function
2	01	1st Notch frequency	50~5000	Hz	Specifies the center frequency of the first notch filter. Specifying 5000 disables the notch filter.
2	02	1st notch width selection	0~20	-	Specifies the frequency width of the first notch filter.
2	03	1st notch depth selection	0-99	-	Specifies the depth at the center frequency of the first notch filter.
2	04	2nd notch frequency	50~5000	Hz	Specifies the center frequency of the second notch filter. Specifying 5000 disables the notch filter.
2	05	2nd notch width selection	0~20	-	Specifies the frequency width of the second notch filter.
2	06	2nd notch depth selection	0~99	-	Specifies the depth at the center frequency of the second notch filter.
2	07	3rd Notch frequency *1	50~5000	Hz	Specifies the center frequency of the third notch filter. Specifying 5000 disables the notch filter.
2	08	3rd notch width selection *1	0~20	-	Specifies the frequency width of the third notch filter.
2	09	3rd notch depth selection *1	0~99	-	Specifies the depth at the center frequency of the third notch filter.
2	10	4th Notch frequency *1	50~5000	Hz	Specifies the center frequency of the fourth notch filter. Specifying 5000 disables the notch filter.
2	11	4th notch width selection *1	0~20	-	Specifies the frequency width of the fourth notch filter.
2	12	4th notch depth selection *1	0~99	-	Specifies the depth at the center frequency of the fourth notch filter.

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

2) Usage

Specify a resonance frequency on the basis of the frequency characteristics measurement function of the setup support software, or operating waveform on the waveform graphic function, and specify a Notch frequency for use.

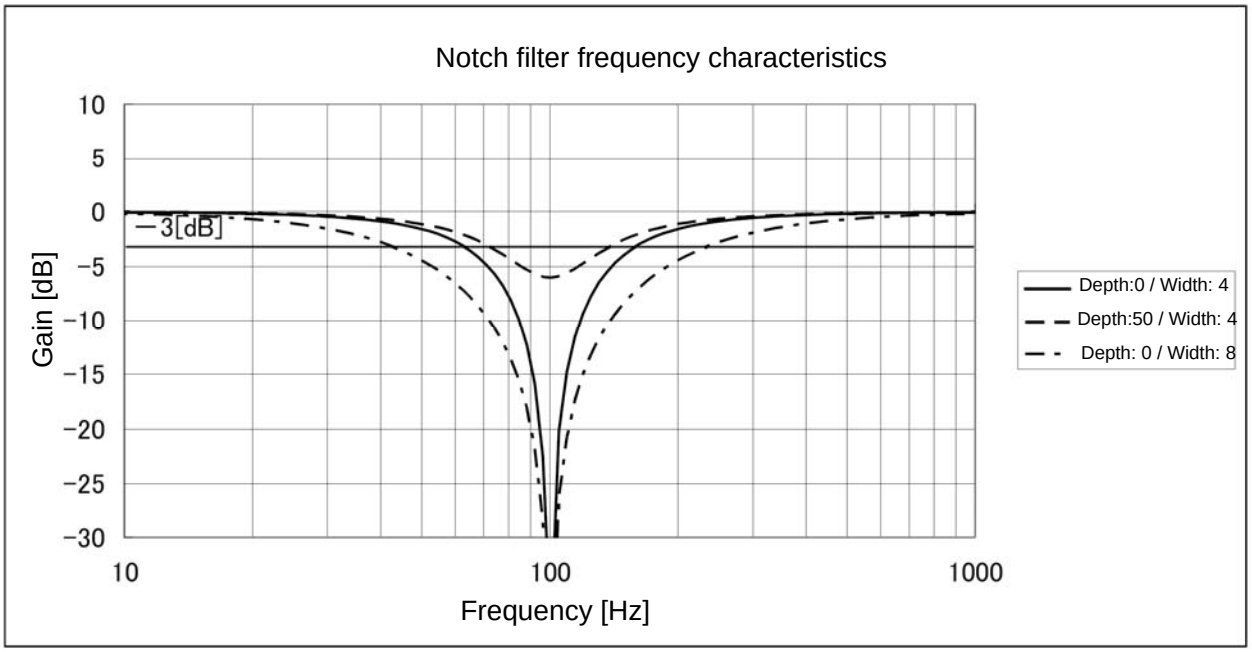
3) Notch width/depth

A value on the left of the following table is specified for a width of Notch filter, which is a ratio of frequency band width in which damping factor becomes –3 [dB] against the Notch center frequency with depth of "0."

The depth of a notch filter is an I/O ratio that provides the complete interruption of the center frequency input with a setting of 0 and complete passage with a setting of 100. In [dB], the values are as shown in the rightmost column of the table below on the right.

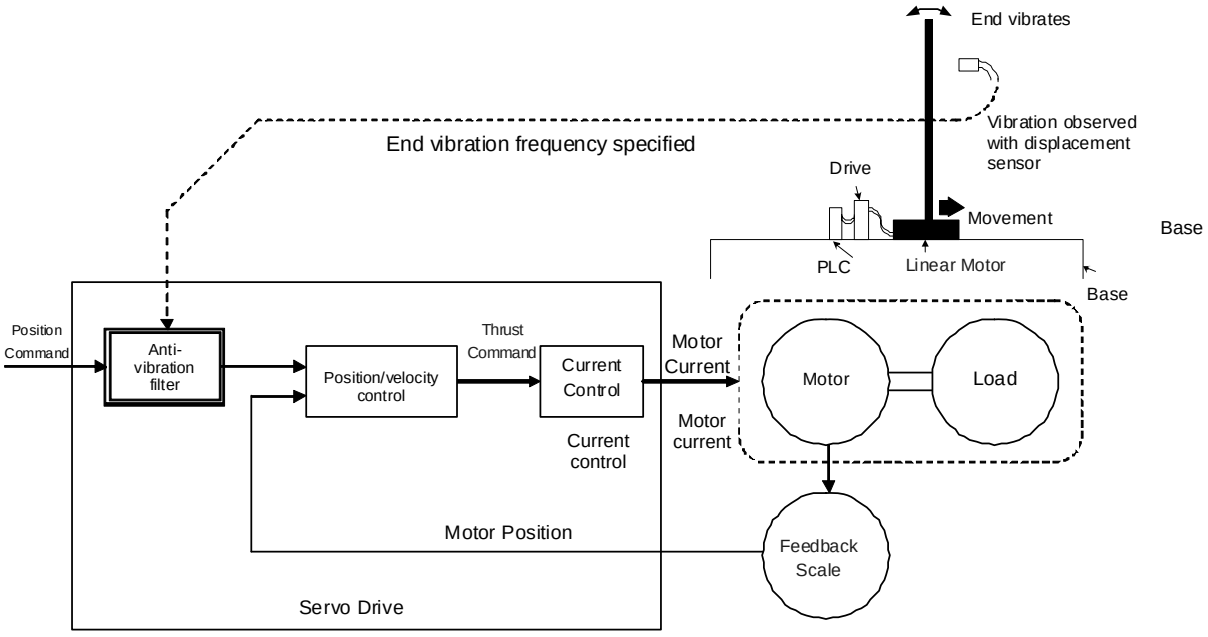
Notch width	Bandwidth/Center frequency	
	A4 series (Reference)	A5 series
0	0.41	0.50
1	0.56	0.59
2	0.71	0.71
3	0.86	0.84
4	1.01	1.00
5		1.19
6		1.41
7		1.68
8		2.00
9		2.38
10		2.83
11		3.36
12		4.00
13		4.76
14		5.66
15		6.73
16		8.00
17		9.51
18		11.31
19		13.45
20		16.00

Notch depth	I/O ratio	In [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

When an end of the equipment vibrates or the entire device shakes, damping control can be used to remove the vibration frequency component from a position command for the reduction of vibration. Of the four frequency settings, up to two can be used simultaneously.



1) Scope of applications

Damping control functions under the following conditions.

	Conditions for the functioning of damping control
Control mode	Must be position control. Pr0.02 = 0: Position control Pr0.02 = 3: 1st control mode of position and speed control Pr0.02 = 4: 1st control mode of position and thrust control

2) Cautions

Damping control may not function normally or may not be effective in the following conditions.

	Conditions hindering the functioning of damping control
Load condition	· Vibration is excited by a factor other than a command (external force, etc.). · The ratio of the resonance frequency to the antiresonance frequency is large. · The vibration frequency is out of the 1.0 - 200.0 [Hz] range.

3) Related parameters

The operation of damping control can be specified by using the following parameters.

<table>
<tr><th>Category</th><th>No.</th><th>Parameter</th><th>Setup range</th><th>Unit</th><th>Function</th></tr>
<tr><td>2</td><td>13</td><td>Selection of damping filter switching</td><td>0~3</td><td>-</td><td>Specifying the mode for switching between four filters used for damping control.
· 0: up to two filters can be used simultaneously.
· 1 or 2: switched by external input (VS-SEL1/VS-SEL2)
<table>
<tr><th>Pr 2.13</th><th>VS-SEL2</th><th>VS-SEL1</th><th>1st vibration suppression</th><th>2nd vibration suppression</th><th>3rd vibration suppression</th><th>4th vibration suppression</th></tr>
<tr><td>0</td><td>-</td><td>-</td><td>Enabled</td><td>Enabled</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td rowspan="2">1</td><td>-</td><td>OFF</td><td>Enabled</td><td>Invalid</td><td>Enabled</td><td>Invalid</td></tr>
<tr><td>-</td><td>ON</td><td>Invalid</td><td>Enabled</td><td>Invalid</td><td>Enabled</td></tr>
<tr><td rowspan="4">2</td><td>OFF</td><td>OFF</td><td>Enabled</td><td>Invalid</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td>OFF</td><td>ON</td><td>Invalid</td><td>Enabled</td><td>Invalid</td><td>Invalid</td></tr>
<tr><td>ON</td><td>OFF</td><td>Invalid</td><td>Invalid</td><td>Enabled</td><td>Invalid</td></tr>
<tr><td>ON</td><td>ON</td><td>Invalid</td><td>Invalid</td><td>Invalid</td><td>Enabled</td></tr>
</table>
· 3: switched by direction
<table>
<tr><th>Pr 2.13</th><th>Position command</th><th>1st vibration suppression</th><th>2nd vibration suppression</th><th>3rd vibration suppression</th><th>4th vibration suppression</th></tr>
<tr><td rowspan="2">3</td><td>Positive</td><td>Enabled</td><td>Invalid</td><td>Enabled</td><td>Invalid</td></tr>
<tr><td>Negative</td><td>Invalid</td><td>Enabled</td><td>Invalid</td><td>Enabled</td></tr>
</table></td></tr>
<tr><td>2</td><td>14</td><td>1st damping frequency</td><td>0~2000</td><td>0.1 Hz</td><td>Specifies the first damping frequency of damping control to suppress vibration of an end of the load. Measure the frequency of the vibration of the load end and specify in increments of 0.1 [Hz].
The effective frequency setting range is 1.0 - 200.0 [Hz]. Specifying 0 - 9 disables the setting.</td></tr>
<tr><td>2</td><td>15</td><td>1st damping filter setup</td><td>0~1000</td><td>0.1 Hz</td><td>Specify a small value if torque saturation has occurred when specified to enable the first damping frequency. Specify a large value for faster operation.
Normally, use 0 as the setting.
Note) A maximum setting value is internally limited to smaller value of corresponding damping frequency or (2000 - damping frequency).</td></tr>
<tr><td>6</td><td>41</td><td>1st damping depth</td><td>0 – 1000</td><td>-</td><td>Specifies the depth of first damping frequency.
Depth becomes shallow become the deepest in set value 0, and enlarging a set value.
The delay grows though the effect of the damping control improves by depth deep. The effect of the damping control becomes small though the delay becomes small when depth is shoaled.
Please use it when you want to fine-tune the effect of the damping control and the delay.</td></tr>
<tr><td>2</td><td>16</td><td>2nd damping frequency</td><td>0~2000</td><td>0.1 Hz</td><td>Specifies the second damping frequency of damping control to suppress vibration of an end of the load. Measure the frequency of the vibration of the load end and specify in increments of 0.1 [Hz].
The effective frequency setting range is 1.0 - 200.0 [Hz]. Specifying 0 - 9 disables the setting.</td></tr>
<tr><td>2</td><td>17</td><td>2nd damping filter setup</td><td>0~1000</td><td>0.1 Hz</td><td>Specify a small value if torque saturation has occurred when specified to enable the second damping frequency. Specify a large value for faster operation.
Normally, use 0 as the setting.
Note) A maximum setting value is internally limited to smaller value of corresponding damping frequency or (2000 - damping frequency).</td></tr>
</table>

*1 Switching of damping frequency and damping filter setup is performed during output of positioning completion, and upon starting up command of changing command pulse (before positioning command filtering) from "0" to a value other than "0" for an command pulse detection cycle (0.166 ms).
If damping frequency is particularly high or it is changed to be invalid, and a wide range of positioning completion has been specified, massive amount of residing pulses in the filter (an area found by integrating a value of subtracting position command after filtering from position command before filtering with time) may be suddenly released immediately after switching. Therefore, a sudden action of returning to a correct position may result in temporary rotation of motor faster than originally instructed. Use caution.

*2 There is a delay in applying changed vibration suppression frequencies and damping filter setup to internal calculations. If a switching timing of *1 comes within the delay time, the changes may be suspended.

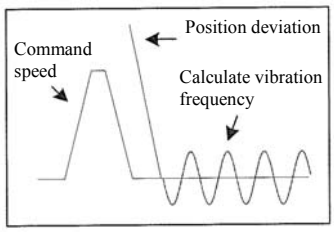
Category	No.	Parameter	Setup range	Unit	Function
2	18	3rd damping frequency	0~2000	0.1 Hz	Specifies the third damping frequency of damping control to suppress vibration of an end of the load. Measure the frequency of the vibration of the load end and specify in increments of 0.1 [Hz]. The effective frequency setting range is 1.0 - 200.0 [Hz]. Specifying 0 - 9 disables the setting.
2	19	3rd damping filter setup	0~1000	0.1 Hz	Specify a small value if torque saturation has occurred when specified to enable the third damping frequency. Specify a large value for faster operation. Normally, use 0 as the setting. Note) A maximum setting value is internally limited to smaller value of corresponding damping frequency or (2000 - damping frequency).
2	20	4th damping frequency	0~2000	0.1 Hz	Specifies the fourth damping frequency of damping control to suppress vibration of an end of the load. Measure the frequency of the vibration of the load end and specify in increments of 0.1 [Hz]. The effective frequency setting range is 1.0 - 200.0 [Hz]. Specifying 0 - 9 disables the setting.
2	21	4th damping filter setup	0~1000	0.1 Hz	Specify a small value if torque saturation has occurred when specified to enable the fourth damping frequency. Specify a large value for faster operation. Normally, use 0 as the setting. Note) A maximum setting value is internally limited to smaller value of corresponding damping frequency or (2000 - damping frequency).

4) Usage

1) Setting of damping frequency (Pr2.14, Pr2.16, Pr2.18, Pr2.20)

Measure the vibration frequency of the end of the load. If it can be directly measured with a laser displacement gauge, etc., read the vibration frequency in increments of 0.1 [Hz] from the measured waveform and specify the value for the parameter.

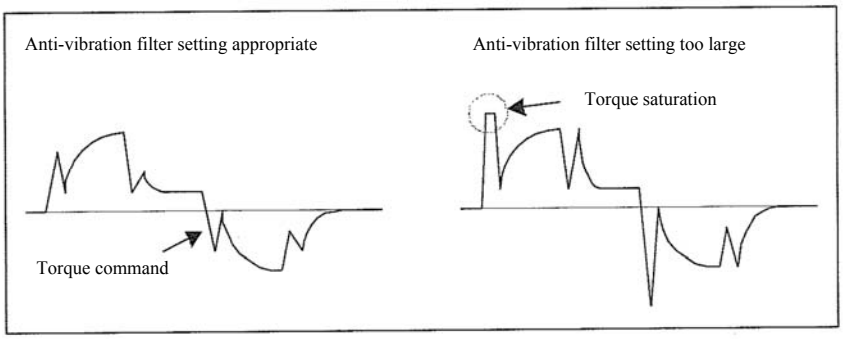
If a measuring instrument is not available, measure a frequency using the vibration frequency monitor of the setup support software, or using the residing vibrations of position deviation waveform measured with the waveform graphic function.



2) Setting of damping filter setup (Pr2.15, Pr2.17, Pr2.19, Pr2.21)

Specify 0 first to monitor the thrust waveform during operation.

Setting the large value can reduce the stabilization time, but it increases ripple at the command change point as shown in the figure below. Specify the value in the range that does not cause thrust saturation in the actual conditions of use. Thrust saturation may impair the damping effect.



3) Setting of depth of damping (Pr6.41) *Effecive only for the 1st damping setting.

Specify 0 first. To shorten the stabilization time from the current condition, setting value is enlarged little by little. If you set the enlarging value, stabilization time will be shorten, but damping effort will be reduced. Please adjust it while confirming the condition of the stabilization time and the vibration.

5-2-7 Feed Forward Function

Position deviation can be reduced and response can be improved in comparison with controlling by feedback only, but also using the velocity feed forward function, which calculates speed control command required for operations on the basis of internal position command and adds the calculation to speed control, which is calculated by comparison with position feedback.

The thrust feed forward function, which calculates thrust command required for operations on the basis of speed control command and adds the calculation to thrust command calculated by comparison with speed feedback, improves responses of the speed control system.

1) Related parameters

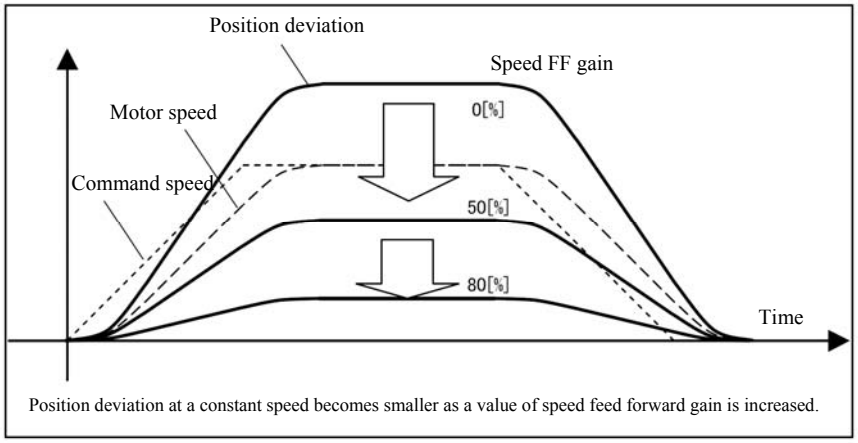
A5 series is capable of using two feed forward functions, velocity feed forward and thrust feed forward.

Category	No.	Parameter	Setup range	Unit	Function
1	10	Velocity feed forward gain	0~1000	0.1%	This adds a value, which is obtained by multiplying a speed control command calculated on the basis of internal position command with a ratio of this parameter, to a speed command from position control process.
1	11	Velocity feed forward filter	0~6400	0.01 ms	A time constant of primary delay filter is specified for inputting to velocity feed forward.
1	12	Thrust feed forward gain	0~1000	0.1%	This adds a value, which is obtained by multiplying a thrust command calculated on the basis of speed control command with a ratio of this parameter, to a thrust command from speed control process.
1	13	Thrust feed forward filter	0~6400	0.01 ms	A time constant of primary delay filter is specified for inputting to thrust feed forward.
6	00	Analog thrust feed forward gain setting * [LA1] is not possible to use it.	0~100	0.1 V/100%	Input gain for analog thrust feed forward is specified. 0 to 9 are invalid.
6	10	Function expansion settings	0~511	-	Bits related with analog thrust feed forward are specified. Bit 5 0: analog thrust feed forward Invalid 1: analog thrust feed forward Valid *The least significant bit is set as bit 0.

2) Example of using velocity feed forward

Velocity feed forward is made valid by gradually increasing velocity feed forward gain with velocity feed forward filter specified at approximately 50 (0.5 ms). Position deviation during operation at a constant speed becomes smaller as expressed by the following equation, in accordance with a value of velocity feed forward gain.

Position deviation [Command unit] = Command speed [Command unit/s]/position loop gain [1/s] × (100 - velocity feed forward gain [%]) / 100



Position deviation at a constant speed becomes smaller as a value of speed feed forward gain is increased.

If a gain is specified as 100 [%], position deviation theoretically becomes "0." However, this causes significant overshoot in acceleration and deceleration.

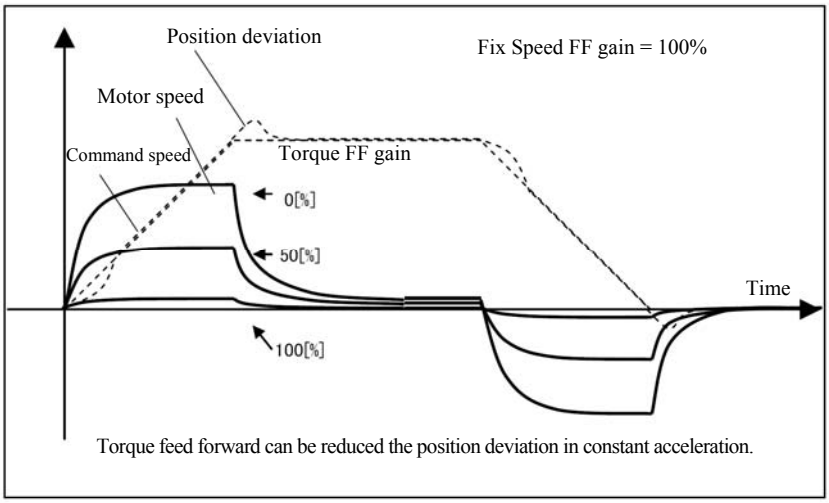
If an updating cycle of position command input is longer than a control cycle of drive, or if pulse frequencies are uneven, operating noise may be louder when velocity feed forward is valid. In that case, use position command filter (Primary delay/FIR smoothing) of specify a higher value for velocity feed forward filter.

3) Example of using thrust feed forward

To use thrust feed forward, mass ratio must be specified correctly. Use an estimated value used for operation of real-time auto tuning again, or specify an mass ratio calculated on the basis of machine specifications for Pr0.04 "Mass ratio."

Thrust feed forward is made valid by gradually increasing thrust feed forward gain with thrust feed forward filter specified at approximately 50 (0.5 ms).

Increasing thrust feed forward gain can make position deviation closer to "0" under a constant acceleration/deceleration. Therefore, under ideal conditions with no influence from disturbance thrust, position deviation can be almost "0" for all operating ranges in operations of a trapezoid speed pattern.



However, under actual conditions, position deviation does not become completely "0" because there is always disturbance thrust.

Just as the case with velocity feed forward, specifying a larger time constant for thrust feed forward filter reduces operating noises. However, it makes position deviation larger at a changing point of acceleration.

Moreover, the noise element of the thrust feed forward output increases when the scale resolution is low and high-ranking controller's instruction update cycle are long. In that case, please enlarge a set value of Pr1.13 "Thrust feed forward filter".

4) Example of using analog thrust feed forward [LA1] is not possible to use it.

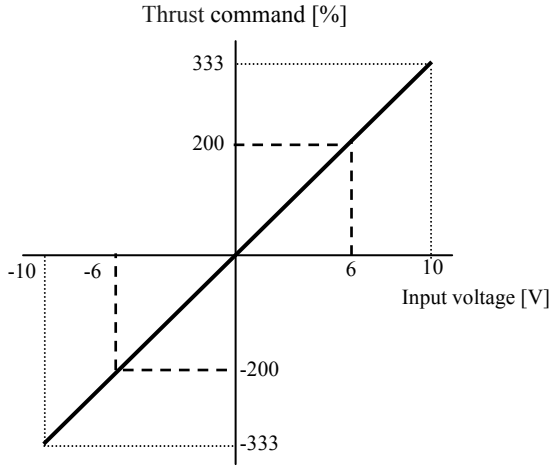
Specifying "1" for bit 5 of Pr6.10 "Function expansion setup" makes analog thrust feed forward valid. If analog input 3 is used for another function (e.g. Analog thrust limit), the function is made invalid.

A voltage [V] applied to analog input 3 is converted into a thrust by Pr6.00 "Analog thrust feed forward conversion gain " and the value is added to thrust command [%].

Conversion of input voltage [V] to analog input 3 into thrust command [%] to motor is performed as shown in the following graph.

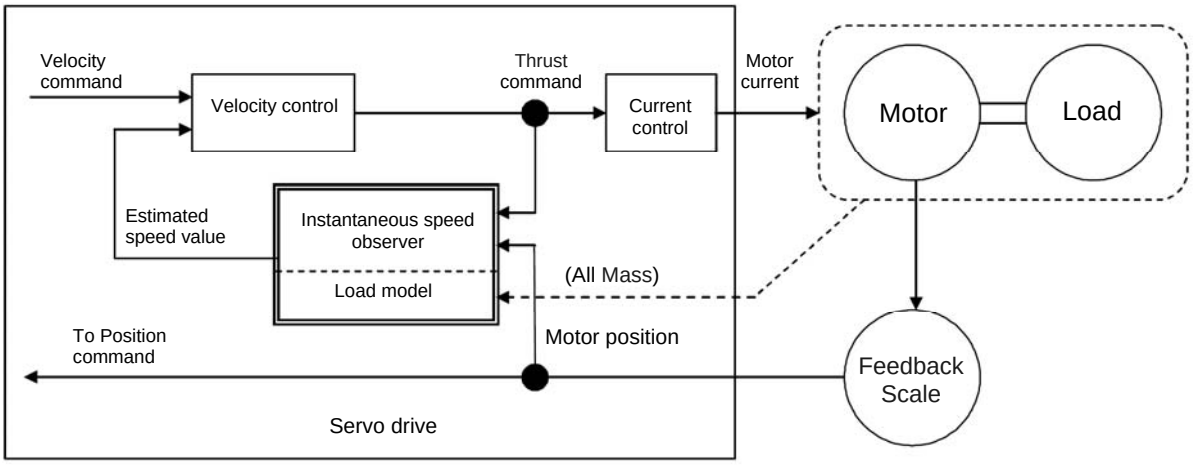
The gradient of graph is that for Pr6.00=30. The gradient depends on Pr6.00 setting values.

Thrust command [%] =
100 × Input voltage [V] / (Pr6.00 Setting value × 0.1)



5-2-8 Instantaneous Speed Observer

This function improves speed detection accuracy by estimating a motor speed using a load model, improving response and reducing vibrations at halting at the same time.



(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating instantaneous speed observer
Control mode	· Either position or speed control.
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor rotation. · Real-time auto tuning is invalid. (Pr0.02=0) · Motor type is linear motor. (Pr9.00=1) · The speed estimation is not working while executing the magnetic pole position estimation.

(2) Cautions

☐ This function may NOT operate correctly or have no effect under the following conditions.

	Conditions that may interfere with effect of instantaneous speed observer
Loads	· A mass load, which regards a motor and loads as one, is significantly different from actual device. Example) A significant resonance point exists in a frequency band at 300 [Hz] or lower. A nonlinear element such as a significant backlash exists. · Load mass changes. · A disturbance thrust with significant high-frequency component is applied.
Other	· A scope of positioning settling is extremely narrow.

(3) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
6	10	Function expansion settings	0~511	-	Specify valid/invalid of function using speed observer function permission bit (bit0. Bit 0 0: Invalid 1: Valid *The least significant bit is set as bit 0.

(4) Usage

1) Setting of Pr0.04 "Mass ratio"

Specify mass ratio as precisely as possible.

- If Pr0.04 "Mass ratio" usable for normal position control has been found by real-time automatic gain tuning, use the Pr0.04 setting value on an as-is basis.
- If a mass ratio has already known by load calculation, input a calculated value.
- If a mass ratio is unknown, measure a mass ratio by performing auto tuning.

2) Adjustment under normal position control

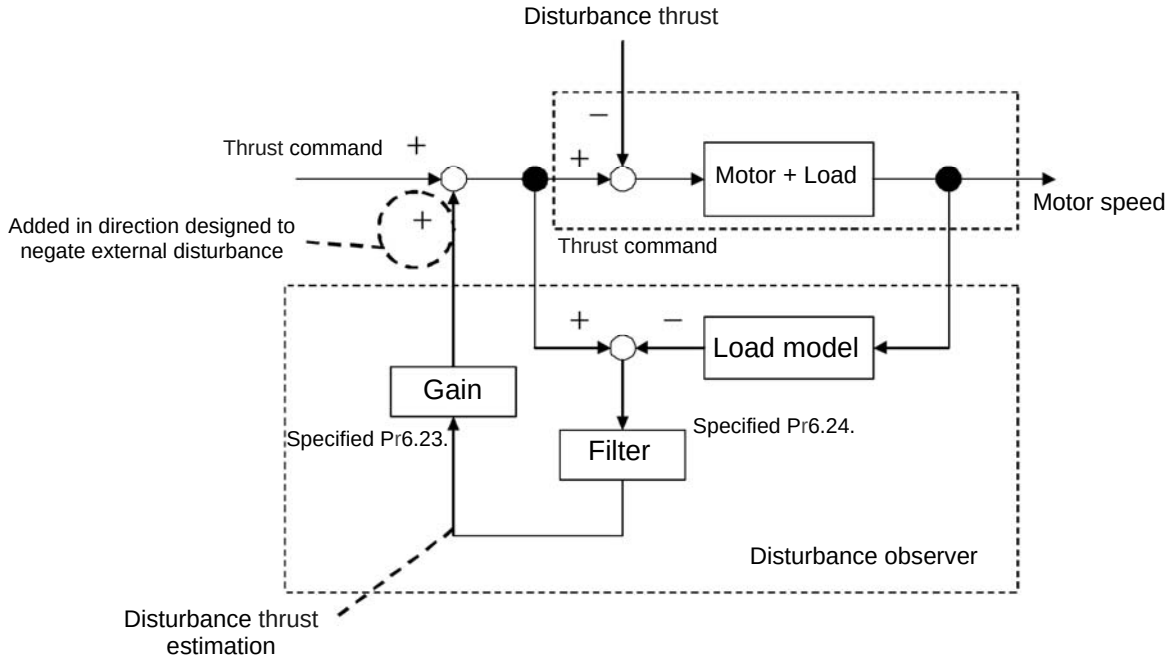
- Adjust position loop gain and velocity loop gain.

3) Specify Pr6.10 "Function expansion setup"

- Making instantaneous speed observer function valid by Pr6.10 "Function expansion setup" switches speed detection system into instantaneous speed observer.
- If thrust waveform changes or operating noises become louder, recover previous settings immediately and check the cautions above and item 1).
- If the setting has effects of changing thrust waveform or reducing operating noises, make fine turning of Pr0.04 "Mass ratio" by verifying position deviation waveform and actual speed waveform to find settings that make least changes. If position loop gain or velocity loop gain has been changed, an optimum value of Pr0.04 " Mass ratio" may change. Make fine tuning again.

5-2-9 Disturbance Observer

This function reduces influences of disturbance thrust and reduces vibrations using disturbance thrust estimation value estimated with the disturbance observer.



(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating disturbance observer
Control mode	· Under position control or speed control
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor rotation. · Real-time auto tuning is invalid. (Pr0.02=0) · Instantaneous speed observer function is invalid. (Pr6.10 bit0=0) · Motor type is linear motor. (Pr9.00=1) · The disturbance observer is not working while executing the magnetic pole position estimation.

(2) Cautions

☐ This function may have no effect under the following conditions.

	Conditions that may interfere with effect of disturbance observer
Loads	· A resonance point exists in a cutoff frequency estimated by the disturbance observer. · Disturbance thrust contains much high frequency components. · Scale resolution is low.

(3) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
6	10	Function expansion settings	0 - 511	-	Bits related to disturbance observer are specified. Bit 1 0: Disturbance observer Invalid 1: Disturbance observer Valid Bit 2 0: Always valid mode 1: Valid only when 1st gain is selected *The least significant bit is set as bit 0. Example) When disturbance observer is used only with 1st gain selected Setting value= Specify 6. When disturbance observer is always used in valid mode. Setting value= Specify 2.
6	23	Disturbance thrust compensating gain	-100 - 100	%	To set the compensation gain for the disturbance thrust.
6	24	Disturbance observer filter	10 - 2500	0.01 ms	To set the filter time constant for the disturbance thrust compensation.
6	40	Disturbance thrust compensation phase setting	0 - 60	Degree	The phase with the disturbance thrust estimation advances and sets the compensation value. It can compensate for the phase lag of the filter processing by Pr6.24 " Disturbance observer filter ". The effect of the turbulence suppression might become good because it basically sets it to about 45-50 degree.

(4) Usage

1) Specify disturbance observer Valid/Invalid mode, and operation mode (Always valid, Valid only with 1st gain selected) by Pr6.10 "Function expansion setup".
2) Specify Pr6.24 "Disturbance observer filter".
   Specify a larger value first, and specify a smaller value for Pr6.23 "Disturbance thrust compensating gain" to verify operations. Then try to specify smaller values gradually for Pr6.24. Smaller filter setting values allows estimating disturbance thrust with less delay and has larger effects in reducing influence of disturbance. However, it results in louder operating noises. Find settings to keep the conditions in balance.
3) Specify Pr6.23 "Disturbance thrust compensating gain."
   Specify higher value Pr6.23 after specifying Pr6.24.
   Specifying higher gain increases effects of reducing influences of disturbance. However, it makes operating noises louder. Find settings to keep the conditions in balance in consideration of Pr6.24 "Disturbance observer filter" also.
4) Specify Pr6.40 “Disturbance thrust compensation phase setting”
   When it doesn't go well by setting only Pr6.23 and Pr6.24, Pr6.40 is set.
   Please set Pr6.24 based on the following type. And Pr6.40 set to 45-50 degree, then the disturbance controlling effect might become high.
   Pr6.24 “Disturbance observer filter” [0.01ms] = 100000 / (2 π * Disturbance frequency[Hz])

5-2-10 3rd Gain Switching

In addition to normal Gain switching function described in Section 5-2-5, specifying 3rd gain is allowed to switch gain just before stopping. By specifying a higher gain for a specified period of time just before stopping, settling time for positioning can be shorter.

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating 3rd Gain switching function
Control mode	· Under position control
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

(2) Related parameters

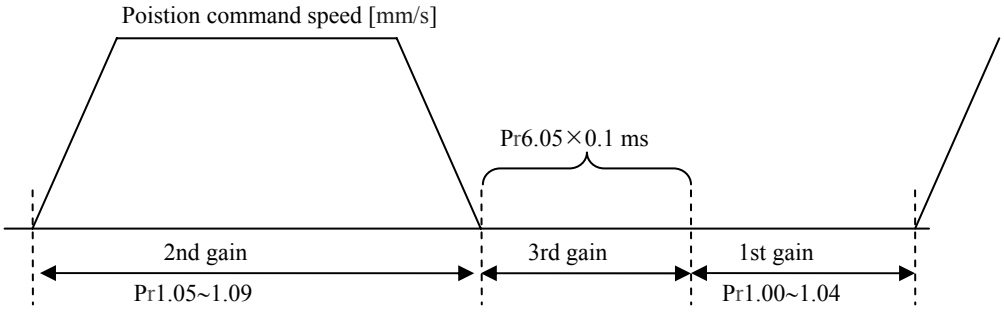
Category	No.	Parameter	Setup range	Unit	Function
6	05	Position 3rd gain valid time	0~10000	0.1 ms	Time when 3rd gain is made valid is specified.
6	06	Position 3rd gain scale factor	50~1000	%	3rd gain is specified by magnification against 1st gain. 3rd gain=1st gain×Pr6.06/100

(3) Usage

Specify time of applying 3rd gain in Pr6.05 "Position 3rd gain valid time" under conditions that gain switching function operates normally. Then specify magnification of 3rd gain against 1st gain, in Pr6.06 "Position 3rd gain scale factor".

- If 3rd gain is not used, specify Pr6.05=0 and Pr6.06=100.
- 3rd gain is valid only under position control.
- In 3rd gain area, 3rd gain is used for position loop gain/speed proportional gain only, and 1st gain setting is used for other areas.
- If 2nd gain switching conditions are satisfied in the 3rd gain area, it switches to 2nd gain.
- Upon switching from 2nd gain to 3rd gain, Pr1.19 "Position gain switching time" is applied.
- Note that switching from 2nd gain to 1st gain by parameter change also makes a 3rd gain area.

Example) In the case of Pr1.15 "Mode of position control switching"=7, switching conditions: with position command



[3rd gain area]
Position loop gain=Pr1.00×Pr6.06/100
Speed ratio gain=Pr1.01×Pr6.06/100
1st gain value is used for speed integral constant, speed detection filter and thrust filter as it is.

5-2-11 Friction Thrust Compensation

Two types of friction thrust compensation functions are available for reducing influences from frictions exists in mechanical system: Biased load compensation that compensates offset thrust at constant degree, and dynamic friction compensation that changes direction in accordance with operating directions.

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating friction thrust compensation
Control mode	· Depends on functions. Refer to parameter descriptions in section (2).
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

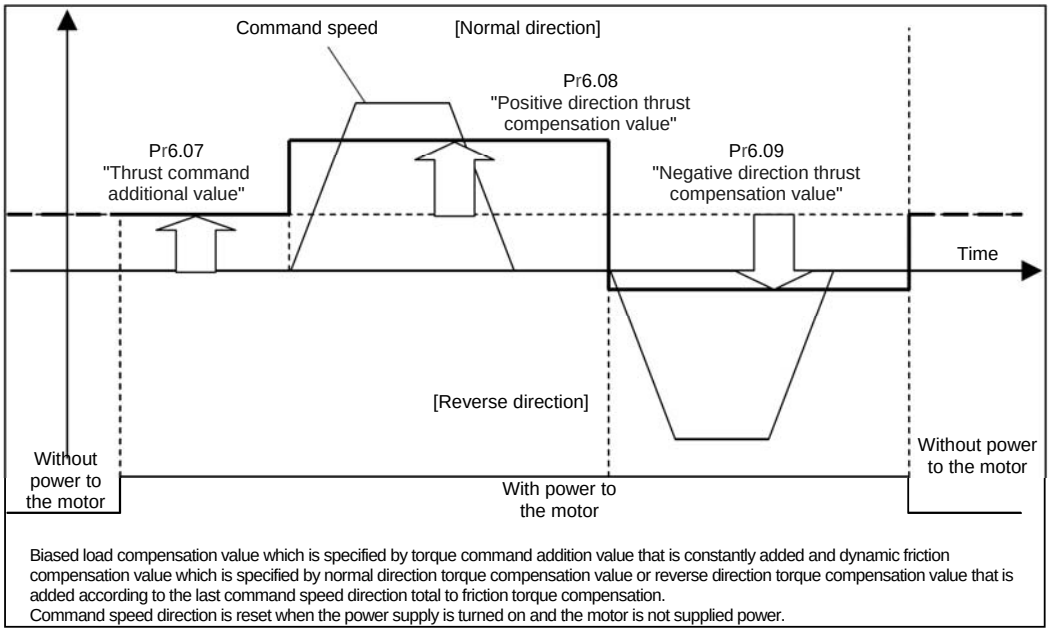
(2) Related parameters

Settings of friction thrust compensation are specified in combination of the following 3 parameters:

Category	No.	Parameter	Setup range	Unit	Function
6	07	Thrust command additional value	-100~100	%	Specify a biased load compensation value, which is always added to thrust command in other control modes than thrust control.
6	08	Positive direction thrust compensation value	-100~100	%	Specify a dynamic friction compensation value, which is added to thrust command when normal direction position command is input under position control.
6	09	Negative direction thrust compensation value	-100~100	%	Specify a dynamic friction compensation value, which is added to thrust command when reverse direction position command is input under position control.

(3) Usage

Friction thrust compensation is added in accordance with input position command direction, as show in the following figure:



Pr6.07 "Thrust command additional value" reduces variations of positioning operations, by specifying a thrust command value that may be added as a constant biased load torque applied to a motor due to gravity on vertical axis.

Pr6.08 "Positive direction thrust compensation value" and Pr6.09 "Negative direction thrust compensation value" prevents prolonging and variations of positioning settling time due to dynamic friction, by specifying friction thrust for each rotating direction on parameters, for the loads requiring larger dynamic friction thrust due to radial loads, such as belt drive axis.

Biased load compensation and dynamic friction compensation can be used either by combining or separately. However, note that the following restrictions are applicable by conditions of control mode switching and servo-on status:

· Under thrust control:Regardless of parameter settings, biased load compensation and dynamic friction compensation is set to "0."

· Under speed control and servo-off status: Biased load compensation is valid according to Pr6.07. Dynamic friction compensation is set to "0" regardless of parameter settings.

· Under position control and servo-on status: Current values for biased load compensation and dynamic friction compensation are retained until the first position command is input. At the point of changing from status without position command to status with position command, biased load compensation is updated in accordance with Pr6.07. Also, in accordance with command direction, and in accordance with parameter Pr6.08 or Pr6.09, dynamic friction compensation value is updated.

5-2-12 Mass Ratio Switching

Mass ratio can be switched between 1st and 2nd by mass ratio switching (J-SEL). This is useful for application in which load mass changes in two steps.

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating mass ratio switching function
Control mode	· This is available in all control modes.
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation. · Real-time auto tuning must be invalid. (Pr0.02=0) · Adaptive filter function must be invalid. (Pr2.00=0) · Instantaneous speed observer function is invalid. (Pr6.10 bit0=0) · Disturbance observer function must be invalid. (Pr6.10 bit1=0)

(2) Cautions

· Mass ratio must be switched with motor halting. Switching during operation may cause vibration or oscillation.

· If a difference between 1st mass ratio and 2nd mass ratio is large, vibrations may occur even when a motor is halting. Be sure to use the function after verifying that the vibrations cause no problems with an actual device.

(3) Related parameters

Settings of mass ratio switching function are specified in combination of the following 3 parameters:

Category	No.	Parameter	Setup range	Unit	Function
6	10	Function expansion setup	0~511	–	Specify bits related to mass ratio switching. Bit 3 0: Mass ratio switching Invalid 1: Valid * The least significant bit is set as bit 0. Example) When mass ratio switching is valid. Setting value=8
0	04	Mass ratio	0~10000	%	Specify 1st mass ratio. Specify a ratio of load mass against rotor mass of motor.
6	13	2nd Mass ratio	0~10000	%	Specify 2nd mass ratio. Specify a ratio of load mass against rotor mass of motor.

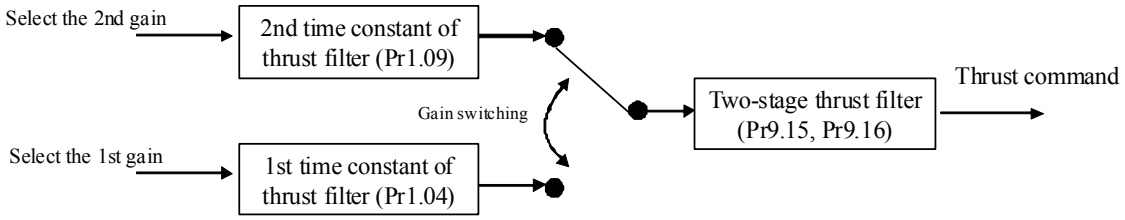
(4) Usage

Switch between 1st mass ratio and 2nd mass ratio by inputting mass ratio switching (J-SEL).

Mass ratio switching (J-SEL)	Applied mass ratio
OFF	1st mass ratio (Pr0.04)
ON	2nd mass ratio (Pr6.13)

5-2-13 Two-Stage Thrust Filter Function

In addition to current 1st/2nd thrust filter (Pr1.09, Pr1.04), the another thrust filter can be set. The controlling effect of the high vibrational element can be given by using two stage thrust filters.



(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating two-stage thrust filter function
Control mode	· This is available in all control modes.
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

(2) Cautions

· The control becomes unstable when a set value is enlarged too much, and the vibration might be generated. Please set it to an appropriate value while confirming the situation of the machine.

· When Pr9.16 "Two-stage thrust filter" is changed while operating, the vibration might be generated. Please change while stopping.

(3) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
9	15	Two-stage thrust filter	0 - 2500	0.01ms	Specify the time constant of two-stage thrust filter. Setting value 0 is disabling the function. [Use as second order filter as Pr9.16 >= 50] Correspindent time constant is 5 – 159(0.05 – 1.59ms). (It is equivalent to frequency 100 – 3000Hz) Setting value 1 – 4 operates as 5(3000Hz), 159 – 2500 operates as 159(100Hz)
9	16	Two-stage thrust filter damping term	0 - 1000	-	Specify the damping term of two-stage thrust filter. The filter term of two-stage thrust filter is switched according to this setting value. 0 - 49 : work as first order filter. 50 -1000 : work as second order filter. In setting value 1000, it becomes a second order filter about ζ=1.0. It comes to vibrate by reducing a setting value. Please use it basically in set value 1000.

(4) Usage

Set two-stage thrust filter when you cannot take the vibration of a high region with a current first/second thrust filter.

Please assume Pr9.16 "Two-stage thrust filter damping term" =1000(ζ=1.0), and adjust Pr9.15 "Two-stage thrust filter".

6. Applied Functions

6-1 Thrust Limit Switching

The parameters below have functions to switch thrust limit values per the operation direction or with the input of the thrust limit switch (TL-SEL).

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating thrust limit switching function
Control mode	· Position control, speed control
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

* During thrust control, the switch function is invalid and only Pr0.13 "1st thrust limit" is valid.

(2) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	13	1st thrust limit	0~500	%	To set the 1st limit value of the motor output thrust.
5	21	Selection of thrust limit	0~6	—	To set up the selecting mode of the thrustlimit. 0: Positive direction → P-ATL (0 - 10 V), negative direction → N-ATL (-10 - 0 V) 1: Normal direction/Reverse direction →Pr0.13 2: Normal direction →Pr0.13, Reverse direction →Pr5.22 3: TL-SEL off →Pr0.13, TL-SEL on →Pr5.22 4: Positive direction → P-ATL (0 - 10 V), negative direction → N-ATL (0 - 10 V) 5: Positive/negative directions → P-ATL (0 - 10 V) 6: TL-SEL OFF Normal direction →Pr0.13, Reverse direction →Pr5.22 TL-SEL ON Normal direction →Pr5.25, Reverse direction →Pr5.26
5	22	2nd thrust limit	0~500	%	To set the 2nd limit value of the motor output thrust.
5	23	Thrust limit switching setup 1	0~4000	ms/100%	To set the rate of change (gradient) when the thrustlimits switch from the 1st to 2nd.
5	24	Thrust limit switching setup 2	0~4000	ms/100%	To set the rate of change (gradient) when the thrustlimits switch from the 2nd to 1st.
5	25	External input positive direction thrust limit	0~500	%	To set a thrust limit in the positive direction when the thrust limit switch is entered.
5	26	External input negative direction thrust limit	0~500	%	To set a thrust limit in the negative direction when the thrust limit switch is entered.

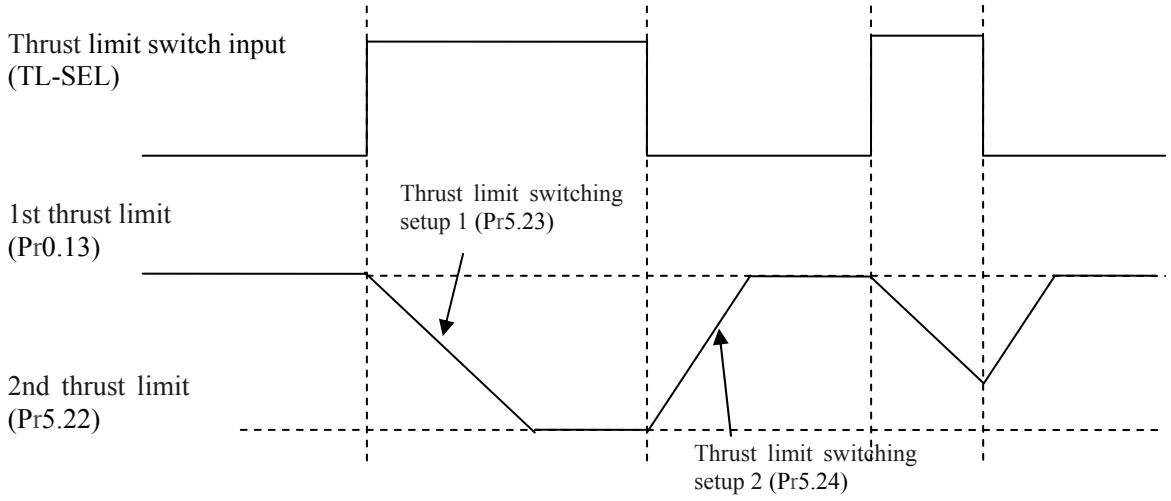
(3) Description

· The following table shows the thrust limit switch modes.

Pr5.21	Thrust limit switch input (TL-SEL)	Thrust limit switching setup (Pr5.23, Pr5.24)	Positive thrust limit	Negative thrust limit
0			Analog input *1	
1	–	–	Pr0.13	
2	–	–	Pr0.13	Pr5.22
3	OFF	Enabled	Pr0.13	
	ON		Pr5.22	
4			Analog input *1	
5				
6	OFF	–	Pr0.13	Pr5.22
	ON		Pr5.25	Pr5.26

*1 To specify thrust limit values by using the analog input, please refer to 6-2 “Analog Thrust Limit.”

· Setting up the rate of change used when the thrust limits switch
To use with Pr5.21 " Selection of thrust limit "=3, a slope can be specified for change at thrust limit switching. This setting is invalid for the other selections.
A change rate (slope) specified by Pr5.23 "Thrust limit switching setup 1" is used upon switching from 1st thrust limit to 2nd thrust limit, and a change rate (slope) specified by Pr5.24 "Thrust limit switching setup 2" is used upon switching from 2nd thrust limit to 1st thrust limit. The signs for the rates (gradients) will be switched automatically within the driver based on the magnitude correlation between the Pr0.13 “1st thrust limit” and the Pr5.22 “2nd thrust limit”.
Specifying "0" for Pr5.23 " Thrust limit switching setup 1" and Pr5.24 " Thrust limit switching setup 2" makes immediately switching.



Note) If 1st Pr0.13 ”Thrust limit” and Pr5.22 “2nd Thrust limit” s changed on the front panel or by communication, the change rate settings are ignored and a thrust limit value after change is immediately applied. The setting of the rate of change is valid only for the switchover executed by the entry of the thrust limit switch (TL-SEL).

6-2 Analog Thrust Limit [LA1] is not possible to use it.

The following shows the functions to set torque limits by using the analog inputs 1 and 2. A maximum value of thrust limit is restricted by Pr0.13 "1st thrust limit".

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating analog thrust limit
Control mode	· Position control, speed control
Other	· In Servo On status · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

(2) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	13	1st thrust limit	0~500	%	To set the 1st limit value of the motor output thrust.
5	21	Selection of thrust limit	0~6	–	To set up the selecting mode of the thrust limit. 0: Positive direction → P-ATL (0 - 10 V), negative direction → N-ATL (-10 - 0 V) 1: Positive/negative directions →Pr0.13 2: Positive direction →Pr0.13, negative direction →Pr5.22 3: TL-SEL off →Pr0.13, TL-SEL on →Pr5.22 4: Positive direction → P-ATL (0 - 10 V), negative direction → N-ATL (0 - 10 V) 5: Positive/negative directions → P-ATL (0 - 10 V) 6: With TL-SEL off, positive direction →Pr0.13, negative direction →Pr5.22 With TL-SEL on, positive direction →Pr5.25, negative direction →Pr5.26
5	27	Input gain of analog thrust limit	10~100	0.1 V /100%	The conversion gain from voltage V to the thrust limit % is set to analog thrust limit input (P-ATL,N-ATL).
4	25	Analog input 2 (AI2) offset setup	-342~342	5.86 mV	To set up the offset adjusting value for the voltage applied to the analog input 2.
4	26	Analog input 2 (AI2) filter	0~6400	0.01 ms	To set the time constant of the 1st delay filter for the voltage applied to the analog input 2.
4	28	Analog input 3 (AI3) offset setup	-342~342	5.86 mV	To set the offset adjusting value for the voltage applied to the analog input 3.
4	29	Analog input 3 (AI3) filter	0~6400	0.01 ms	To set up the time constant of the 1st delay filter for the voltage applied to the analog input 3.

(3) Description

Pr5.21	Positive analog thrust limit input (P-ATL)	Negative analog thrust limit input (N-ATL)	Positive thrust limit	Negative thrust limit
0	0~10V	-10~0V	P-ATL	N-ATL
1			Set up by using parameters. *1	
2				
3				
4	0~10V	0~10V	P-ATL	N-ATL
5	0~10V	No effect	P-ATL	
6			Set up by using parameters. *1	

*1 To specify thrust limit values by using parameters, please refer to 5-1 “Thrust Limit Switching.”

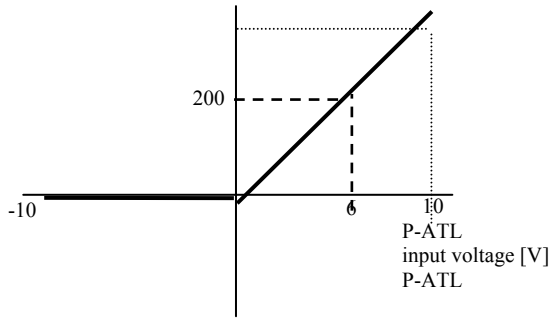
The following graphs show the conversion from the input voltage [V] of the analog thrust limit to the thrust command [%] of the motor.

The gradient used in the graphs is in case Pr5.27=30. It will vary depending on the setting done for Pr5.27.

· Pr5.21 "Selection of thrust limit" = 0

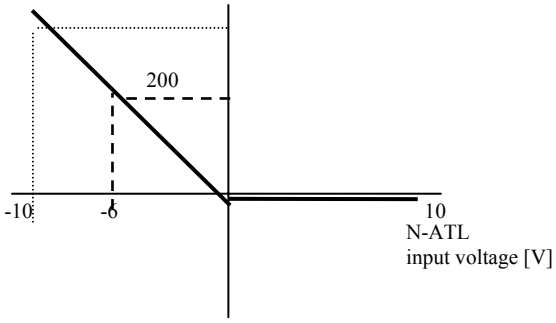
Positive analog thrust limit [%] =
100 × input voltage [V] / (Pr5.27 setting value × 0.1)

Positive thrust limit [%]



Negative analog thrust limit [%] =
100 × (- input voltage [V]) / (Pr5.27 setting value × 0.1)

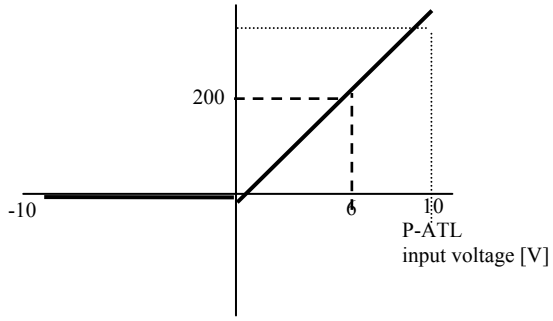
Negative thrust limit [%]



· Pr5.21 "Selection of thrust limit" = 4

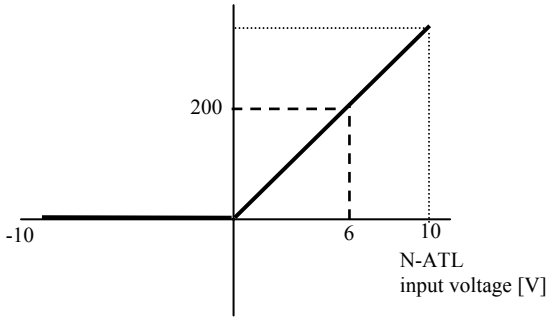
Positive analog thrust limit [%] =
100 × input voltage [V] / (Pr5.27 setting value × 0.1)

Positive thrust limit [%]



Negative thrust command [%] =
100 × input voltage [V] / (Pr5.27 setting value × 0.1)

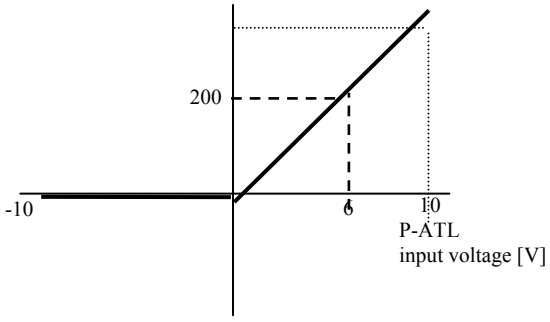
Negative thrust limit [%]



· Pr5.21 "Selection of thrust limit" = 5

Positive/negative analog thrust limit [%] =
100 × input voltage [V] / (Pr5.27 setting value × 0.1)

Positive/negative thrust limit [%]



6-3 Motor Movement Range Setting

If the motor travels exceeding the motor movable range which is set with Pr5.14 "Motor working range setup" in addition to the position command input range, the software limit protection will make an alarm stop.
The use of this function will prevent collision with the machine end caused by motor oscillation.

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Conditions for operating motor working range function
Control mode	· Position control
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

(2) Cautions

· Note that this function does not provide protection against abnormal position commands.

· If software limit protection works, the device slows down and halts in accordance with Pr5.10 " Sequence at alarm".
Some loads may contact an edge of device and cause damage. Specify a range for Pr5.14 in consideration of slowing down operations.

· The software limit protection is invalid during the trial run performed via the front monitor and when the frequency characteristics function is used through the communication.

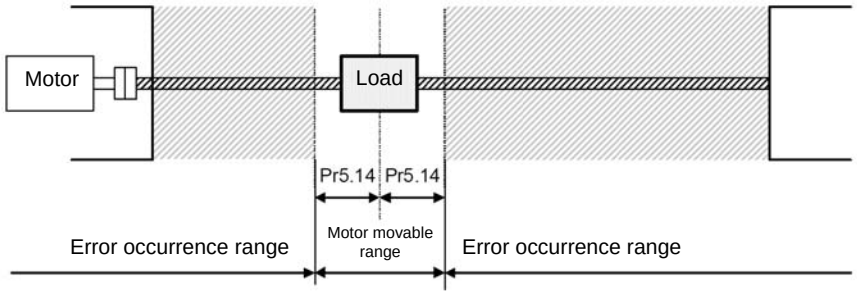
(3) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	14	Motor working range setup	0~1000	0.1 magnetic pole pitch	To set the motor working range in addition to the position command input range. Exceeding the value set with this parameter will prompt the software limit protection.

(4) Example of movement:

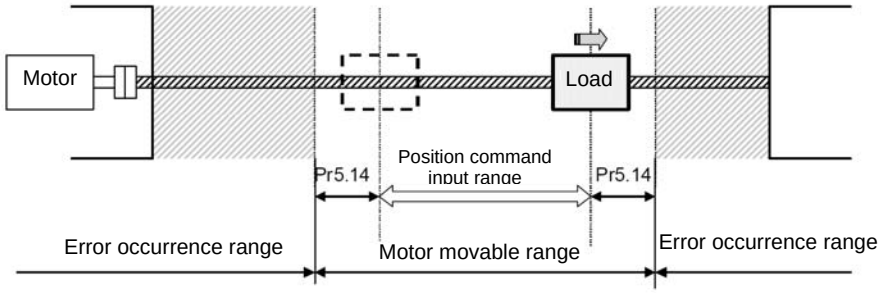
1) When no position command is entered (with the servo control on)

The motor movable range will be set only by Pr5.14 at both sides of the motor because there is no position command entered. If the load enters the error occurrence range (the lightly shaded area in the figure below) due to vibration and other reasons, the motor movable range protection will be activated.



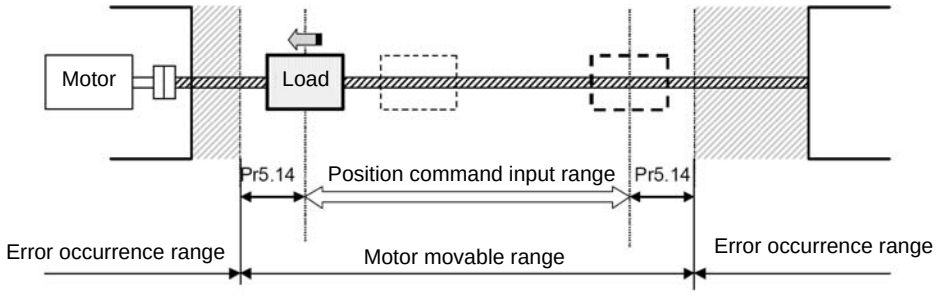
2) When the load moves to the right (with the servo control on)

Entering a position command to the right will extend the motor movable range accordingly: the total movable range will be the position command input range together with the movable area set by Pr5.14 added to the both sides.



3) When the load moves to the left (with the servo control on)

Entering a position command to the left will further extend the position command input range.



・ Conditions to clear the position command input range

The following conditions will clear the position command input range to 0:

・ The power is turned on
・ While a position deviation is being cleared (with the deviation counter clear being valid, and the input of the overtravel limit being valid with Pr5.05 "Sequence at over-travel inhibit" = 2)
・ At the start and end of the trial run performed by communication
・ While executing the magnetic pole position estimation.

6-4 Electronic Gear Switching

With the following parameters, it is possible to switch between maximum of 4 numerators of the command scaling by using DIV1 and DIV2.
For the command scaling function, please refer to 4-2-2 "Command Scaling (Electronic Gear)."

(1) Scope of application

☐ This function is applicable only when the following conditions are satisfied:

	Operating conditions for specified frequency division multiplication switching function
Control mode	· Position control
Other	· In Servo On status. · Factors other than control parameters such as the deviation counter clear and command pulse inhibition inputs and the thrust limit are appropriately configured and do not cause any problem in normal motor operation.

(2) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
0	09	1st numerator of electronic gear	1~ 1073741824	–	To set the numerator used for the command scaling performed for the command pulse input.
0	10	Denominator of electronic gear	1~ 1073741824	–	Specifies the denominator for scaling for a command pulse input.
5	00	2nd numerator of electronic gear	1~ 1073741824	–	To set the 2nd numerator used for the command scaling performed for the command pulse input.
5	01	3rd numerator of electronic gear	1~ 1073741824	–	To set the 3rd numerator used for the command scaling performed for the command pulse input.
5	02	4th numerator of electronic gear	1~ 1073741824	–	To set the 4th numerator used for the command scaling performed for the command pulse input.

· The following table shows DIV1 and DIV2, and their corresponding numerators and denominators used for the command scaling.

DIV1	DIV2	Command scaling	
		Numerator	Denominator
OFF	OFF	Pr0.09	Pr0.10
ON	OFF	Pr5.00	Pr0.10
OFF	ON	Pr5.01	Pr0.10
ON	ON	Pr5.02	Pr0.10

6-5 Setting of Sequence Movements

A series of actions can be defined for various operation states.

6.5.1 Drive prohibition input (POT , NOT) sequence

The following shows how to prescribe actions taken after an overtravel limit (POT or NOT) is entered.

(1) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	04	Over-travel inhibit input setup	0~2	–	Specify drive prohibition input (POT, NOT) input operations. 0: POT →Normal direction drive prohibited, NOT →Functions as reverse direction drive prohibition. If POT is input during normal direction operation, the system halts in accordance with Pr5.05 "Sequence at over-travel inhibit". For Reverse direction, the system performs the same operation when NOT is input. 1: POT , NOT is invalid and has no effect on operations. 2: Inputting either POT or NOT activates Err38.0 "Over-travel inhibit input protection".
5	05	Sequence at over-travel inhibit	0~2	–	If Pr5.04 "Over-travel inhibit input setup"= 0, specify status during slowdown and after halting after inputting drive prohibition input (POT, NOT).
5	11	Thrust setup for emergency stop	0~500	–	To set a thrust limit for the immediate stop.

(2) Item

· Details of Pr5.05 " Sequence at over-travel inhibit"

Pr5.04	Pr5.05	During deceleration *6	After stop	Position deviation/ Feedback scale deviation
0	0	Dynamic brake applied	For the overtravel direction, thrust command =0	Retained *2
	1	For the overtravel direction, thrust command =0	For the overtravel direction, thrust command =0	Retained *2
	2	Immediate stop *5	For the overtravel direction, command =0 *1	Cleared before and after the deceleration *3

*1 This represents the following: the position command = 0 for the position control, speed command = 0 for the velocity control, and speed limit = 0 for the thrust control.

*2 If commands keep coming for the overtravel direction with the overtravel limit on, the position deviations may accumulate to result in Err24.0 "Position deviation excess protection". In case an overtravel limit is turned on, stop commands for the overtravel direction.

*3 Position deviations/feedback scale deviations are cleared twice at the start and end of the deceleration; therefore, it is necessary to execute an homing operation to return to origin if the position is being controlled.

*4 f a setting value for Pr5.04 "Over-travel inhibit input setup" is "2," Err38.0 "Over-travel inhibit input protection" is activates when either POT or NOT is turned on. Therefore, the system operates in accordance with Pr5.10"Sequence at alarm", not with this setting value. If other types of errors occur also, Pr5.10 "Sequence at alarm" takes precedence.

*5 "Immediate stop" refers to the control to stop immediately with the servo control on.
Thrust command values for that case are restricted by Pr5.11 "Thrust setup for emergency stop".
Because instantaneous stopping slows down a motor suddenly, position deviation of position control becomes larger instantaneously, and it may cause Err24.0 "Position deviation excess protection" or Err34.0 "Software limit protection". In that case, specify appropriate values for Pr0.14 "Position deviation excess setup" and Pr5.14 "Motor working range setup".

*6 "During deceleration" refers to the section from the state where the motor is operating until the speed is reduced to 30 mm/s or below. Once the speed reduction achieves 30 mm/s and thus it transfers to the "After stop" state, the post-stop actions will be performed regardless of the motor speed.

6-5-2 Sequence at Servo Off

This section shows how to define actions taken while the servo control is off.

(1) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	06	Sequence at Servo-Off	0~9	–	To set the states during the deceleration and after the stop when the servo control is turned off.
5	11	Thrust setup for emergency stop	0~500	–	To set a thrust limit for the immediate stop.

(2) Item

· Details of Pr5.06 "Sequence at Servo-Off"

Pr5.06	During deceleration *4	After stop	Feedback scale deviation
0	Dynamic brake (DB) applied	Dynamic brake (DB) applied	Clear *5
1	Free-run (DB OFF)	Dynamic brake (DB) applied	Clear*5
2	Dynamic brake (DB) applied	Free (DB OFF)	Clear*5
3	Free-run (DB OFF)	Free (DB OFF)	Clear*5
4	Dynamic brake (DB) applied	Dynamic brake (DB) applied	Retained *2
5	Free-run (DB OFF)	Dynamic brake (DB) applied	Retained *2
6	Dynamic brake (DB) applied	Free (DB OFF)	Retained *2
7	Free-run (DB OFF)	Free (DB OFF)	Retained *2
8	Immediate stop *1 *6	Dynamic brake (DB) applied	Clear*5
9	Immediate stop *1 *6	Free (DB OFF)	Clear*5

*1 "Immediate stop" refers to the control to stop immediately with the servo control on.
Thrust command values for that case are restricted by Pr5.11 "Thrust setup for emergency stop".

*2 If commands keep coming or the motor stays running with the servo control off, the position deviations may accumulate to result in Err24.0 "Position deviation excess protection". Also if the servo control is turned on with a significant level of feedback scale deviations, the motor may make an abrupt start in order to perform the control to set the deviations to 0. Use due care when using the system with the feedback scale deviations retained.

*3 If an error occurred with servo turned off, the system operates in accordance with Pr5.10 "Sequence at alarm". If the main power supply is turned off with servo turned off, the system operates in accordance with Pr5.07 "Sequence at main power OFF".

*4 "During deceleration" refers to the section from the state where the motor is operating until the speed is reduced to 30mm/s or below. Once the speed reduction achieves 30mm/s and thus it transfers to the "After stop" state, the post-stop actions will be performed regardless of the motor speed.

*5 Feedback scale deviation are cleared before and after slowing down, and they are always cleared to zero after shifting to servo-off status.

*6 While executing the magnetic pole position estimation, motor do not stop immediately, dynamic brake(DB) applied.

6-5-3 Sequence at Main Power Off

This section explains how to set up actions taken when the main power is off.

(1) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	07	Main power off action	0~9	–	To define the states during the deceleration and after the stop when the main power is turned off.
5	11	Thrust setup for emergency stop	0~500	–	To set a thrust limit for the immediate stop.

(2) Item

· Details of Pr5.07 "Sequence at main power OFF"

Pr5.07	During deceleration	After stop	Feedback scale deviation
0	Dynamic brake (DB) applied	Dynamic brake (DB) applied	Clear *5
1	Free-run (DB OFF)	Dynamic brake (DB) applied	Clear *5
2	Dynamic brake (DB) applied	Free (DB OFF)	Clear *5
3	Free-run (DB OFF)	Free (DB OFF)	Clear *5
4	Dynamic brake (DB) applied	Dynamic brake (DB) applied	Retained *2
5	Free-run (DB OFF)	Dynamic brake (DB) applied	Retained *2
6	Dynamic brake (DB) applied	Free (DB OFF)	Retained *2
7	Free-run (DB OFF)	Free (DB OFF)	Retained *2
8	Immediate stop *1 *6	Dynamic brake (DB) applied	Clear *5
9	Immediate stop *1 *6	Free (DB OFF)	Clear *5

*1 "Immediate stop" refers to the control to stop immediately with the servo control on.
Thrust command values for that case are restricted by Pr5.11 "Thrust setup for emergency stop".

*2 If position commands keep coming or the motor stays running with the main power off, the position deviations may accumulate to result in Err24.0 "Position deviation excess protection". Also if the servo control is turned on with a significant level of feedback scale deviations, the motor may make an abrupt start in order to perform the control to set the deviations to 0. Use due care when using the system with the feedback scale deviations retained.

*3 If an error occurred with main power supply turned off, the system operates in accordance with Pr5.10 "Sequence at alarm".
If the main power supply is turned off with servo turned on, Err13.1 "Main power supply undervoltage protection (AC interception detection) " occurs with Pr5.08 "LV trip selection at main power OFF"=1. Therefore, the system operates in accordance with Pr5.10 "Sequence at alarm".

*3 "During deceleration" refers to the section from the state where the motor is operating until the speed is reduced to 30 mm/s or below. Once the speed reduction achieves 30 mm/s and thus it transfers to the "After stop" state, the post-stop actions will be performed regardless of the motor speed.

*5 Feedback scale deviation is cleared before and after slowing down. They are always cleared to zero after shifting to off-status of main power supply.

*6 While executing the magnetic pole position estimation, motor do not stop immediately, dynamic brake(DB) applied.

6-5-4 Sequence at Alarm

This section shows how to specify actions when there is an alarm.

(1) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	10	Sequence at alarm	0~7	–	To set up the states during the deceleration and after the stop when an alarm occurs.

(2) Item

· Details of Pr5.10 "Sequence at alarm"

Pr5.10	During deceleration *3	After stop	Feedback scale deviation
0	Dynamic brake (DB) applied	Dynamic brake (DB) applied	Cleared *1
1	Free-run (DB OFF)	Dynamic brake (DB) applied	Cleared *1
2	Dynamic brake (DB) applied	Free (DB OFF)	Cleared *1
3	Free-run (DB OFF)	Free (DB OFF)	Cleared *1
4	Operation A: Instantaneous stopping *4 Operation B: DB operation *2	Dynamic brake (DB) applied	Cleared *1
5	Operation A: Instantaneous stopping *4 Operation B: DB OFF *2	Dynamic brake (DB) applied	Cleared *1
6	Operation A: Instantaneous stopping *4 Operation B: DB operation *2	Free (DB OFF)	Cleared *1
7	Operation A: Instantaneous stopping *4 Operation B: DB OFF *2	Free (DB OFF)	Cleared *1

*1 Feedback scale deviations at the time when an alarm occurs will be retained while the alarm is still there, and they will be cleared when the alarm is cleared. However, position deviationis cleared as for the state of the alarm when decelerating by the immediate stop.

*2 The selection of the operation A or B shows whether an immediate stop is executed. An alarm that necessitates an immediate stop will prompt the operation A, an immediate stop, if the setting value is 4, 5, 6 or 7. An alarm that does not require an immediate stop will result in the actions specified with the operation B; i.e. either application of the dynamic brake (DB) or free-run. (Refer to section 6-5-5.)
Refer to 7-1 "List of Protective Functions" for alarms that require an immediate stop.

*3 "During deceleration" refers to the section from the state where the motor is operating until the speed is reduced to 30 mm/s or below. Once the speed reduction achieves 30 mm/s and thus it transfers to the "After stop" state, the post-stop actions will be performed regardless of the motor speed.

*4 While executing the magnetic pole position estimation, motor do not stop immediately, operation B applied.

6-5-5 Emergency Stop at Alarm

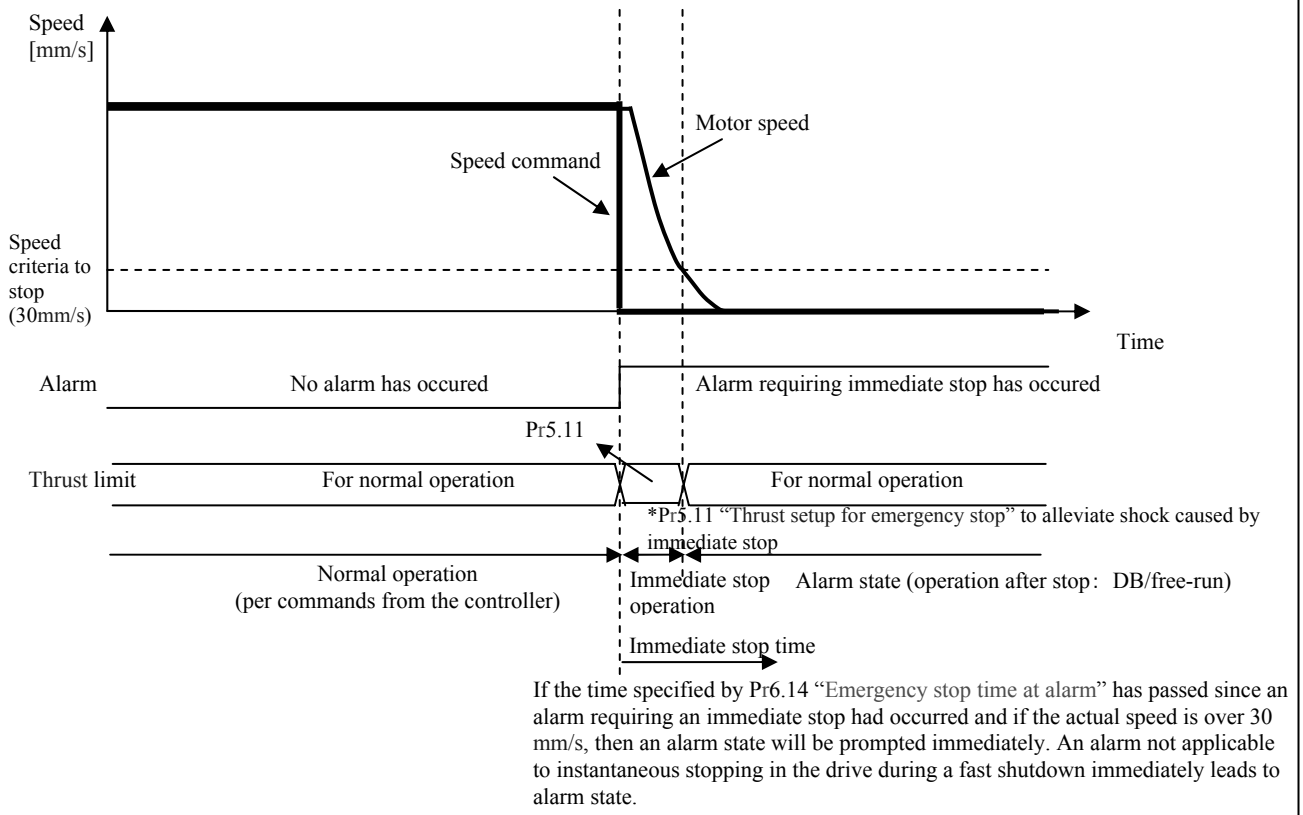
If an alarm occurs that requires an immediate stop, setting the following parameters will control the motor to immediately stop it.

(1) Related parameters

Category	No.	Parameter	Setup range	Unit	Function
5	10	Sequence at alarm	0~7	–	To set up the states during the deceleration and after the stop when an alarm occurs. The immediate stop is valid when the parameter is set to either 4, 5, 6 or 7.
5	11	Thrust setup for emergency stop	0~500	–	To set a thrust limit for the immediate stop.
9	10	Overspeed level	0~20000	mm/s	If the motor speed exceeds the value set with this parameter, Err26.0 "Over-speed protection" occurs. If the value is set to 0, Err60.0 (Motor setting error protection) occurs
6	14	Emergency stop time at alarm	0~1000	ms	To set the allowable time for the immediate stop to complete when there is an alarm. The time exceeding the value set for this parameter will force a state of alarm. If 0 is set for this parameter, the immediate stop doesn't do, and become an alarm state immediately.
6	15	2nd over-speed level setup	0~20000	mm/s	If the motor speed exceeds the value set for this parameter during an immediate stop which has been caused by an alarm, Err26.1 "2nd over-speed protection" will occur. If the value is set to 0, Err26.1 will occur by setting of Pr5.13 " Overspeed level".

(2) Item

· Immediate stop operation when an alarm requiring an immediate stop occurs



(Note) To protect against runaway upon instantaneous stopping, specify an allowable excessive speed level in Pr6.15 "2nd over-speed level setup". If 2nd excessive speed protection, which is an error not applicable to instantaneous stopping, is activated, it immediately leads to error tripping.
While executing the magnetic pole position estimation, motor do not stop immediately, error trip occurs.

7. Protective/Warning Functions

Different specifications may be partly applied for the option unit I/F and when the block operation function is valid. See the respective Technical Reference for the details.

7-1 List of Protective Functions

This servo drive has various integrated protective functions. If any of these functions is activated, the driver will turn off the alarm output signal (ALM) and go into a trip state, showing the error code number in the 7-segment LED at the front panel.

Err code		Alarm	Attribute		
Main	Sub		History	Can be cleared?	Immediate 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	
18	0	Over-regeneration load protection	○		○
	1	Over-regeneration Tr error protection	○		
24	0	Encoder communication error protection	○	○	○
	1	Encoder communication data error protection	○	○	○
26	0	Velocity deviation excess protection	○	○	
	1	Hybrid deviation excess error protection	○	○	
27	0	Over-speed protection	○	○	○
	2	2nd over-speed protection	○	○	○
28	0	Command pulse input frequency error protection	○	○	○
29	0	Command pulse multiplier error protection	○	○	
30	0	Limit of pulse replay error protection		○	
33	0	Deviation counter overflow protection	○		
	1	Safety detection	○		
	2	IF overlaps allocation error 1 protection	○		
	3	IF overlaps allocation error 2 protection	○		
	4	IF input function number error 1 protection	○		
	5	IF input function number error 2 protection	○		
	6	IF output function number error 1 protection	○		
	7	IF output function number error 2 protection	○		
34	0	CL fitting error protection	○	○	
36	0~2	INH fitting error protection			
37	0~2	Software limit protection			
38	0	EEPROM parameter error protection		○	
39	0	EEPROM check code error protection	○	○	○
	1	Over-travel inhibit input protection	○	○	○
	2	Analog input1 excess protection	○	○	○

(Continued)

Err code		Alarm	Attribute		
Main	Sub		History	Can be cleared?	Immediate stop *6
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	○		
55	0	A-phase connection error protection	○		
	1	B-phase connection error protection	○		
	2	Z-phase connection error protection	○		
	3	CS signal wiring error	○		
	4	A/B phase open error	○		
60	0	Motor setting error			
	1	Motor combination error 1			
	2	Motor combination error 2			
	3	Linear motor auto-setup error		○	
61	0	Magnetic pole position estimation error 1	○		
	1	Magnetic pole position estimation error 2	○		
	2	Magnetic pole position estimation error 3			
87	0	Compulsory alarm input protection		○	
93	3	Feedback scale connection error			
Other numbers		Other faults	○		

*1: If Err16.0 "Over-load protection" started to work, it can be canceled about 10 seconds after the occurrence.

*2: If an alarm that cannot be cleared has occurred, first remove the causes and then turn off the control power to reset it.

*3: If an alarm that can be cleared occurred, you can clear it through the alarm clear input (A-CLR), front panel operation or communication interface. Please execute the alarm clear while stopping without fail after confirming safety.

*4: If the control circuit within the servo drive has malfunctioned due to reasons such as excessive noise, the following may be displayed.

In such a case, immediately turn off the power.

*5: A fast shutdown refers to an alarm that causes an immediate stop when Pr5.10 "Sequence at alarm" is set to the value between 4 and 7. Please refer to 6-5-4 "Sequence at Alarm" for details.
While executing the magnetic pole position estimation, motor do not stop immediately, error trip occurs.

7-2 Details of Protective Functions

Protective function		Name	Cause	Action
Main	Sub			
11	0	Control power supply undervoltage protection	The PN voltage at the converter of the control power has reduced to the specified value or less. 1) The supply voltage is too low. An instantaneous power failure has occurred. 2) The power supply capacity is too small: the supply voltage has reduced due to rush current when the main power was turned on. 3) The servo drive has failed (circuit failure).	Measure the line voltage of L1C-L2C at the connector and terminal block. 1) Increase the supply voltage capacity. Change the power supply. 2) Increase the power supply capacity. 3) Replace with a new servo drive.
12	0	Over-voltage protection	The supply voltage has exceeded the allowable input voltage range. → The PN voltage at the converter has increased to the specified value or more. The supply voltage is too high. A sudden voltage increase due to a phase advance capacitor and/or UPS (uninterruptible power supply system). 1) The regenerative resistor has disconnected wires. 2) The external regenerative resistor is inappropriate, not absorbing regenerative energy. 3) The servo drive has failed (circuit failure).	Measure the line voltage of the connectors (L1, L2, and L3). Enter the correct voltage. Remove the phase advance capacitors. 1) By using a tester, measure the resistance of the resistor externally attached between the terminals B1-B2 of the servo drive. If ∞, there is disconnected wiring. 2) Change the regenerative resistance and wattage to the specified values. 3) Replace with a new servo drive.
13	0	Main power supply undervoltage protection (between P to N)	When Pr5.08 "LV trip selection at main power OFF" is set to 1, instantaneous power failure between L1 and L3 occurred for a longer time than specified in Pr5.09 "Detection time of main power off", or the P-N voltage of the main power converter decreased below the defined value at servo-on. 1) The supply voltage is too low. An instantaneous power failure has occurred.	Measure the line voltage of connectors (L1, L2, and L3). 1) Increase the supply voltage capacity. Change the power supply. Remove the cause for the electromagnetic contactor to have failed, and turn on the power again. 2) Check the setting of Pr5.09 "Detection time of main power off". Provide the correct setting for each phase of the power supply. 3) Increase the power supply capacity. Refer to "List of peripheral devices applicable to the servo drive" for the capacity of the power supply. 4) Make the correct connection for each phase of the power supply (L1, L2, and L3). Use L1 and L3 for single phase 100 V and single phase 200 V. 5) Replace with a new servo drive.
	1	Main power supply undervoltage protection (AC interception detection)	2) An instantaneous power failure has occurred. 3) The power supply capacity is too small: the supply voltage has reduced due to rush current when the main power was turned on. 4) Open phase: The servo drive specified with a 3-phase input was operated with a single phase power supply. 5) The servo drive has failed (circuit failure).	
14	0	Over-current protection	Current flowing in the converter has exceeded the specified value. 1) The servo drive has failed (such as component failure in circuit and IGBT) 2) Short circuit of the motor wires U, V, and W 3) Ground fault of the motor wires 4) Burnout of the motor 5) Contact failure of the motor wires 6) The dynamic brake relay has adhered because the servo control has been turned on and off frequently. 7) The motor is not suitable for the servo drive. 8) Timing of the pulse input is either the same as or earlier than that of the servo turning on.	1) Turn on the servo control with the motor wires disconnected. If the failure occurs immediately, replace the servo drive with a new (operating) one. 2) Check for whiskers of the connector lead wires to make sure the motor wire connections U, V, and W are not short circuited. Make the correct connection of the motor wires. 3) Check the insulation resistance between the motor wires U, V, and W and the motor ground wires. If the insulation is insufficient, replace the motor. 4) Check the resistance between the motor wires for balance. If the balance is poor, replace the motor. 5) Check for any lost connector pin at the motor connections U, V, and W. Fix any loose or lost pins properly. 6) Change the servo drive. Stop starting and stopping the operation by turning the servo control on and off. 7) Check the name plates of the motor and servo drive for their part numbers (for the capacity). Replace the motor to fit the servo drive. 8) Wait for 100 ms at the minimum after the servo control is turned on before entering any pulse.
	1	IPM error protection		

(Continued)

Protective function		Name	Cause	Action
Main	Sub			
15	0	Over-heat protection	The temperature of the servo drive heat sink and power devices has increased to the specified value or more. 1) The ambient temperature of the servo drive has exceeded the specified value. 2) Overload	1) Improve the ambient temperature and cooling conditions for the servo drive. 2) Increase the capacity of the servo drive and motor. Specify a longer acceleration time. Reduce load.
16	0	Over-load protection	Thrust command value has exceeded the over-load level specified in Pr5.12 "Over-load level setup"and resulted in overload protection according to the time characteristics. 1) The load is too heavy, the effective thrust has exceeded the rated thrust, and the operation continued for too many hours. 2) Oscillation and hunting due to poor gain tuning. The motor is showing vibration and abnormal noise. The set value specified in Pr0.04 "Mass ratio" is abnormal. 3) The motor wiring is wrong or disconnected 4) The machine has collided or suddenly got heavy. The machine has been distorted. 5) The electromagnetic brake was kept applied. 6) While making multiple connections, the motor wire was connected to some other axes, resulting in incorrect wiring.	Check the thrust (current) curve for oscillation and excessive amplitude by using the analog output or the communication. See the front panel or communication to check for an overload warning indication and load factor. 1) Increase the capacity of the servo drive and motor. Specify a longer acceleration time. Reduce load. 2) Redo the gain tuning. 3) Connect the motor wires to the wiring diagram. Change the cables. 4) Remove the distortion of the machine. Reduce load. 5) Measure the brake terminal voltage. Release the brake. 6) Make the correct connection for the motor wires, feedback scale wires and their axes.
18	0	Over-regeneration load protection	Regenerative energy has exceeded the capacity of the regenerative resistor. 1) Regenerative energy generated during the deceleration due to large load mass has increased voltage at the converter, causing less regenerative resistor energy to be absorbed, resulting in further voltage increase. 2) Due to high motor velocity, regenerative energy cannot be fully absorbed during the specified deceleration time. 3) The operating limit of the external resistor is restricted to 10 % duty.	Check the load factor of the regenerative resistor either with the front panel or by communication. The regenerative resistor should not be used for continuous regenerative braking. 1) Check the operation patterns (velocity monitor). Check the display for the indication of regenerative resistor load factor and a regeneration over warning. Increase the capacity of the motor and servo drive. Make the deceleration time more gradual. Use an external regenerative resistor. 2) Check the operation patterns (velocity monitor). Check the display for the indication of regenerative resistor load factor and a regeneration over warning. Increase the capacity of the motor and servo drive. Make the deceleration time more gradual. Decrease the motor velocity. Use an external regenerative resistor. 3) Set Pr0.16 to 2. Important: When specifying 2 for Pn0.16, always provide the external protection such as a thermal fuse, as it will loose the protection for the regenerative resistor, resulting in its possible overheat and burnout.
	1	Over-regeneration Tr error protection	· The transistor of the servo drive for regenerative operation has failed.	· Change the servo drive.

(Continued)

Protective function		Name	Cause	Action
Main	Sub			
24	0	Position deviation excess protection	Position deviation pulses have exceeded the setup of Pr0.14 "Position deviation excess setup". 1) The motor operation is not following the command. 2) The set value specified in Pr0.14 "Position deviation excess setup" is too small.	1) Check if the motor operates according to the position command pulse input. Check the thrust monitor to see if the output thrust has saturated. Perform a gain tuning. Set the upper limit in Pr0.13 "1st thrust limit" and Pr5.24 "2nd thrust limit". Make the feedback scale wiring connections to the wiring diagram. Extend the acceleration time. Reduce the load and lower the velocity. 2) Set a greater value in Pr0.14.
	1	Velocity deviation excess protection	The difference (speed deviation) between in-position preset velocity and actual speed exceeded the Pr6.02 "Velocity deviation excess setup". Note: When in-position preset velocity becomes zero by force, such as the immediate stop because of the command pulse inhibition (INH) and the positive/ negative overtravel limit, the speed deviation increases in that moment. Also, the speed deviation increases during startup of in-position preset velocity, so apply a fully flexible setting.	· Increase the Pr6.02 setting value. · Make longer the acceleration and deceleration duration of the in-position preset velocity, or improve the following capability with the gain adjustment. · Disallow the velocity deviation excess detection. (Pr6.02=0)
26	0	Over-speed protection	The motor rotational speed has exceeded the set value specified in Pr9.10 "Over-speed level setup".	· Stop giving excessive speed command. · Check the input frequency and scaling ratio for the command pulse. · If there is an overshoot because the gain tuning is poor, redo it. · Connect the feedback scale wires to the wiring diagram.
	1	2nd over-speed protection	The motor rotational speed has exceeded the set value specified in Pr6.15 "2nd over-speed level setup".	
27	0	Command pulse input frequency error protection	The command pulse input frequency has exceeded 1.2 times the value specified in Pr5.32 "Command pulse input maximum setup".	· Check the command pulse input.
	2	Command pulse multiplier error protection	The scaling ratios used to set the Command pulse counts per one motor revolution, the command scaling numerators 1-4, and the denominator of electronic gear are not appropriate.	· Check the setting values for the command scaling.
28	0	Limit of pulse replay error protection	The output frequency for pulse regeneration has exceeded the limit value.	· Check the set value specified in 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.

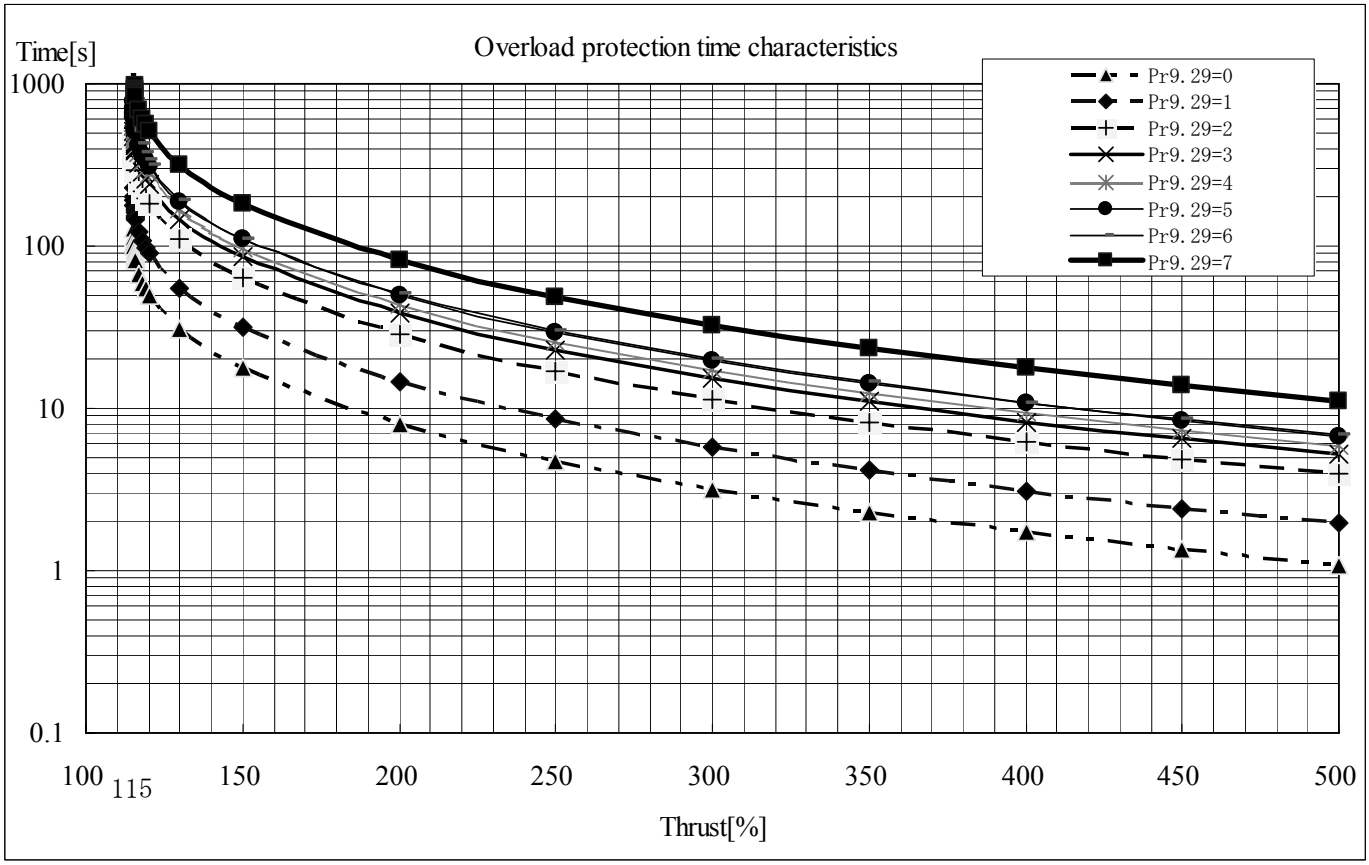
(Continued)

Protective function		Name	Cause	Action
Main	Sub			
29	0	Deviation counter overflow protection	The position deviation value based on the feedback scale pulse has exceeded 2^{29}(536870912).	· Check if the motor operates according to the position command. · Check the thrust monitor to see if the output thrust has saturated. · Perform a gain tuning. · Set the upper limit in Pr0.13 "1st thrust limit" and Pr5.24 "2nd thrust limit". · Make the feedback scale wiring connections to the wiring diagram.
30	0	Safety detection	One or both of the input photocouplers for Safety input 1 and/or Safety input 2 were turned off.	· Check the wiring of Safety inputs 1 and 2.
33	0	IF overlaps allocation error 1 protection	Duplicate assignment of a function to the input signals (SI1, SI2, SI3, SI4, and SI5).	· Correct the function assignment to the connector pins.
	1	IF overlaps allocation error 2 protection	Duplicate assignment of a function to the input signals (SI6, SI7, SI8, SI9, and SI10).	· Correct the function assignment to the connector pins.
	2	IF input function number error 1 protection	Undefined numbers are used for the function assignment of the input signals (SI1, SI2, SI3, SI4, and SI5).	· Correct the function assignment to the connector pins.
	3	IF input function number error 2 protection	Undefined numbers are used for the function assignment of the input signals (SI6, SI7, SI8, SI9, and SI10).	· Correct the function assignment to the connector pins.
	4	IF output function number error 1 protection	Undefined numbers are used for the function assignment of the output signals (SO1, SO2, and SO3).	· Correct the function assignment to the connector pins.
	5	IF output function number error 2 protection	Undefined numbers are used for the function assignment of the output signal (SO4, SO5, and SO6).	· Correct the function assignment to the connector pins.
	6	CL fitting error protection	The deviation counter clear function is assigned to an input signal other than SI7.	· Correct the function assignment to the connector pins.
	7	INH fitting error protection	The command pulse inhibition input enable function is assigned to an input signal other than SI10.	· Correct the function assignment to the connector pins.
34	0	Software limit protection	The motor has exceeded the allowable motor operation range specified in Pr5.14 "Motor working range setup" against the position command input range. 1) The gain is not appropriate. 2) The set value specified in Pr5.14 is too small.	1) Verify the gain (the balance between the position loop gain and velocity loop gain) and the mass ratio. 2) Set a greater value in Pr5.14. Or, set Pr5.14 to 0 to disable the protection function.
36	0 1 2	EEPROM parameter error protection	When the EEPROM was read out when the power was turned on, the data in the parameter storage area was destroyed.	· Redo the entire parameter setting. · If the problem persists, there may be a failure. Replace the servo drive with a new one and return the old one to the dealer of the product for investigation (repair).
37	0 1 2	EEPROM check code error protection	When the EEPROM was read out when the power was turned on, the data that has been confirmed for writing was destroyed.	There may be a failure. Change the servo drive. Return them to the dealer for investigation (and repair).
38	0	Over-travel inhibit input protection	When Pr5.04 "Over-travel inhibit input setup" is set to 0, both of the positive/negative-direction drive prohibition inputs (POT /NOT) were turned on. When Pr5.04 is set to 2, either of the positive/negative-direction drive prohibition inputs was turned on.	· Check for malfunctions of switches, wires and power supplies connected to the positive/negative overtravel limits. Pay special attention to the power supply (DC 12 - 24 V) to see if it is taking too much time to start.

(Continued)

Protective function		Name	Cause	Action
Main	Sub			
39	0	Analog input1 excess protection	The voltage applied to Analog input 1 was more than the value specified in Pr4.24 "Analog input 1 (AI1) overvoltage setup".	· Set Pr4.24 "Analog input 1 (AI1) overvoltage setup" correctly. Check the connecting status of the I/O connector. · Set Pr4.24 to 0 to disable the protection function.
	1	Analog input2 excess protection	The voltage applied to Analog input 2 was more than the value specified in Pr4.27 "Analog input 2(AI2) overvoltage setup".	· Set up Pr4.27 "Analog input 2(AI2) overvoltage setup" correctly. Check the connecting status of the I/O connector. · Set Pr4.27 to 0 to disable the protection function.
	2	Analog input3 excess protection	The voltage applied to Analog input 3 was more than the value specified in Pr4.30 "Analog input 3 (AI3) overvoltage setup".	· Set Pr4.30 "Analog input 3 (AI3) overvoltage setup" correctly. Check the connecting status of the I/O connector. · Set Pr4.30 to 0 to disable the protection function.
50	0	Feedback scale connection error protection	The communication between the feedback scale and the servo drive has been disrupted for the specified number of times, activating the function to detect a disconnected wiring.	· Make the correct connections of the feedback scale wires. Correct any wrong connections of the connector pin. · Correct the type of feedback scale (A/B phase type, serial incremental type, serial absolute type) according with Pr3.23 "Feedback scale type selection".
	1	Feedback scale communication error protection	The data communication from the feedback scale is erroneous. The data error is mainly due to noise. The feedback scale cables are connected but there is a communication data error.	· Make sure the feedback scale supply voltage is DC 5 V +/- 5 % (4.75 – 5.25 V). Bear this in mind especially when the feedback cables are long. · Separate the feedback scale wires from the motor wires if they are bundled together. Connect the shield to FG. Refer to the connection diagram of the feedback scale.
51	0	Feedback scale status 0 error protection	The bit 5 of the feedback scale error code (ALMC) has turned to 1. Verify the feedback scale specifications.	After removing the cause of the error, clear the feedback scale error from the front panel. Then, turn off the control power to reset.
	1	Feedback scale status 1 error protection	The bit 5 of the feedback scale error code (ALMC) has turned to 1. Verify the feedback scale specifications.	
	2	Feedback scale status 2 error protection	The bit 5 of the feedback scale error code (ALMC) has turned to 1. Verify the feedback scale specifications.	
	3	Feedback scale status 3 error protection	The bit 5 of the feedback scale error code (ALMC) has turned to 1. Verify the feedback scale specifications.	
	4	Feedback scale status 4 error protection	The bit 5 of the feedback scale error code (ALMC) has turned to 1. Verify the feedback scale specifications.	
	5	Feedback scale status 5 error protection	The bit 5 of the feedback scale error code (ALMC) has turned to 1. Verify the feedback scale specifications.	

Protective function		Name	Cause	Action
Main	Sub			
55	0	A-phase connection error protection	There is a malfunction such as disconnected wiring at the A phase connection of the feedback scale.	· Check the A phase connection of the feedback scale. · Check the according with Pr3.23 “Feedback scale type selection“ and connected feedback scale (A/B phase or serial incremental, serial absolute type).
	1	B-phase connection error protection	There is a malfunction such as disconnected wiring at the B phase connection of the feedback scale.	· Check the B phase connection of the feedback scale.
	2	Z-phase connection error protection	There is a malfunction such as disconnected wiring at the Z phase connection of the feedback scale.	· Check the Z phase connection of the feedback scale.
	3	CS signal wiring error	The logic of the CS signal became abnormal. (CS1, 2, 3 are all ‘L’ or all ‘H’)	· Check the CS signal connection.
	4	A/B phase open error	The pulse of the A/B phase is extremely few during the change in the CS signal.	· Check the CS signal, A/B phase.
60	0	Motor setting error	Initial setting paramters of motor or feedback s cale are not finished.	· Set the initial setting parameters.
	1	Motor combination error 1	Rated / maximum current of the motor exceeds rated / maximum current that the drive allows.	· Check the setting value of Pr9.06 “Rated motor effective current”(unit 0.1Arms) and Pr9.07 “Maximum instantaneous motor current”(unit 0.1A). · If there’s no problem on the setting, increase the drive size.
	2	Motor combination error 2	· The rated current of the motor is too small to the rated current of the drive. · The mass ratio (M) of the moving part to rated thrust (F) is too large. (The M/F ratio is too large.) · The self adjustment current proportion and integration gain are too large. · The ratio of the maximum current to the rated current of the motor is larger than that of 500%.	· Check the setting value of Pr9.06 “Rated motor effective current”(unit 0.1Arms). If there’s no problem on the setting, decrease the drive size. · Check the setting value of Pr9.05 “Rated motor thrust”(unit 0.1N), Pr9.04 “Weight of motor's movable section”(unit 0.01kg). · Check the setting value of Pr9.06 “Rated motor effective current”(unit 0.1Arms), Pr9.08 “Motor phase inductance”(unit 0.01mH) and Pr9.09 “Motor phase resistance”(unit 0.01 Ω). · Check the setting value of Pr9.06 “Rated motor effective current”(unit 0.1Arms) and Pr9.07 “Maximum instantaneous motor current”(unit 0.1A).
	3	Linear motor auto-setup error	· An external servo on was input while executing linear motor auto-setup function.	· Please do not input an external servo on while executing linear motor auto-setup function.
61	0	Magnetic pole position estimation error 1	The magnetic pole position estimation was not normally completed. · Direction setting mistake of feedback scale · Lack in thrust command/command time when magnetic pole position is estimated. · Vertical axis. · The offset load or friction are large.	· Check the direction of feedback scale. · Adjust the Pr9.22 “Thrust command time for estimating magnetic poles position” and Pr9.23 “Command thrust for estimating magnetic poles position”. · The magnetic pole position estimation can not use onvertical axis ,axis has large offset load and friction.
	1	Magnetic pole position estimation error 2	The motor can not stop though the time set by Pr9.27 "Time limit of motor stop for estimatin g magnetic poles position" passed.	· Increase the setting of Pr9.27. · Check the offset load on installation environment. (Does not the motor work for the state of thrust command =0 either?)
	2	Magnetic pole position estimation error 3	· Pr9.20 "Magnetic poles detection method selection" =3 was set with the magnetic pole position estimation was not executed. · Pr9.20=3 was set when the feedback scale was not absolute type.	· Make to Pr9.20=2 and execute the magnetic pole position estimation once. After wards, this error doesn't occur by returning it to Pr9.20=3. · Confirm the connected feedback scale is absolute type.
87	0	Compulsory alarm input protection	Forced alarm input (E-STOP) has been input.	Check the wiring of forced alarm input (E-STOP).
93	3	Feedback scale connection error	The setting of Pr3.23 “Feedback scale type sel ection” and connected serial feedback scale do not accord.	Pr3.23 is set according to the type of the connected f eedback scale (incremental / absolute type).
Other numbers		Other error	The control circuit has malfunctioned due to reasons such as excessive noise. The servo drive’s self diagnosis function was performed and something has gone wrong inside the driver.	· Turn off the power and turn it on again. · If the error still occurs, you may have a failure. Stop the operation, and replace the motor and/or servo drive. Return them to the dealer for investigation (and repair).



Category	No.	Parameter	Setup range	Unit	Function
9	29	Overload protection time constant setting	0 – 7	-	0 : Standard specification Select the overload protection above 7 characteristic.

Note) The overload protection doesn't guarantee alarm protection by generation of heat etc. of the motor.
Please use it after confirming in a real system environment, there is no problem such as motor generation of heat.

7-3 Warning Functions

A warning is generated before the protective function is activated. This allows you to check the status such as an overload in advance.

In principle, a warning will automatically return to the state where it is not issued if the faulty state is corrected. However, the warning state will be kept during latch duration as shown in the following figure. To clear a latched warning before the latch time expires, perform the procedure taken to execute an alarm clear.

(1)Related parameters

Category	No.	Parameter	Setup range	Unit	Function
4	40	Selection of alarm output 1	0~10	–	Selects the warning output by the Warning output 1(WARN1). Set value 0: OR output of all warnings 1 and after: See the following table.
4	41	Selection of alarm output 2	0~10	–	Select the warning output by the Warning output 2(WARN2). Set value 0: OR output of all warnings 1 and after: See the following table.

(2) Warning type

Warning number	Warning	Item	Pr6.27 *1	Pr4.40/Pr4.41 *2	Pr6.38-compatible bit *3
A0	Overload	The load factor has exceeded 85% of the protection level.	○	1	bit7
A1	Regeneration over	The regeneration load factor has exceeded 85% of the protection level.	○	2	bit5
A3	Fan stop	The fan has stopped for over 1 second.	○	4	bit6
A6	Oscillation detection warning	Oscillation state was detected.	○	7	bit9
A7	Life detection warning	The remaining life of the capacitor or fan has fallen below the defined value.	Always fixed with no time limit.	8	bit2
A8	Feedback scale abnormal warning	The feedback scale device has issued a warning.	○	9	bit8
A9	Feedback scale communication warning	The number of consecutive feedback scale communication errors has exceeded the defined value.	○	10	bit10

*1 For "○", you can set a value between 1 and 10s in Pr6.27 "Alarm latch time selection", or set no time limit. Battery warnings and life warnings are set with "no time limit."

*2 Select the warning output by the Warning output signal 1 (WARN1) and Warning output signal 2 (WARN2) using Pr4.40 "Selection of alarm output 1" and Pr4.41 "Selection of alarm output 2". If set to 0, OR output of all warnings will be output. Also, do not set a value other than the set values listed in the above table.

*3 Each warning detection can be masked using Pr6.38 "Alarm mask setup". The supported bits are listed in the table. Bit=1 masks the warning detection.

*4 Warning can be cleared by an alarm clear function. In the state of Alarm clear input (A-CLR) is On, warning is always cleared

7-4 Protection Function Setting before Gain Adjustment

When carrying out the gain adjustment, you can enjoy the comfortable usage of it by properly setting the parameters below according to the operating condition.

1) Overtravel limit setting

Allows you to proactively avoid a collision at the end by entering the limit sensor signal into the amplifier. Refer to positive/ negative overtravel limit (POT/ NOT) in the interface specification. Also, set up the following parameters related to overtravel limits:

Pr5.04 "Over-travel inhibit input setup"

Pr5.05 "Sequence at over-travel inhibit"

2) Thrust limit

The damage can be reduced when a problem, such as equipment's bite and collision, occurs by restricting the motor's maximum thrust. To uniformly restrict the torque with parameter, set up Pr0.13 "1st thrust limit".

However, when restricted to less than practically necessary thrust, be careful that the position deviation excess protection can occur because a overspeed protection due to overshooting or a command delay occurs.

Also, the limited thrust state can be externally detected by allocating the thrust limited output (TLC) as the interface specification to the output signal.

3) Overspeed protection

When the motor runs at unusual high-speed, Err26.0 "Over-speed protection" is generated.

By default, it is automatically set to 1.2 times of maximum speed [r/min] of the motor used.

When the maximum speed under customer's operating condition is less than the motor's maximum speed, set up Pr9.10 "Over-speed level setup" according to the expression below:

> Pr9.10 "Over-speed level setup" = Vmax × (1.2 to 1.5)
>
> Vmax: Motor's maximum speed [mm/s] under the operating condition
>
> The coefficient enclosed in parentheses is a margin for avoiding the frequent occurrence of overspeed protections.

In addition, when making the motor speed slow at initial adjustment, by establishing a value by multiplying the speed by the margin, you can use the value as a protection just in case it turns into an oscillation state.

4) Position deviation excess protection

Err24.0 "Position deviation excess protection" is generated by detecting the excessive deviation between position command.

The excessive position deviation level can be set up in Pr0.14 "Position deviation excess setup". Also, the detection position can be selected from the command position deviation [pulse (per command basis)] and the feedback scale deviation [pulse (per feedback scale basis)] in Pr5.20 "Position setup unit select". (Refer to control block diagram)

By default, 100000 [pulse (command unit)] is established.

Because the position deviation in normal operation can change according to working speed and gain setting, set Pr0.14 to the value calculated from the expression below based on the customer's operating condition.

■ Pr5.20=0 (detected by command position deviation):

Pr0.14 "Position deviation excess setup" = Vc/Kp × (1.2 to 2.0)

Vc : aximum frequency [pulse (command unit)/s] of the position command pulse

Kp : Position loop gain [1/s]

The coefficient enclosed in parentheses is a margin for avoiding the frequent occurrence of position deviation excess protection.

Note 1: To change the position loop gain Kp, calculate the gain by using the minimum value.

Note 2: To use a position command filter or a damping control, add the value below.

Position command smoothing filter: Vc × filtering constant [s]

Position command FIR filter: Vc × filtering constant [s] / 2

damping control: Vc / (π × damping frequency [Hz])

■ Pr5.20=1 (detected by feedback scale deviations):

Pr0.14 "Position deviation excess setup" = Ve/Kp × (1.2 to 2.0)

Ve : aximum operating frequency [pulse/s] per feedback scale basis

Kp : Position loop gain [1/s]

Note 3: To change the position loop gain Kp, calculate the gain by using the minimum value.

Note 4: When Pr5.20=1, the position command filter or damping control setting does not impact on it.

5) Motor working range

During the position or full closed control, Err34.0 “Software limit protection” is generated by detecting that the motor exceeded the preset position range by more than the rotation amount established in Pr5.14 “Motor working range setup”.

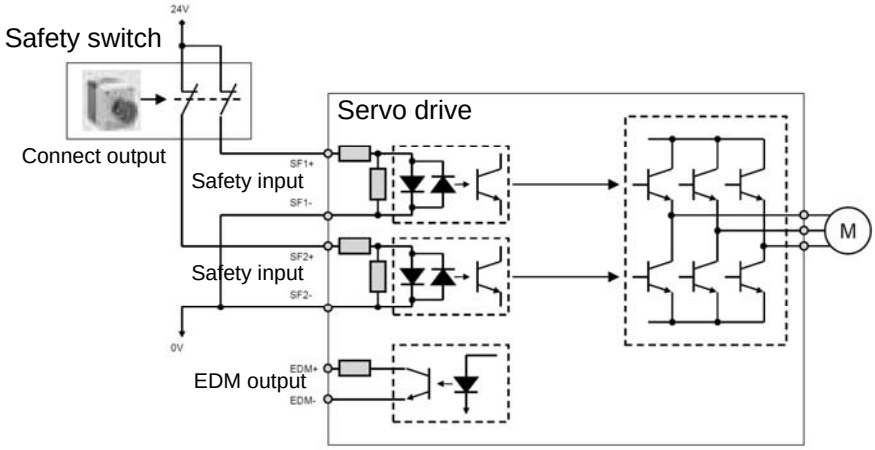
For more information, refer to 6-3 “Motor Movement Range Setting.”

8. Safety Function [LA1] is not possible to use it.

This servo drive is equipped with a safety function.

8-1 Overview of Safe Torque Off (STO) [LA1] is not possible to use it.

The safe torque off (referred to as STO hereafter) function is a safety function that breakes the motor current by forcefully turning off the drive signal of the power transistor within the servo drive by the safety input signal via circuit (hardware), causing the output thrust of the motor to be turned off.



When the STO function starts to work, the servo drive turns off the servo ready output signal (S-RDY) and enters into a safety state.

Also, it becomes an alarm state, displaying the error code № on the 7-segment LED on the front panel.

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

8-2 Specifications of Input/Output Signals [LA1] is not possible to use it.

8-2-1 Safety Input Signal

· Two channels of the safety input circuits that start the STO function are available.

Category	Signal	Code	Connector pin	Item	Control mode		
					Position	Velocity	Thrust
Input	Safety input 1	SF1+	CN8-4	· This is the input 1 that starts the STO function. This input shuts off the upper-arm drive signal of the power transistor. · To use this input, connection must be such that the photocoupler of the input circuit is turned off when starting the STO function.	○		
		SF1-	CN8-3				
	Safety input 2	SF2+	CN8-6	· This is the input 2 that starts the STO function. This input shuts off the lower-arm drive signal of the power transistor. · To use this input, connection must be such that the photocoupler of the input circuit is turned off when starting the STO function.	○		
		SF2-	CN8-5				

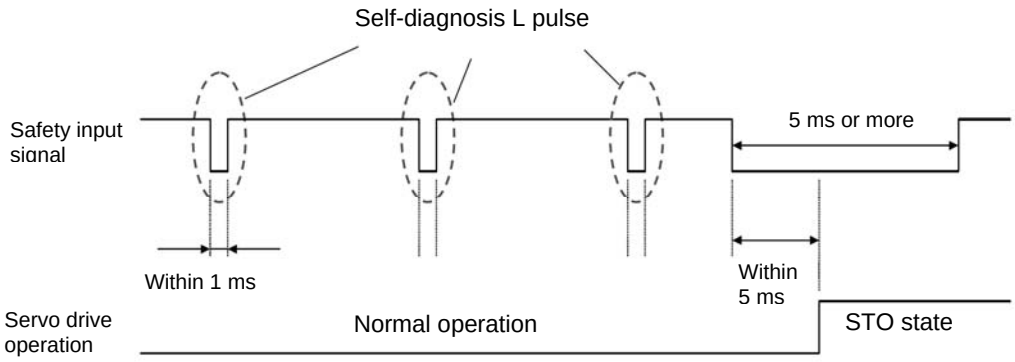
· For both Safety inputs 1 and 2, the STO function starts to work within 5 minutes after the input and the output thrust of the motor is turned off.

Note) Self-diagnosis L pulse for safe equipment

When connecting safety equipment such as a safety controller or safety sensor, their safety output signals may include a self-diagnosis L pulse. To prevent the STO function from being started incorrectly by the self-diagnosis L pulse, the safety input circuit is equipped with a filter that removes the self-diagnosis L pulse.

So, if the time during which the safety input signal is turned off is 1 minute or less, the safety input circuit will not recognize it as turned off.

To make the safety input circuit recognize the turned-off state without fail, the turned-off state of the safety input signal must be kept for 5 minutes or more.



8-2-2 Output Signal for External Device Monitor (EDM) [LA1] is not possible to use it.

· This is a monitor output for monitoring the state of the safety input signal using an external device. Connect it to the terminal for external device monitor of safety equipment such as a safety controller or safety sensor.

Category	Signal	Code	Connector pin	Item	Control mode		
					Position	Velocity	Thrust
output	EDM output	EDM+	CN8-8	· This outputs a monitor signal for detecting a safety function failure. * This output signal is not a safety output.	○		
		EDM-	CN8-7				

· The logical relation between the safety input signal and the EDM output signal is as follows:
In a normal state, when the Safety inputs 1 and 2 are both turned off, which means the two channels of the safety inputs are both running the STO function, the photocoupler of the EDM output circuit is turned on.

Signal	Code	Photocoupler logic			
Safety input	SF1	ON	ON	OFF	OFF
	SF2	ON	OFF	ON	OFF
EDM output	EDM	OFF	OFF	OFF	ON

By monitoring the above-mentioned photocoupler logic states (all the four states) using an external device, a failure in the safety input circuit and the EDM output circuit can be detected. Namely on error, it is found out that, the photocoupler of EDM output circuit will not be turned ON regardless of the fact that both safety inputs 1 and 2 are turned OFF, or by contrast, the photocoupler of EDM output circuit will be turned ON regardless of the fact that either/both safety input 1 or/and 2 are turned ON.

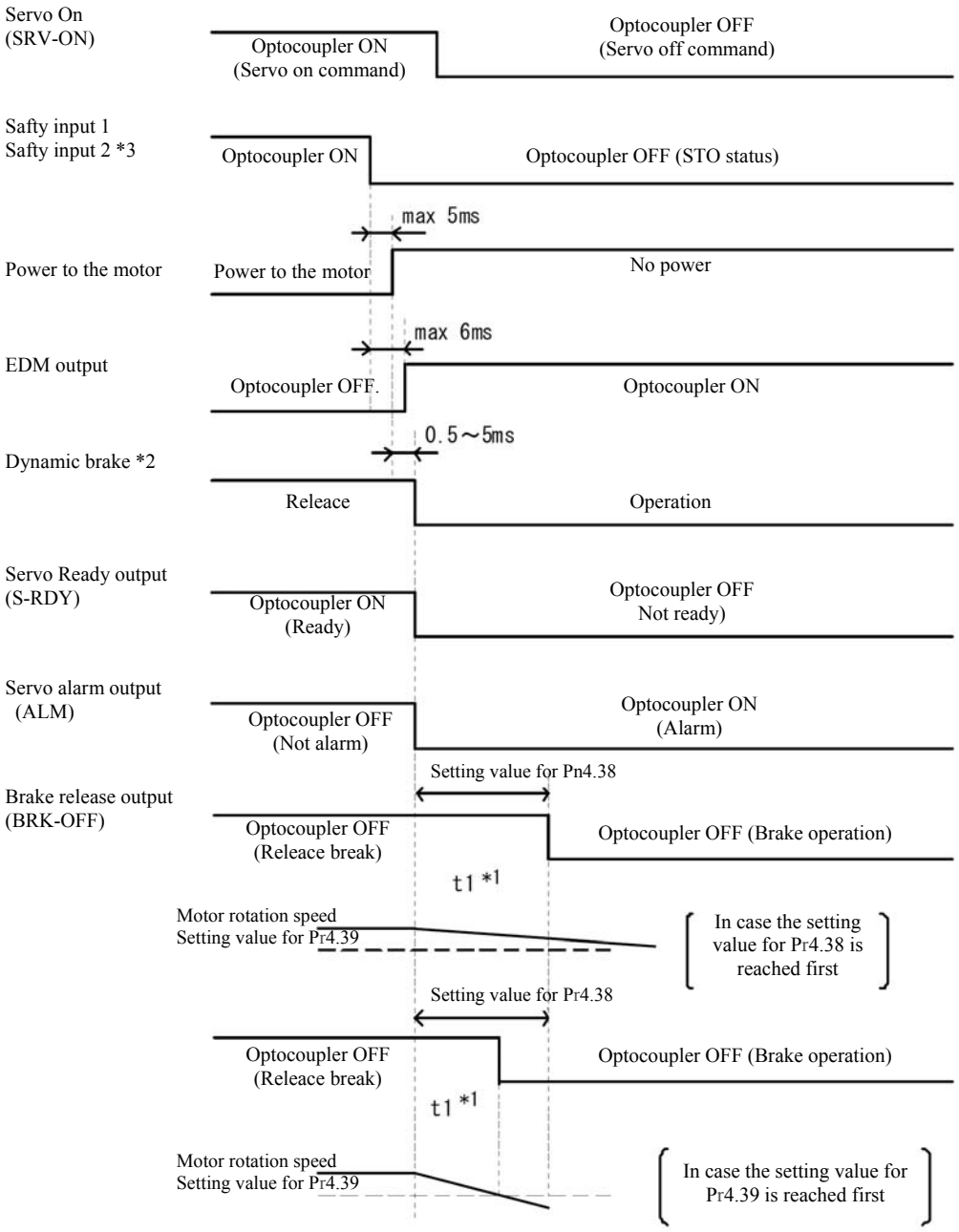
· The delay time from the input of the Safety input 1 and 2 signals till the output of the EDM output signal is 6 minutes at maximum.

8-2-3 Block Diagram of Internal Signal Circuit

Please refer to the "Safety circuit block diagram" at the end of this document.

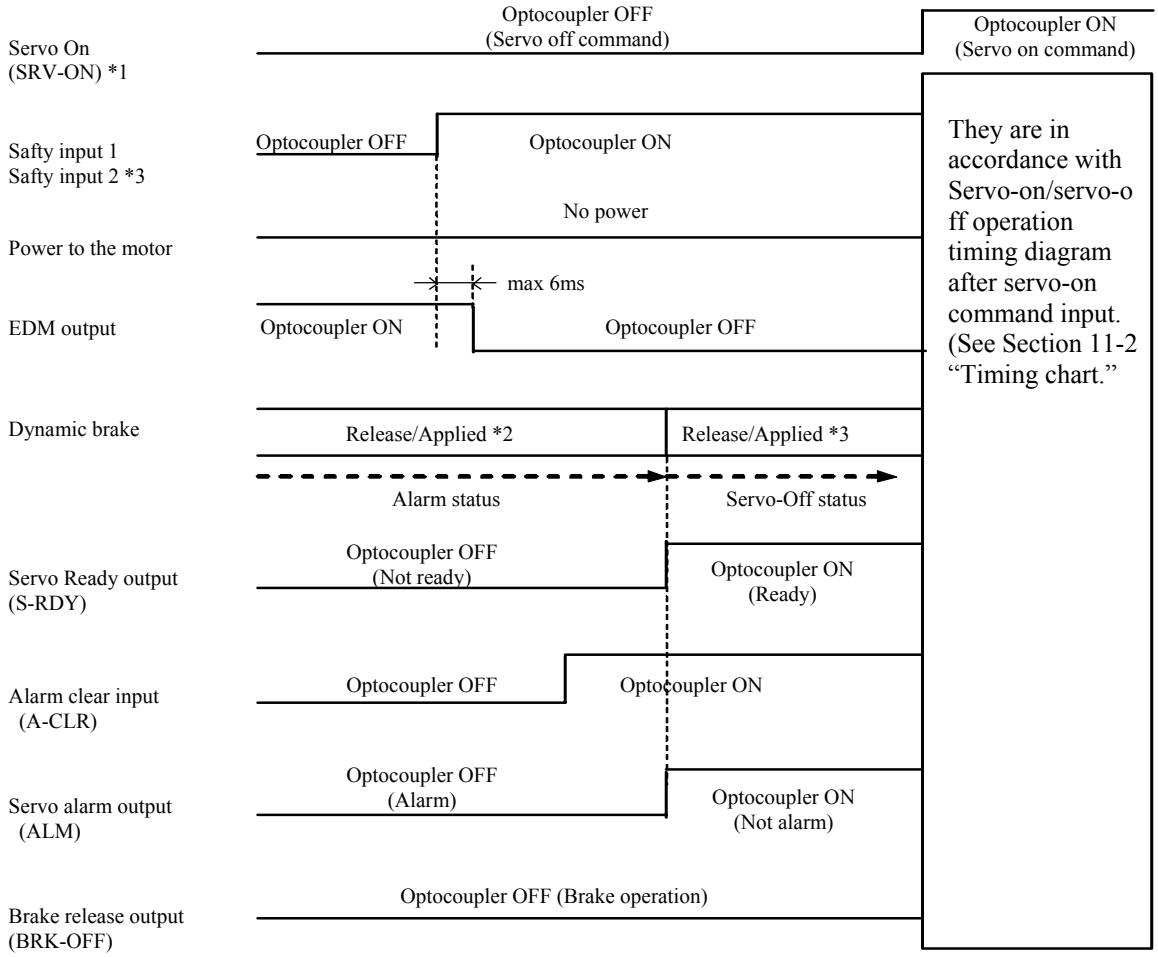
8-3 Details of Functions [LA1] is not possible to use it.

8-3-1 Timing Chart of Operations to Safe Sate [LA1] is not possible to use it.



*1. t1 is the earlier time of either the set value specified in Pr4.38 "Mechanical brake action at running setup" or the time spent until the motor rotation speed becomes the value in Pr4.39 "Brake release speed setup" or less.
*2. The dynamic brake is in accordance with the setting of Pr5.10 "Sequence at alarm."
*3. When either of Safety input 1 or 2 is turned off, the state will transit to STO.

8-3-2 Timing Chart of Returning from Safe State [LA1] is not possible to use it.



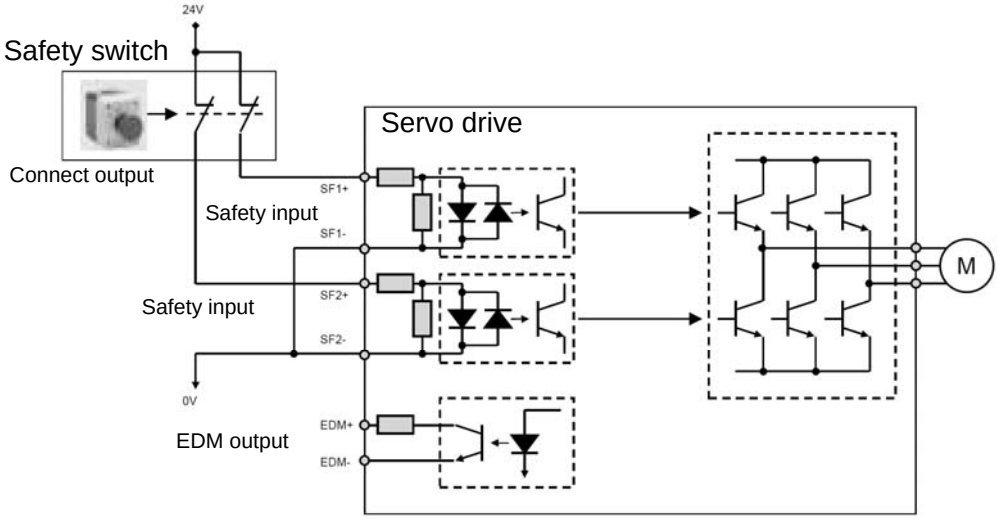
*1. Ensure that the servo-on input is turned OFF, and return the photocoupler of Safety inputs 1 and 2 to ON. This will cause an alarm occurrence state, so you need to clear the alarm.
Before clearing the alarm, ensure that both Safety inputs 1 and 2 are returned to ON.
If you clear the alarm while either or both of them are turned OFF, an alarm will immediately occur.

*2. Due to the alarm occurrence state, the dynamic brake runs in accordance with Pr5.10 "Sequence at alarm."

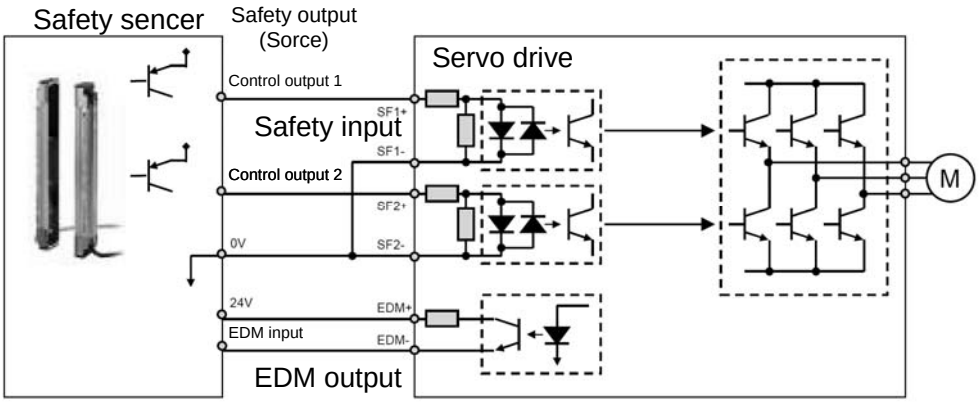
*3. Due to the normal servo-off state, the dynamic brake runs in accordance with Pr5.06 "Sequence at servo-off."

8-4 Examples of Connection [LA1] is not possible to use it.

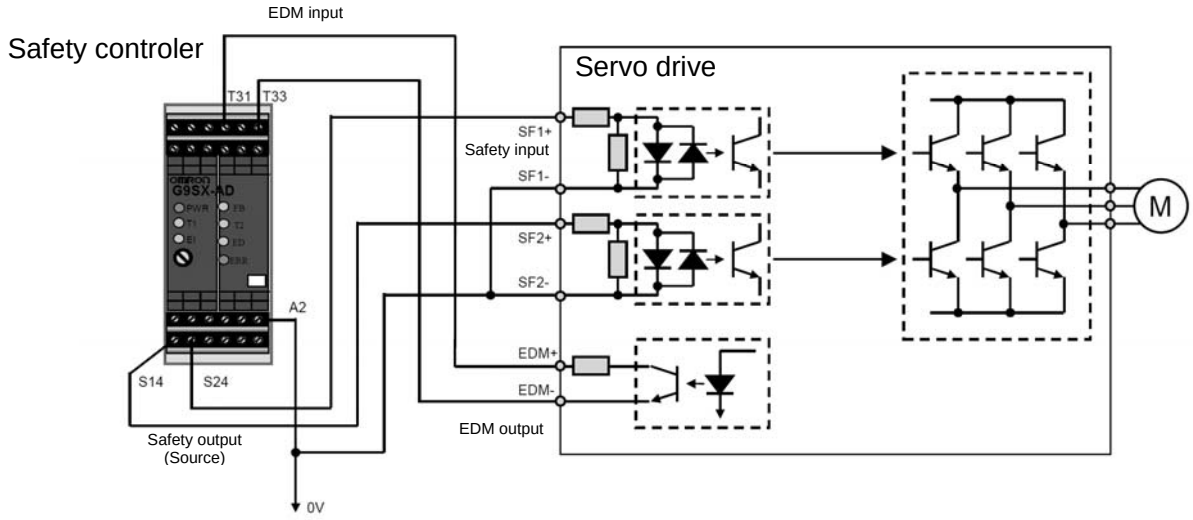
8-4-1 Connection with Safety Switch [LA1] is not possible to use it.



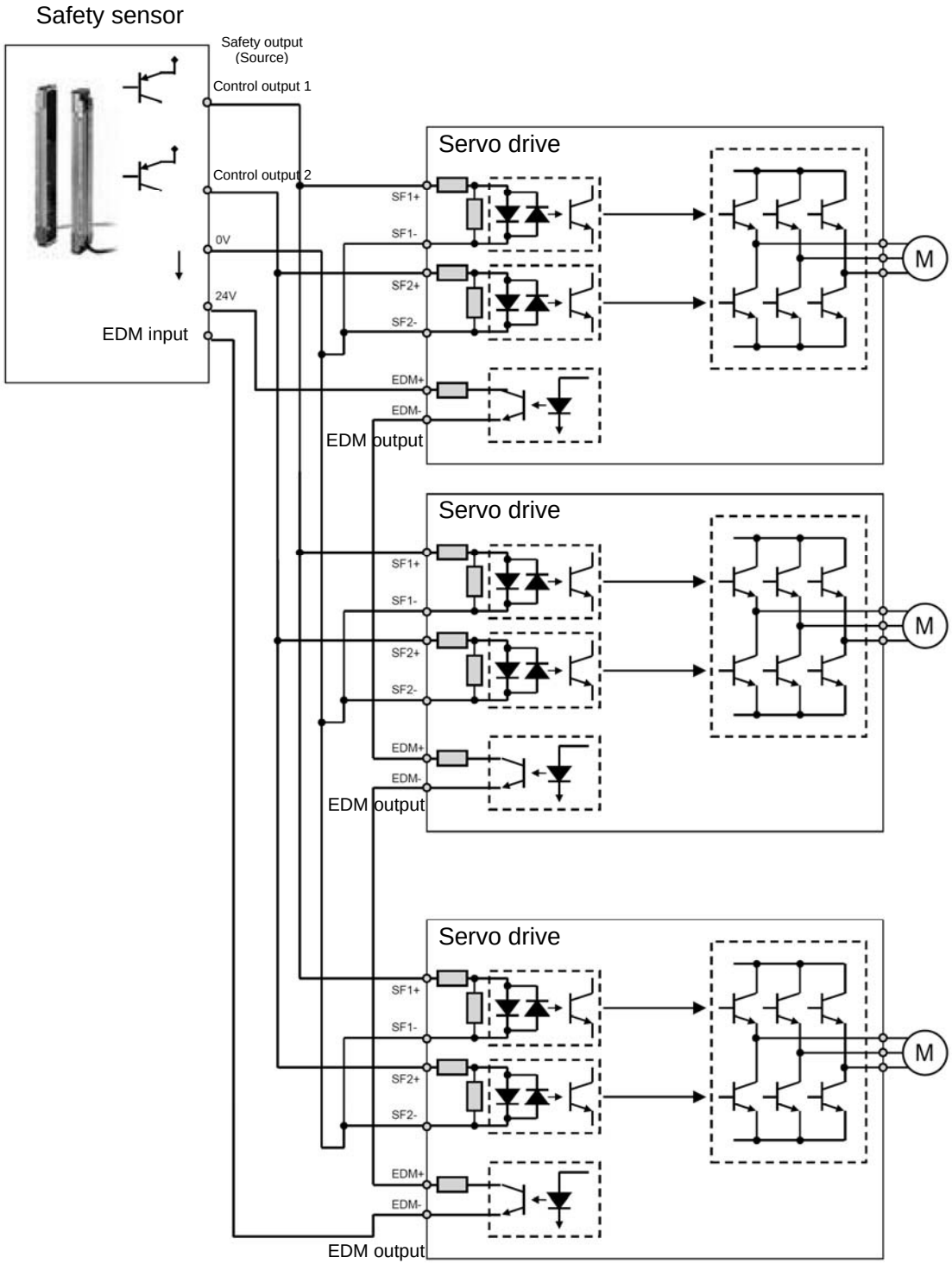
8-4-2 Connection with Safety Sensor [LA1] is not possible to use it.



8-4-3 Connection with Safety Controller [LA1] is not possible to use it.



8-4-4 Connection When Using Plural Axes [LA1] is not possible to use it.



- Current capacity required for one channel of safety output (source): 50xNumber of connected axes (mA)
- DC24V allowable supply voltage: 24V±15%
- Maximum number of axes that can be connected: 8 axes

8-5 Safety Precautions [LA1] is not possible to use it.

- When using the STO function, be sure to conduct risk assessment for the equipment to ensure that the system safety requirements are met.

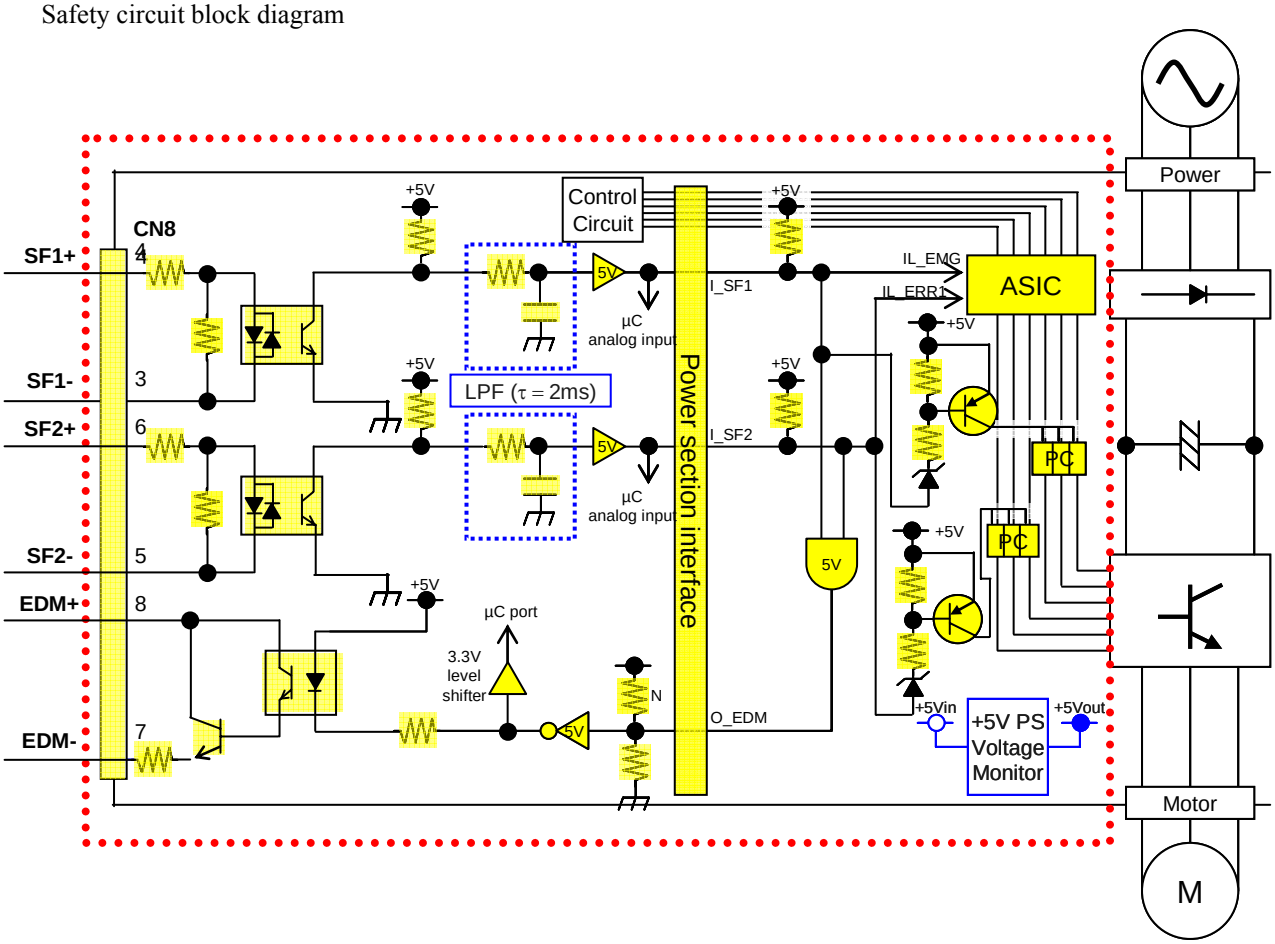
- Even when the STO function is running, there still exist the following risks. So, please consider its safety through risk assessment.
  - The presence of external force (e.g. gravity force on vertical axes) will cause the motor to move. If the motor needs to be held, another measure must be taken such as using an external brake. However, please note that the brake that comes with a servo motor is only for holding, not designed for braking.
  - Or, even when no external force is present, if the parameter Pr5.10 "Sequence at alarm" is set to Free-run (dynamic brake disabled), the motor will free-run, thus resulting in a long stop distance. Attention must be paid to prevent this from causing a problem.
  - A failure in the power transistor, etc. may cause the motor to move in a range of 180 electrical degrees at maximum. Attention must be paid to prevent this from causing a problem.
  - The STO function shuts off the power supply to the motor, while the power supply to the servo drive is not shut off and there is no electrical insulation. For maintenance of the servo drive, another measure must be taken such as shutting off the power supply to the servo drive.

- EDM output signal is not a safety output. Please do not use it for purposes other than monitoring failures.

- The dynamic brake and external brake clear signal outputs are not safety-related parts. In system design, please ensure that possible failure in external brake clear in STO state should not result in dangerous consequences.

- When using the STO function, connect devices that are compliant with safety standards.

Safety circuit block diagram



9. Others

9-1 List of parameters

Category 0: Base configuration

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
0	00	Operational direction setup	-	0~1	Specifies the relationship between the commanded direction and the count direction of feedback scale. 0:Negative direction operation of feedback scale count for positive direction command 1:Positive direction operation of feedback scale count for positive direction command	Power reset	All	4-1
	01	Control mode setup	-	0~5	To select a control mode for the servo drive. 0: Position control, 1: Speed control, 2: Thrust control, 3:Position/speed control, 4: Position/thrust control, 5:Speed/ thrust control,	Power reset	All	–
	02	Real-time auto-gain tuning setup	-	0~6	To select an action mode for the real-time auto tuning.	Always valid	All	5-1-1
	03	Selection of machine stiffness at realtime auto-gain tuning	-	0~31	To set the machine stiffness when the real-time auto tuning is executed.	Always valid	All	5-1-1
	04	Mass ratio	%	0~10000	To set the load mass ratio to the motor's rotor mass .	Always valid	All	–
	05	Selection of command pulse input	-	0~1	To select the command pulse input. 0: Optocoupler input, 1: Line driver input	Power reset	Position,	4-2-1
	06	Command pulse operation direction	-	0~1	To set the counting direction of the command pulse.	Power reset	Position	4-2-1
	07	Command pulse input mode setup	-	0~3	To specify the command pulse counting mode. 0,2: 90-degree phase difference two-phase pulse 1: Positive direction pulse string+negative direction pulse string 3: Pulse string+symbol	Power reset	Position	4-2-1
	09	1st numerator of electronic gear	-	1~2^{30}	To set a numerator in case the command scaling function is set with numerator/denominator.	Always valid	Position	4-2-2
	10	Denominator of electronic gear	-	1~2^{30}	To set a denominator in case the command scaling function is set with numerator/denominator.	Always valid	Position	4-2-2
	11	Numerator of pulse output division	P/r	1~262144	Set the numerator of pulse output division.	Power reset	All	4-2-4
	12	Reversal of pulse output logic	-	0~3	To select the phase B logic of pulse regeneration and the output source.	Power reset	All	4-2-4
	13	1st thrust limit	%	0~500	To set the 1st thrust limit for the motor output. Also, actual output thrust is limited by the maximum thrust of the applicable motor.(Notice; parameter value is not limited.) Actual maximum motor thrust is calculated by below formula. Maximum thrust limit[%] = 100*Pr9.07/(Pr9.06*√2) Pr9.07 "Maximum instantaneous motor current" Pr9.06 "Rated motor effective current"	Always valid	All	6-1
	14	Position deviation excess setup	Command unit	0~2^{27}	To set the maximum position deviation. If set to 0, detection of Err24.0 "Position deviation excess protection" is disabled. The unit is as per Pr5.20 "Position setting unit selection."	Always valid	Position,	7-4
	16	External regenerative resistor setup	-	0~3	To define the setting for the regenerative resistor.	Power reset	All	4-5
	17	Load factor of external regenerative resistor selection	-	0~4	To select the type of load factor calculations for the external regenerative resistor.	Power reset	All	4-5

Category 1: Gain Tuning

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
1	00	1st gain of position loop	0.1/s	0~30000	To set the gain for the 1st position loop.	Always valid	Position	5-2
	01	1st gain of velocity loop	0.1Hz	1~32767	To set the 1st gain of velocity loop	Always valid	All	5-2
	02	1st time constant of velocity loop integration	0.1ms	1~10000	To set the 1st time constant of velocity loop integration. if the setting value=10000, integration becomes invalid.	Always valid	All	5-2
	03	1st filter of speed detection	-	0~5	To select the 1st filter of speed detection out of 6 preset steps.	Always valid	All	5-2
	04	1st time constant of thrust filter	0.01ms	0~2500	To set the 1st time constant of thrust filter.	Always valid	All	5-2
	05	2nd gain of position loop	0.1/s	0~30000	To set the 2nd gain of position loop.	Always valid	Position	5-2
	06	2nd gain of velocity loop	0.1Hz	1~32767	To set the 2nd gain of velocity loop.	Always valid	All	5-2
	07	2nd time constant of velocity loop integration	0.1ms	1~10000	To set the 2nd time constant of velocity loop integration. if the setting value=10000, integration becomes invalid.	Always valid	All	5-2
	08	2nd filter of speed detection	-	0~5	To select the 2nd filter of speed detection out of 6 preset steps.	Always valid	All	5-2
	09	2nd time constant of thrust filter	0.01ms	0~2500	To set the time constant for the 2nd time constant of thrust filter.	Always valid	All	5-2
	10	Velocity feed forward gain	0.1%	0~1000	To set the velocity feed forward gain.	Always valid	Position	5-2-7
	11	Velocity feed forward filter	0.01ms	0~6400	To set the time constant of the velocity feed forward filter.	Always valid	Position	5-2-7
	12	Thrust feed forward gain	0.1%	0~1000	To set the thrust feed forward gain.	Always valid	Position, velocity	5-2-7
	13	Thrust feed forward filter	0.01ms	0~6400	To set the thrust feed forward filter.	Always valid	Position, velocity	5-2-7
	14	2nd gain setup	-	0~1	To set this parameter to carry out an optimum tuning by using the function to switch gains.	Always valid	All	5-2-4
	15	Mode of position control switching	-	0~10	To select the gain switching condition for the position control.	Always valid	Position	5-2-4
	16	Delay time of position control switching	0.1ms	0~10000	To set the delay time when switching from the second gain to the first gain.	Always valid	Position	5-2-4
	17	Level of position control switching	-	0~20000	To set the gain switching level.	Always valid	Position	5-2-4
	18	Hysteresis at position control switching	-	0~20000	To set the gain switching hysteresis.	Always valid	Position	5-2-4
	19	Position gain switching time	0.1ms	0~10000	To set the gain switching time of the position loop gain.	Always valid	Position	5-2-4
	20	Mode of velocity control switching	-	0~5	To select the gain switching condition for the velocity control.	Always valid	Velocity	5-2-4
	21	Delay time of velocity control switching	0.1ms	0~10000	To set the delay time when switching from the second gain to the first gain.	Always valid	Velocity	5-2-4
	22	Level of velocity control switching	-	0~20000	To set the gain switching level.	Always valid	Velocity	5-2-4
	23	Hysteresis at velocity control switching	-	0~20000	To set the gain switching hysteresis.	Always valid	Velocity	5-2-4
	24	Mode of thrust control switching*1	-	0~3	To select the gain switching condition for the thrustcontrol.	Always valid	Thrust	5-2-4
	25	Delay time of thrust control switching *1	0.1ms	0~10000	To set the delay time when switching from the second gain to the first gain.	Always valid	Thrust	5-2-4
	26	Level of thrust control switching *1	-	0~20000	To set the gain switching level.	Always valid	Thrust	5-2-4
	27	Hysteresis at thrust control switching *1	-	0~20000	To set the gain switching hysteresis.	Always valid	Thrust	5-2-4

*1 [LA1] is not possible to use it.

Category 2: Anti-vibration filter

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
2	00	Adaptive filter mode setup	-	0~4	Set the adaptive filter mode.	Always valid	Position, velocity	5-1-2
	01	1st notch frequency	Hz	50~5000	To set the notch frequency for the 1st resonance suppressing notch filter. Match it to the machine's resonance frequency.	Always valid	All	5-2-5
	02	1st notch width selection	-	0~20	Sets the notch width for the first resonance prevention notch filter.	Always valid	All	5-2-5
	03	1st notch depth selection	-	0~99	To set the notch depth for the 1st resonance suppressing notch filter.	Always valid	All	5-2-5
	04	2nd notch frequency	Hz	50~5000	To set the notch frequency for the 2nd resonance suppressing notch filter. Match it to the machine's resonance frequency.	Always valid	All	5-2-5
	05	2nd notch width selection	-	0~20	To set the notch width for the 2nd resonance suppressing notch filter.	Always valid	All	5-2-5
	06	2nd notch depth selection	-	0~99	To set the notch depth for the 2nd resonance suppressing notch filter.	Always valid	All	5-2-5
	07	3rd notch frequency	Hz	50~5000	To set the notch frequency for the 3rd resonance suppressing notch filter. Match it to the machine's resonance frequency. This will be set automatically when the adaptive notch is valid.	Always valid	All	5-2-5 5-1-2
	08	3rd notch width selection	-	0~20	To set the notch width for the 3rd resonance suppressing notch filter. This will be set automatically when the adaptive notch is valid.	Always valid	All	5-2-5 5-1-2
	09	3rd notch depth selection	-	0~99	To set the notch depth for the 3rd resonance suppressing notch filter. This will be set automatically when the adaptive notch is valid.	Always valid	All	5-2-5 5-1-2
	10	4th notch frequency	Hz	50~5000	To set the notch frequency for the 4th resonance suppressing notch filter. Match it to the machine's resonance frequency. This will be set automatically when the adaptive notch is valid.	Always valid	All	5-2-5 5-1-2
	11	4th notch width selection	-	0~20	To set the notch width for the 4th resonance suppressing notch filter. This will be set automatically when the adaptive notch is valid.	Always valid	All	5-2-5 5-1-2
	12	4th notch depth selection	-	0~99	To set the notch depth for the 4th resonance suppressing notch filter. This will be set automatically when the adaptive notch is valid.	Always valid	All	5-2-5 5-1-2
	13	Selection of damping filter switching	-	0~3	To select the switching method in case anti-vibration filters are switched.	Always valid	Position	5-2-6
	14	1st damping frequency	0.1Hz	0~2000	To set the 1st damping frequency to be used for the anti-vibration control to suppress vibration at the end of the load. This will be valid with the setting value at 10 (= 1 Hz) or greater.	Always valid	Position	5-2-6
	15	1st damping filter setup	0.1Hz	0~1000	To fine-tune the 1st anti-vibration control function. Use a small setting value if a thrust saturation is generated; a large setting value if response needs to be raised.	Always valid	Position	5-2-6
	16	2nd damping frequency	0.1Hz	0~2000	To set the 2nd damping frequency to be used for the anti-vibration control to suppress vibration at the end of the load. This will be valid with the setting value at 10 (= 1 Hz) or greater.	Always valid	Position	5-2-6
	17	2nd damping filter setup	0.1Hz	0~1000	To fine-tune the 2nd anti-vibration control function. Use a small setting value if a thrust saturation is generated; a large setting value if response needs to be raised.	Always valid	Position	5-2-6
	18	3rd damping frequency	0.1Hz	0~2000	To set the 3rd damping frequency to be used for the anti-vibration control to suppress vibration at the end of the load. This will be valid with the setting value at 10 (= 1 Hz) or greater.	Always valid	Position	5-2-6
	19	3rd damping filter setup	0.1Hz	0~1000	To fine-tune the 3rd anti-vibration control function. Use a small setting value if a thrust saturation is generated; a large setting value if response needs to be raised.	Always valid	Position	5-2-6
	20	4th damping frequency	0.1Hz	0~2000	To set the 4th damping frequency to be used for the anti-vibration control to suppress vibration at the end of the load. This will be valid with the setting value at 10 (= 1 Hz) or greater.	Always valid	Position	5-2-6
	21	4th damping filter setup	0.1Hz	0~1000	To fine-tune the 4th anti-vibration control function. Use a small setting value if thrust is saturated; a large setting value if response needs to be raised.	Always valid	Position	5-2-6
	22	Positional command smoothing filter	0.1ms	0~10000	To set the time constant of the 1st order filter for the position command.	Always valid	Position	4-2-3
	23	Positional command FIR filter	0.1ms	0~10000	To set the time constant of the FIR filter for the position control.	Always valid	Position	4-2-3

Category 3: Velocity and thrust controls

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
3	00	Speed setup, Internal/External switching	-	0~3	To select the velocity command for the velocity control.	Always valid	Velocity	4-3-1 4-3-2
	01	Speed command rotational direction selection	-	0~1	To select the method to determine the direction for the velocity command.	Always valid	Velocity	4-3-1 4-3-2
	02	Input gain of speed command *1	(mm/s/V	10~2000	To set the gain for the analog velocity command input. Always valid	Always valid	Velocity, thrust	4-3-1
	03	Reversal of speed command input *1	-	0~1	To set the polarity of the analog velocity command.	Always valid	Velocity	4-3-1
	04	1st speed of speed setup	mm/s	-20000~ 20000	Sets the 1st internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	05	2nd speed of speed setup	mm/s		Sets the 2nd internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	06	3rd speed of speed setup	mm/s		Sets the 3rd internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	07	4th speed of speed setup	mm/s		Sets the 4th internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	08	5th speed of speed setup	mm/s		Sets the 5th internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	09	6th speed of speed setup	mm/s		Sets the 6th internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	10	7th speed of speed setup	mm/s		Sets the 7th internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	11	8th speed of speed setup	mm/s		Sets the 8th internal speed command value. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Velocity	4-3-2
	12	Acceleration time setup	ms/ (1000 mm/s)	0~10000	Sets the acceleration time in acceleration processing against a speed command.	Always valid	Velocity	4-3-6
	13	Deceleration time setup	ms/ (1000 mm/s)	0~10000	Sets the deceleration time in deceleration processing against a speed command.	Always valid	Velocity	4-3-6
	14	Sigmoid acceleration/ deceleration time setup	ms	0~1000	Sets the S-curve time against acceleration/deceleration processing of a speed command.	Always valid	Velocity	4-3-6
	15	Speed zero-clamp function selection	-	0~3	To select the function of the speed zero clamp (ZEROSPD).	Always valid	Velocity, thrust	4-3-3
	16	Speed zero clamp level	mm/s	10~20000	To set the threshold speed for position lock transition.	Always valid	Velocity, thrust	4-3-3
	17	Selection of thrust command *1	-	0~2	To select the thrust command and speed limit.	Always valid	Thrust	4-4
	18	Thrust command direction selection *1	-	0~1	To select the method to determine the direction for the thrust command.	Always valid	Thrust	4-4
	19	Input gain of thrust command *1	0.1V/100 %	10~100	To set the gain for the analog thrust command input.	Always valid	Thrust	4-4
	20	Input reversal of thrust command *1	-	0~1	To set the polarity of the analog thrust command.	Always valid	Thrust	4-4

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*1 [LA1] is not possible to use it.

Category 3: Velocity and thrust controls

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
3	21	Speed limit value 1 *1	mm/s	0~20000	To set the speed limit. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Thrust	4-4-1-2
	22	Speed limit value 2 *1	mm/s	0~20000	This parameter allows you to switch speed limits per the direction. Also, the internal value is limited by the lower of the setting value in Pr5.13 and the maximum motor speed × 1.2.	Always valid	Thrust	4-4-1-2
	23	Feedback scale selection	-	0~2	To select the feedback scale type. 0: AB-phase output type 1: Serial communication type (incremental) 2: Serial communication type (absolute)	Power reset	All	4-7-1-3
	26	Feedback scale and CS direction inversion	-	0~3	To set the polarity of the feedback scale feedback pulse and CS signal.	Power reset	All	4-7-1-4 4-7-2
	27	Feedback scale Z phase disconnection detection disable	-	0~1	To enable/disable the disconnection detection of Z-phase when using an AB-phase output type feedback scale. 0: Enabled 1: Disabled	Power reset	All	–

*1 [LA1] is not possible to use it.

Category 4: I/O & Monitor

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
4	00	SI1 input selection	-	0~00FFFFFFh	To set the function and logic of SI1.	Power reset	All	2-3-1
	01	SI2 input selection	-	0~00FFFFFFh	To set the function and logic of SI2.	Power reset	All	2-3-1
	02	SI3 input selection	-	0~00FFFFFFh	To set the function and logic of SI3.	Power reset	All	2-3-1
	03	SI4 input selection	-	0~00FFFFFFh	To set the function and logic of SI4.	Power reset	All	2-3-1
	04	SI5 input selection	-	0~00FFFFFFh	To set the function and logic of SI5.	Power reset	All	2-3-1
	05	SI6 input selection	-	0~00FFFFFFh	To set the function and logic of SI6.	Power reset	All	2-3-1
	06	SI7 input selection	-	0~00FFFFFFh	To set the function and logic of SI7.	Power reset	All	2-3-1
	07	SI8 input selection	-	0~00FFFFFFh	To set the function and logic of SI8.	Power reset	All	2-3-1
	08	SI9 input selection	-	0~00FFFFFFh	To set the function and logic of SI9.	Power reset	All	2-3-1
	09	SI10 input selection	-	0~00FFFFFFh	To set the function and logic of SI10.	Power reset	All	2-3-1
	10	SO1 output selection	-	0~00FFFFFFh	To assign a function to the SO1.	Power reset	All	2-3-2
	11	SO2 output selection	-	0~00FFFFFFh	To assign a function to the SO2.	Power reset	All	2-3-2
	12	SO3 output selection	-	0~00FFFFFFh	To assign a function to the SO3.	Power reset	All	2-3-2
	13	SO4 output selection	-	0~00FFFFFFh	To assign a function to the SO4.	Power reset	All	2-3-2
	14	SO5 output selection	-	0~00FFFFFFh	To assign a function to the SO5.	Power reset	All	2-3-2
	15	SO6 output selection	-	0~00FFFFFFh	To assign a function to the SO6.	Power reset	All	2-3-2
	16	Type of analog monitor 1	-	0~22	To select the type of Analog monitor 1.	Always valid	All	3-3
	17	Analog monitor 1 output gain	-	0~214748364	To select the output gain of Analog monitor 1.	Always valid	All	3-3
	18	Type of analog monitor 2	-	0~22	To select the type of Analog monitor 2.	Always valid	All	3-3
	19	Analog monitor 2 output gain	-	0~214748364	To select the output gain of Analog monitor 2.	Always valid	All	3-3
	20	Type of digital monitor	-	0~3	To select the type of Digital monitor	Always valid	All	3-3
	21	Analog monitor output setup	-	0~2	To select the analog monitor output type.	Always valid	All	3-3
	22	Analog input 1 (AI1) offset setup	0.359 mV	-5578~5578	To set the offset for the analog input 1.	Always valid	All	4-3-1 4-4-1 4-4-2
	23	Analog input 1 (AI1) filter	0.01ms	0~6400	To set the filter for the analog input 1.	Always valid	All	4-3-1 4-4-1 4-4-2
	24	Analog input 1 (AI1) overvoltage setup *1	0.1V	0~100	To set the maximum level of the input voltage for the analog input 1 with the voltage after the offset.	Always valid	All	—
	25	Analog input 2 (AI2) offset setup *1	5.86mV	-342~342	To set the offset for the analog input 2.	Always valid	All	4-4-2 6-2
	26	Analog input 2 (AI2) filter *1	0.01ms	0~6400	To set the filter for the analog input 2.	Always valid	All	4-4-2 6-2
	27	Analog input 2(AI2) overvoltage setup *1	0.1V	0~100	To set the maximum level of the input voltage for the analog input 2 with the voltage after the offset.	Always valid	All	—
	28	Analog input 3 (AI3) offset setup *1	5.86mV	-342~342	To set the offset for the analog input 3.	Always valid	All	6-2
	29	Analog input 3 (AI3) filter *1	0.01ms	0~6400	To set the filter for the analog input 3.	Always valid	All	6-2
	30	Analog input 3 (AI3) overvoltage setup*1	0.1V	0~100	To set the maximum level of the input voltage for the analog input 3 with the voltage after the offset.	Always valid	All	—

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*1 [LA1] is not possible to use it.

Category 4: I/O & Monitor

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
4	31	Positioning complete (In-position) range	Command unit	0~262144	To set the allowable number of pulses in the positioning complete signal (INP). The unit is as per Pr5.20 "Position setup unit select ".	Always valid	Position	4-2-6
	32	Positioning complete (In-position) output setup	-	0~4	To select the criteria for the in-position output.	Always valid	Position	4-2-6
	33	INP hold time	ms	0~30000	To set the INP hold time.	Always valid	Position	4-2-6
	34	Zero-speed	mm/s	10~20000	To set the threshold to detect the zero speed (ZSP).	Always valid	All	2-3-2
	35	Speed coincidence range	mm/s	10~20000	To set the threshold to detect the velocity coincidence (V-COIN) with the differential between speed command and actual velocity.	Always valid	Velocity, thrust	4-3-5
	36	At-speed (Speed arrival)	mm/s	10~20000	To set the threshold to detect the at-speed (AT-SPEED).	Always valid	Velocity, thrust	4-3-4
	37	Mechanical brake action at stalling setup	ms	0~10000	To set the stop time mechanical brake operation setting. The established resolution is 2ms. For example, if the setting value = 11, it will be 12ms.	Always valid	All	11-2-2
	38	Mechanical brake action at running setup	ms	0~10000	To set the run time mechanical brake operation setting. The established resolution is 2ms. For example, if the setting value = 11, it will be 12ms.	Always valid	All	11-2-2
	39	Brake release speed setup	mm/s	30~3000	To set the speed threshold for run time mechanical brake output determination.	Always valid	All	11-2-2
	40	Selection of alarm output 1	-	0~10	To select the warning type for the warning 2 to output.	Always valid	All	7-3
	41	Selection of alarm output 2	-	0~10	To select the warning type for the warning 2 to output.	Always valid	All	7-3
	42	2nd Positioning complete (In-position) range	Command unit	0~262144	Sets the allowable number of pulses in the positioning complete signal 2(INP2). The unit is as per Pr5.20 "Position setup unit select ".	Always valid	Position	4-2-6

Category 5: Extended configuration

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
5	00	2nd numerator of electronic gear	-	1~2^{30}	Sets the numerator of the second command division.	Always valid	Position	6-4
	01	3rd numerator of electronic gear	-	1~2^{30}	Sets the numerator of the third command division.	Always valid	Position	6-4
	02	4th numerator of electronic gear	-	1~2^{30}	Sets the numerator of the the fourth command division.	Always valid	Position	6-4
	03	Denominator of pulse output division	-	0~262144	Set this when the output pulse counts per one motor revolution should be determined based on the ratio of the numerator to the denominator of the division.	Power reset	All	4-2-4
	04	Over-travel inhibit input setup	-	0~2	Sets the operation of the positive/negative drive prohibition inputs.	Power reset	All	6-5-1 7-4
	05	Sequence at over-travel inhibit	-	0~2	Sets the sequence during drive prohibition input.	Power reset	All	6-5-1 7-4
	06	Sequence at Servo-Off	-	0~9	Sets the sequence at servo-off.	Always valid	All	6-5-2
	07	Sequence at main power OFF	-	0~9	Sets the sequence at main power OFF	Always valid	All	6-5-3
	08	LV trip selection at main power OFF	-	0~1	To select between going to the LV trip or turning off the servo control at the main power alarm. 0: The servo is turned off in accordance with Pr5.07 setting, and then the main power is re-supplied to return to servo-on. 1: Tripped due to Err13.1 "Main power supply undervoltage protection (AC interception detection)".	Always valid	All	–
	09	Detection time of main power off	ms	70~2000	To set the time to detect the main power alarm. If set to 2000, the main power off detection is disabled. The established resolution is 2ms. For example, if the setting value = 99, it will be 100ms.	Power reset	All	–
	10	Sequence at alarm	-	0~7	To set the sequence at alarm .	Always valid	All	6-5-4
	11	Thrust setup for emergency stop	%	0~500	To set the thrust limit at the immediate stop. When the setting value = 0, the thrust limit during normal operation is applied.	Always valid	All	6-5-1 6-5-2 6-5-3 6-5-5
	12	Over-load level setup	%	0~500	Sets the overload level. If set to 0, the value is 115%. Also, the internal values are limited by 115%.	Always valid	All	–
	14	Motor working range setup	0.1 magnetic pole pitch	0~1000	To set the maximum travel distance of the motor in addition to the position command.	Always valid	Position	6-3 7-4
	15	I/F reading filter	-	0~3	Selects the signal read cycle for control input. 0:0.166ms,1:0.333ms,2:1ms,3:1.666ms However, the deviation counter clear input (CL) and command pulse prohibition input (INH) are excluded.	Power reset	All	–
	16	Alarm clear input setup	-	0~1	Selects the recognition time for the alarm clear input (A-CLR). 0:120ms 1: As per Pr5.15 "I/F reading filter".	Power reset	All	11-2-5
	17	Counter clear input mode	-	0~4	Selects the reception condition for the counter clear input signal. 0: Disabled 1: Clear by level (without reading filter) 2: Clear by level (with reading filter) 3: Clear by edge (without reading filter) 4: Clear by edge (with reading filter)	Always valid	Position	4-2-5
	18	Invalidation of command pulse inhibit input	-	0~1	Enables/disables the command pulse prohibition input (INH). 0: Enabled 1: Disabled	Always valid	Position	4-2-7
	19	Command pulse inhibit input reading setup	-	0~4	Selects the signal read cycle for the command pulse prohibition input (INH). 0:0.166ms,1:0.333ms,2:1ms,3:1.666ms, 4: No read filter	Power reset	Position	4-2-7

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Category 5: Extended configuration

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
5	20	Position setup unit select	-	0~1	To define the unit for the in-position range and the Position deviation excess protection . 0: Per command 1: Per feedback scale	Power reset	Position	7-4
	21	Selection of thrust limit	-	0~6	To define the mode to select positive/negative thrust limits.	Always valid	Position, velocity	6-1 6-2
	22	2nd thrust limit	%	0~500	To set the 2nd thrust limit for the motor output thrust . Also, actual thrust output value is limited by the maximum thrust of the motor used.(parameter value is not limited.)	Always valid	Position, velocity	6-1
	23	Thrust limit switching setup 1	ms /100%	0~4000	To set the rate of change (gradient) when the thrust limits switch from the 1st to 2nd.	Always valid	Position, velocity	6-1
	24	Thrust limit switching setup 2	ms /100%	0~4000	To set the rate of change (gradient) when the thrust limits switch from the 2nd to 1st.	Always valid	Position, velocity	6-1
	25	External input positive direction thrust limit	%	0~500	Sets the positive direction thrust limit at TL-SEL input when Pr5.21 "Selection of thrust limit" is set to 6. Also, actual thrust output value is limited by the maximum thrust of the motor used.(parameter value is not limited.)	Always valid	Position, velocity	6-1
	26	External input negative direction thrust limit	%	0~500	Sets the negative direction thrust limit at TL-SEL input when Pr5.21 "Selection of thrust limit" is set to 6. Also, actual thrust output value is limited by the maximum thrust of the motor used.(parameter value is not limited.)	Always valid	Position, velocity	6-1
	27	Input gain of analog thrust limit *1	0.1V/ 100%	10~10 0	To set the gain for the analog thrust limit input.	Always valid	Position, velocity	6-2
	28	LED initial status	-	0~37	To set the data type to display in the 7-segment LED at the initial state when the control power is turned on.	Power reset	All	3-1-3 3-2-1
	29	Baud rate of RS232 *1	-	0~6	Defines the RS232 communication speed. 0: 2400, 1: 4800, 2: 9600 3: 19200, 4: 38400, 5: 57600, 6: 115200[bps]	Power Reset	All	4-7-1-5
	30	Baud rate of RS485 *1	-	0~6	Defines the RS485 communication speed. 0: 2400, 1: 4800, 2: 9600 3: 19200, 4: 38400, 5: 57600, 6: 115200[bps]	Power Reset	All	4-7-1-5
	31	Axis address	-	0~127	Sets the axis number for communication.	Power reset	All	–
	32	Command pulse input maximum setup	Kpulse/s	250~4 000	Set the maximum number of command pulse inputs to be used. If the command pulse input frequency exceeds this range, Err27.0 "Command pulse input frequency error protection" will occur. Note) Detection of the command pulse input frequency error is performed against the pulses received by the drive. If the pulse frequency input significantly exceeds this set value, detection may not work correctly.	Power reset	Position	–
	33	Pulse regenerative output limit setup	-	0~1	Enables/disables the detection of Err28.0 "Limit of pulse replay error protection". 0: Invalid 1: Valid	Power reset	All	–
	34	For manufacturer's use	-	–	Must be fixed to 4.	–	—	–
	35	Front panel lock setup	-	0~1	Operations by the front panel are locked. 0: Operations by front panel not locked 1: Operations by front panel locked	Power reset	All	3-1-4

*1 [LA1] is not possible to use it.

Category 6: Specific Configuration

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
6	00	Analog thrust feed forward conversion gain *1	0.1V/100%	0~100	Sets the input gain for the analog thrust FF. 0 to 9 are invalid.	Always valid	Position, velocity	–
	02	Velocity deviation excess setup	mm/s	0~20000	Set up the threshold in Err24.1 "Velocity deviation excess protection". When the setting value = 0, the detection of velocity deviation excess protection will be invalid.	Always valid	Position	–
	04	JOG trial run command speed	mm/s	0~500	To set the command speed for JOG operation (velocity control).	Always valid	All	3-2-4
	05	Position 3rd gain valid time	0.1ms	0~10000	To set the valid time for the 3rd gain of the 3 gain switching steps.	Always valid	Position	5-2-10
	06	Position 3rd gain scale factor	%	50~1000	To set the scaling factor for the 3rd gain with the factor used for the 1st gain.	Always valid	Position	5-2-10
	07	Thrust command additional value	%	-100~100	To set the offset thrust to be added to the thrust command.	Always valid	Position, velocity	5-2-11
	08	Positive direction thrust compensation value	%	-100~100	To set the value added to the thrust command during the operation in the positive direction.	Always valid	Position	5-2-11
	09	Negative direction thrust compensation value	%	-100~100	To set the value added to the thrust command during the operation in the negative direction.	Always valid	Position	5-2-11
	10	Function expansion setup	-	0~511	The several functions are set by the bit. bit0 Speed observer 0: Disabled 1: Enabled bit1 Disturbance observer 0: Disabled 1: Enabled bit2 Disturbance observer operation setting 0:Always enabled 1:Enabled only when the first gain is selected bit3 Mass ratio switching 0: Disabled 1: Enabled bit4 Current response improvement 0: Disabled 1: Enabled bit5 Analog thrust FF *1 0: Disabled 1: Enabled bit6 Current responsibility improvement 0: Disabled 1: Enabled bit7 INP output limitation 0: Disabled 1: Enabled bit8 Speed FF selection 0: Conventional 1: High precision *The least significant bit is set as bit 0.	Always valid	All	5-2-8 5-2-9 5-2-10 2-2
	13	2nd mass ratio	%	0~10000	To set the load mass ratio to the motor's rotor mass.	Always valid	All	5-2-12
	14	Emergency stop time at alarm	ms	0~1000	To set the allowable time for the immediate stop to complete when there is an alarm. The established resolution is 2ms. For example, if the setting value = 11, it will be 12ms.	Always valid	All	6-5-5
	15	2nd over-speed level setup	mm/s	0~20000	If the motor speed exceeds the value set for this parameter during an immediate stop caused by an alarm, it will bring the 2nd over-speed protection state.	Always valid	All	6-5-5
	17	Power-up wait time	-	0~1	Selects the EEPROM write specification when changing a parameter on the front panel. 0: No simultaneous EEPROM write 1: Simultaneous EEPROM write enabled	Power reset	All	3-2-2
	18	Emergency stop time at alarm	0.1s	0~100	To set the initialization time when the power is turned on by adding time to the standard 1.5 s+ α .	Power reset	All	11-2-1
	20	Z-phase setup of feedback scale	μs	0~400	Allows expansion of the width of Z-phase output of the feedback scale.	Power reset	All	4-2-4
	21	Serial absolute feedback scale Z phase setup	pulse	0~2^{28}	Sets the Z-phase regeneration position when using a serial absolute-type feedback scale. 0: Z-phase is output only for the absolute position =0. 1 to 2^{28}: After Z-phase output in the absolute position =0, Z-phase is output at a set pulse cycle. No Z-phase is output until passing over the absolute position =0.	Power reset	All	4-2-4

(Continued)

*1 [LA1] is not possible to use it.

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
6	22	AB-phase regeneration method selection for AB-phase output-type feedback scale	-	0~1	Selects the regeneration method for pulse outputs OA and OB when using an AB-phase output-type feedback scale. 0: No signal regeneration 1: Signal regeneration enabled * Z-phase is always sent as through output without signal regeneration. * If set to enable signal regeneration, the duty of OA and OB is regenerated at the drive side, allowing prevention of waveform distortion. However, please note that delay occurs against the Z-phase.	Power reset	All	4-2-4
	23	Disturbance thrust compensating gain	%	-100~100	To set the compensation gain for the disturbance thrust.	Always valid	Position, Velocity	5-2-9
	24	Disturbance observer filter	0.01ms	10~2500	To set the filter time constant for the disturbance thrust compensation.	Always valid	Position, Velocity	5-2-9
	27	Alarm latch time selection	s	0~10	Sets the warning latch time. 0: Infinite latch time 1 to 10: Latch time 1 to 10[s]	Power reset	All	7-3
	31	Real time auto tuning estimation speed	-	0~3	To set the estimated speed of load characteristics when the real time auto-gain tuning is valid.	Always valid	All	5-1-1
	32	Real time auto tuning custom setup	-	-32768~ 32767	To set the details for the customizing mode of the real time auto-gain tuning.	Always valid	All	5-1-1
	37	Oscillation detection level	0.1%	0~1000	Sets the threshold for oscillation detection. If detecting the thrust vibration exceeding this setting, an oscillation detection warning will occur.	Always valid	All	7-3
	38	Alarm mask setup	-	-32768~ 32767	Performs the mask setting for warning detection. If the corresponding bit is set to 1, the corresponding warning detection is disabled.	Power reset	All	7-3
	39	For manufacturer's use	-	–	Must be fixed to 0.	-	-	-
	40	Disturbance thrust compensation phase setting	Degree	0–60	The phase with the disturbance thrust estimation advances and sets the compensation value.	Always valid	Position, Velocity	5-2-9
	41	1st damping depth	-	0–1000	Specifies the depth of first damping frequency.	Always valid	Position	5-2-6

Category 9: Linear Motor Configuration

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
9	00	Motor type selection	-	0 - 2	Selects the motor type to be connected.	Power reset	All	4-7
	01	Feedback scale resolution/ Number of scale pulses per rotation	0.001 mm/ pulse	0 - 16777216	[Motor : Linear type] Sets up the resolution of feedback scale. [Motor : Rotary type] Sets up the number of feedback scale pulses per rotation.	Power reset	All	4-7
	02	Magnetic pole pitch	0.01 mm	0 - 32767	[Motor : Linear type] Sets up the pitch of magnetic poles. * Rotary type : Unnecessary	Power reset	All	4-7
	03	Number of pole pairs per rotation	Number of pole pairs	0 – 255	Sets up the number of pole pairs per rotation. * Linear type : Unnecessary	Power reset	All	4-7
	04	Weight of motor's movable section/ Motor inertia	0.01 kg/ 0.00001 kgm^2	0 - 32767	[Motor : Linear type] Sets up the weight of motor's movable section. [Motor : Rotary type] Sets up the motor inertia.	Power reset	All	4-7
	05	Rated motor thrust/ Motor inertia	0.1 N/ 0.1 Nm	0 - 32767	[Motor : Linear type] Sets up the rated motor thrust. [Motor : Rotary type] Sets up the motor inertia.	Power reset	All	4-7
	06	Rated motor effective current/ Rated motor torque	0.1Arms	0 - 32767	[Motor : Linear type] Sets up the rated motor current. [Motor : Rotary type] Sets up the rated motor torque.	Power reset	All	4-7
	07	Maximum instantaneous motor current	0.1 A	0 - 32767	Sets up the maximum instantaneous current of the motor.	Power reset	All	4-7
	08	Motor phase inductance	0.01 mH	0 - 32767	Sets up the motor phase inductance.	Power reset	All	4-7
	09	Motor phase resistance	0.01 Ω	0 - 32767	Sets up the motor phase resistance.	Power reset	All	4-7
	10	Overspeed level	(mm/s)/ (r/min)	0 - 20000	Sets up the level to detect Err26.0 (Overspeed protection).	Power reset	All	4-7
	11	Carrier frequency selection	-	0 - 1	Selects the carrier frequency. 0:6 kHz 1:12 kHz	Power reset	All	4-7
	12	Automatic current response adjustment	%	0 - 100	Sets up the reference for current response when automatically setting Pr9.13 (Current proportional gain) and Pr9.14 (Current integrative gain).	Power reset	All	4-7
	13	Current proportional gain	-	0 - 32767	Sets up the current proportional gain.	Always valid	All	4-7
	14	Current integrative gain	-	0 - 32767	Sets up the current integrative gain.	Always valid	All	4-7
	15	Two-stage thrust filter	0.01ms	0 – 2500	To set the time constant for the thrust filter. 0 : disable the filter This setting is always valid regardless of the state of the gain switching.	Always valid	All	5-2-13
	16	Two-stage thrust filter damping term	-	0 – 10000	To set the dampling term for two-stage thrust filter	Always valid	All	5-2-13

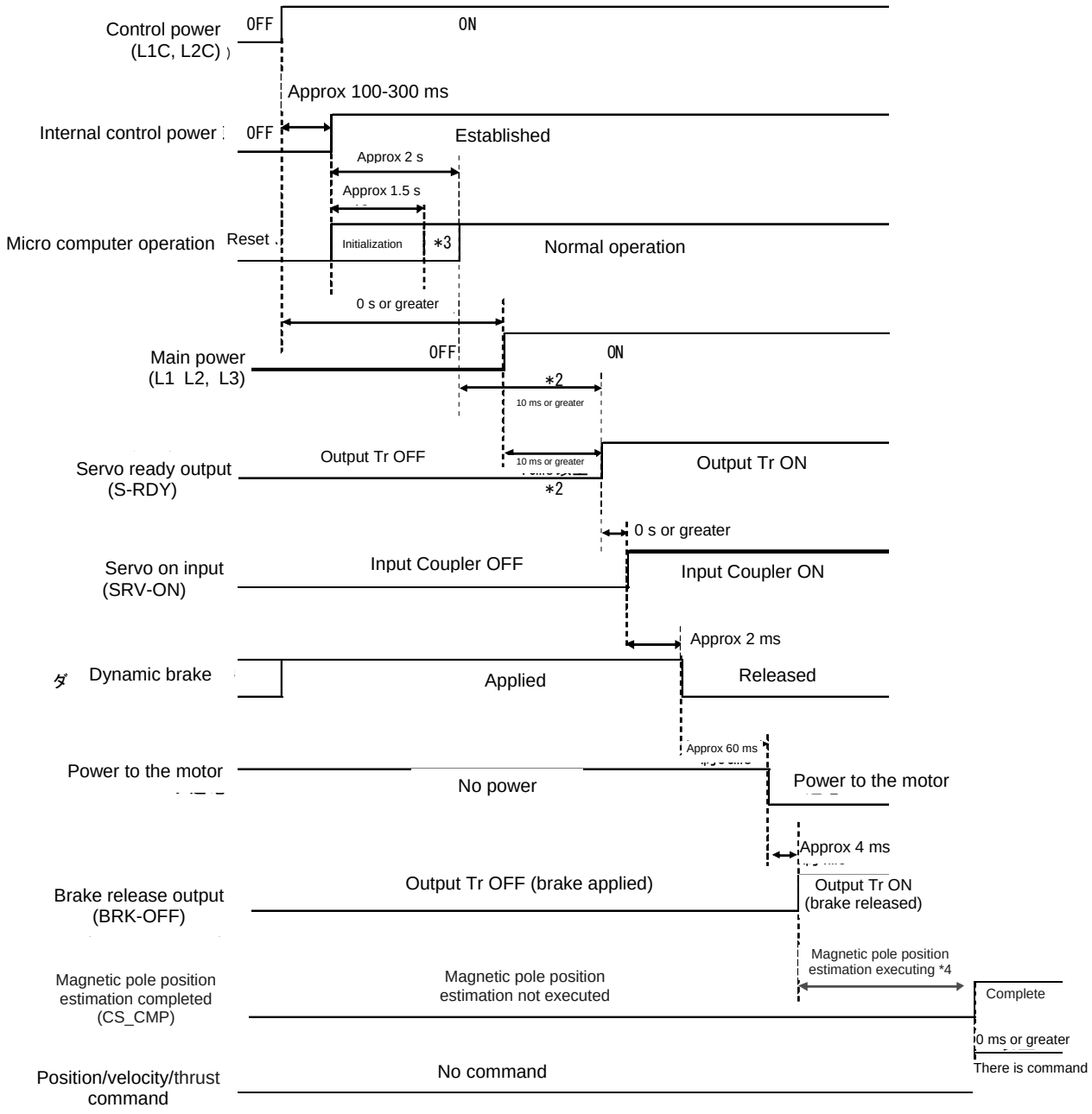
Note) The parameter name and unit change according to the motor type. In the mark part named 'A'/'B', 'A' shows a linear type and 'B' shows the rotary type.

(Continued)

Category	No.	Parameter	Unit	Setup range	Function/description	Attribute	Related control mode	Reference
9	17	For manufacturer's use	-	–	Must be fixed to 0.	-	-	-
	18	For manufacturer's use	-	–	Must be fixed to 0.	-	-	-
	19	For manufacturer's use	-	–	Must be fixed to 0.	-	-	-
	20	Magnetic poles detection method selection	-	0 - 3	Selects the detection method of the magnetic poles position.	Power reset	All	4-7
	21	CS phase setting	Electric angle (°)	0 - 360	Sets up the phase difference between motor's inductive voltage and CS signal.	Power reset	All	4-7
	22	Thrust command time for estimating magnetic poles position	ms	0 - 200	Sets up the application time of a command when estimating the magnetic poles position.	Always valid	All	4-7
	23	Command thrust for estimating magnetic poles position	%	0 - 300	Sets up the thrust of a command when estimating the magnetic poles position.	Always valid	All	4-7
	24	Zero moving pulse width for estimating magnetic poles position	pulse	0 - 32767	Sets up the pulse width for judging as a zero movement when estimating the magnetic poles position.	Always valid	All	4-7
	25	Number of pulses for judging as a motor stop when estimating magnetic poles position	pulse	0 - 32767	Sets up the condition for judging as a motor stop when estimating the magnetic poles position.	Always valid	All	4-7
	26	Time for judging as a motor stop when estimating magnetic poles position	ms	0 - 32767	Sets up the condition for judging as a motor stop when estimating the magnetic poles position.	Always valid	All	4-7
	27	Time limit of motor stop for estimating magnetic poles position	ms	0 - 32767	Sets up the time limit for judging as a motor stop when estimating the magnetic poles position.	Always valid	All	4-7
	28	Thrust command filter for estimating magnetic poles position	0.01 ms	0 – 2500	Sets up the filter time constant for the thrust command when estimating the magnetic poles position. When this setting is zero, the filter is invalid and the command becomes a step command.	Always valid	All	4-7
	29	Overload protection time constant setting	-	0 – 7	0 : Standard specification Select the overload protection above 7 characteristic.	Power reset	All	7-2
	30	Pulse count between magnetic pole	Pulse	0 – 327670000	Information on a linear motor can be set by pulse unit. It is effective only to set a linear motor type. Moreover, it is not possible to use simultaneously with Pr9.02 "Magnetic pole pitch". Please set it by either.	Power reset	All	4-7

9-2 Timing Chart

9-2-1 Timing Chart of Operations After Turning Power On (Magnetic pole position estimation is valid(Pr9.20=2))



- The above chart shows the timing of actions from the time when the control power is turned on until a command is entered.
- Enter the servo-on signal and the position/velocity/thrust commands according to the above chart.

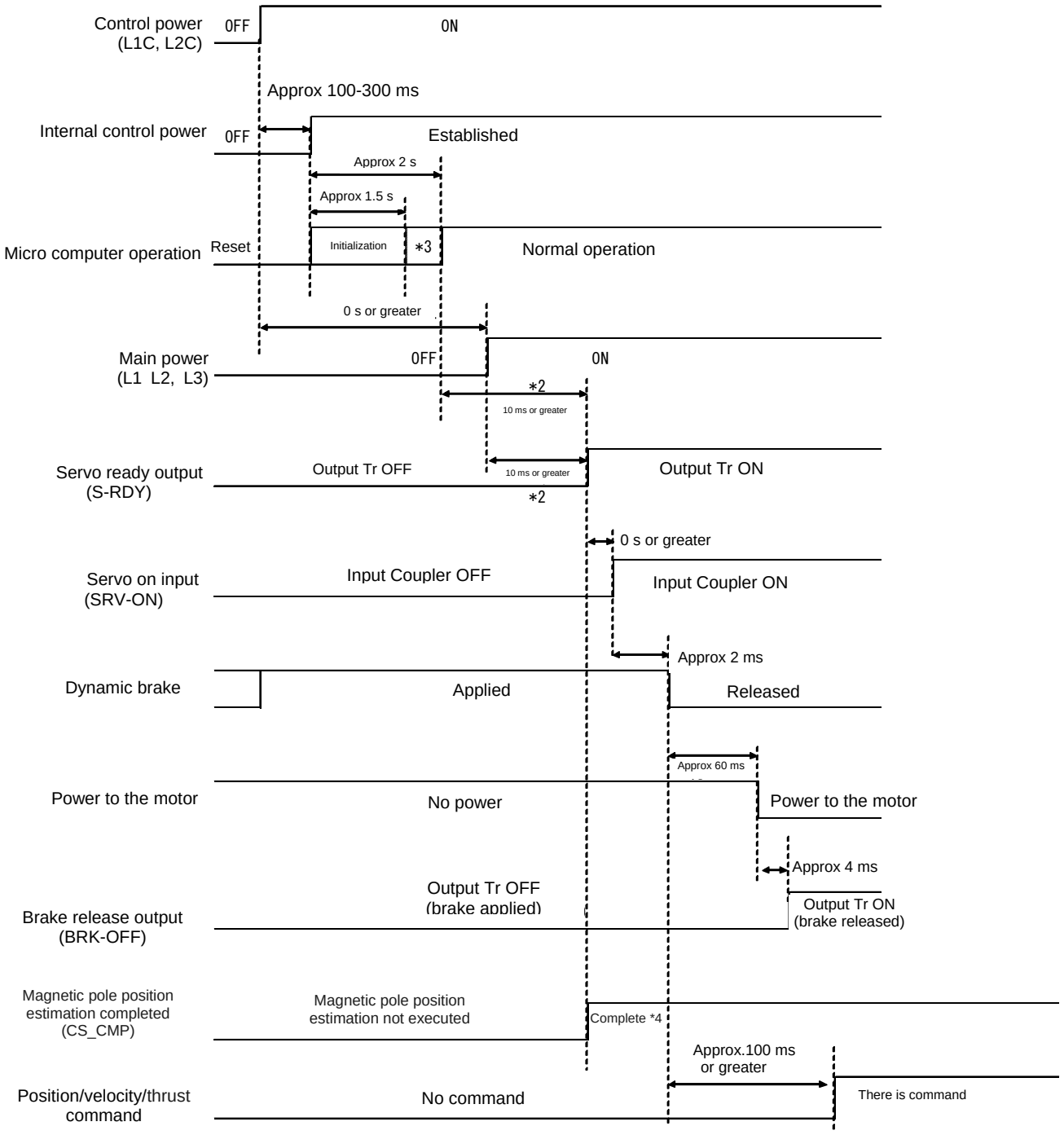
*1. It indicates that the servo-on signal (SRV-ON) is physically input but not received in this section.

*2. S-RDY output is turned on only when the two conditions are met: initialization of the microcomputer has been complete, and the main power has been established.

*3. When the internal control power has been established, the protective functions get activated approximately 1.5 s after the start of the micro computer initialization. To design your system, keep in mind that all the input/output signals connected to the driver should be established before the protective functions start getting activated; use special care for signals that can trigger the protective functions such as positive/negative overtravel limits and feedback scale input. Also, this time can be extended using Pr6.18 "Power-up wait time".

*4. The time of the magnetic pole position estimation depends on the parameter setting etc. Please impress the instruction after confirming the magnetic pole position estimation completed output is turned on. When the ma gnetic pole position estimation is not normally completed, the magnetic pole position estimation completed outp ut is not
turned on.

9-2-2 Timing Chart of Operations After Turning Power On (Magnetic pole position estimation is invalid(Pr9.20=0,1,3))



- The above chart shows the timing of actions from the time when the control power is turned on until a command is entered.
- Enter the servo-on signal and the position/velocity/thrust commands according to the above chart.

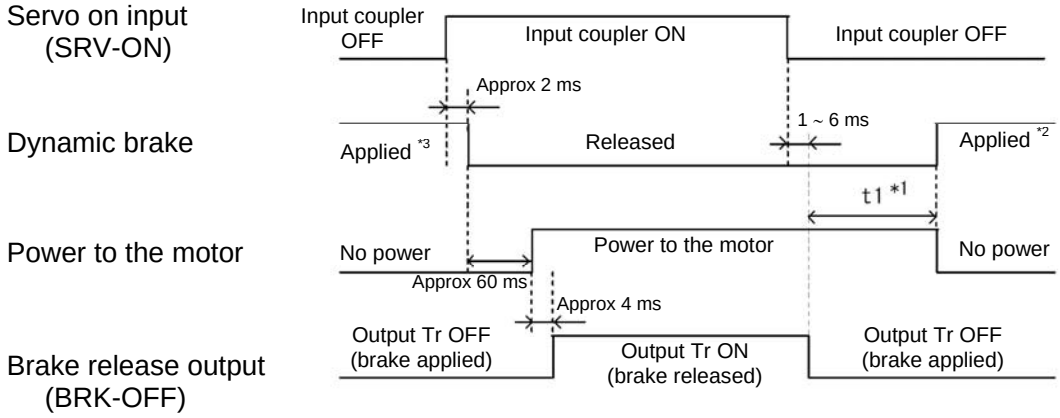
*1. It indicates that the servo-on signal (SRV-ON) is physically input but not received in this section.

*2. S-RDY output is turned on only when the two conditions are met: initialization of the microcomputer has been complete, and the main power has been established.

*3. When the internal control power has been established, the protective functions get activated approximately 1.5 s after the start of the micro computer initialization. To design your system, keep in mind that all the input/output signals connected to the driver should be established before the protective functions start getting activated; use special care for signals that can trigger the protective functions such as positive/negative overtravel limits and feedback scale input. Also, this time can be extended using Pr6.18 "Power-up wait time".

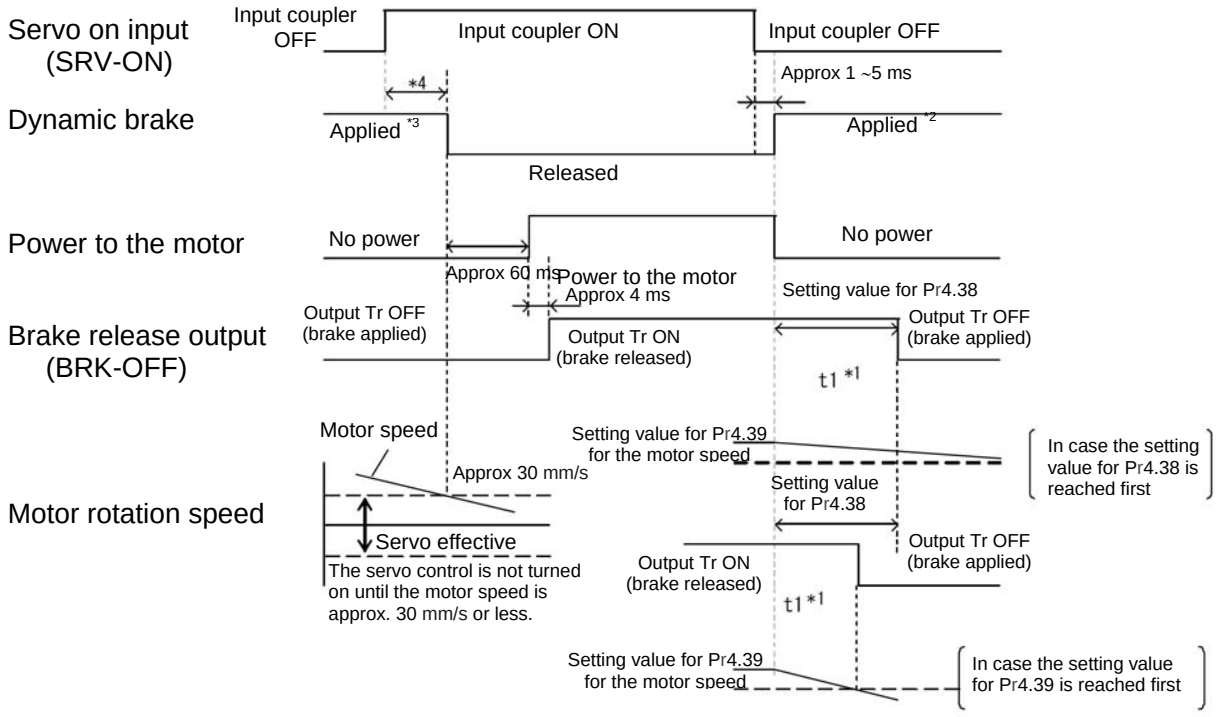
*4. When Err61.2 " Magnetic pole position estimation error 3" occured or Pr9.20=0 are set, the output transistor is not turned on.

9-2-3 Timing Chart of Servo On/Off When Monitor is Turned Off
(For normal operations, stop the motor before turning the servo control on and off.)



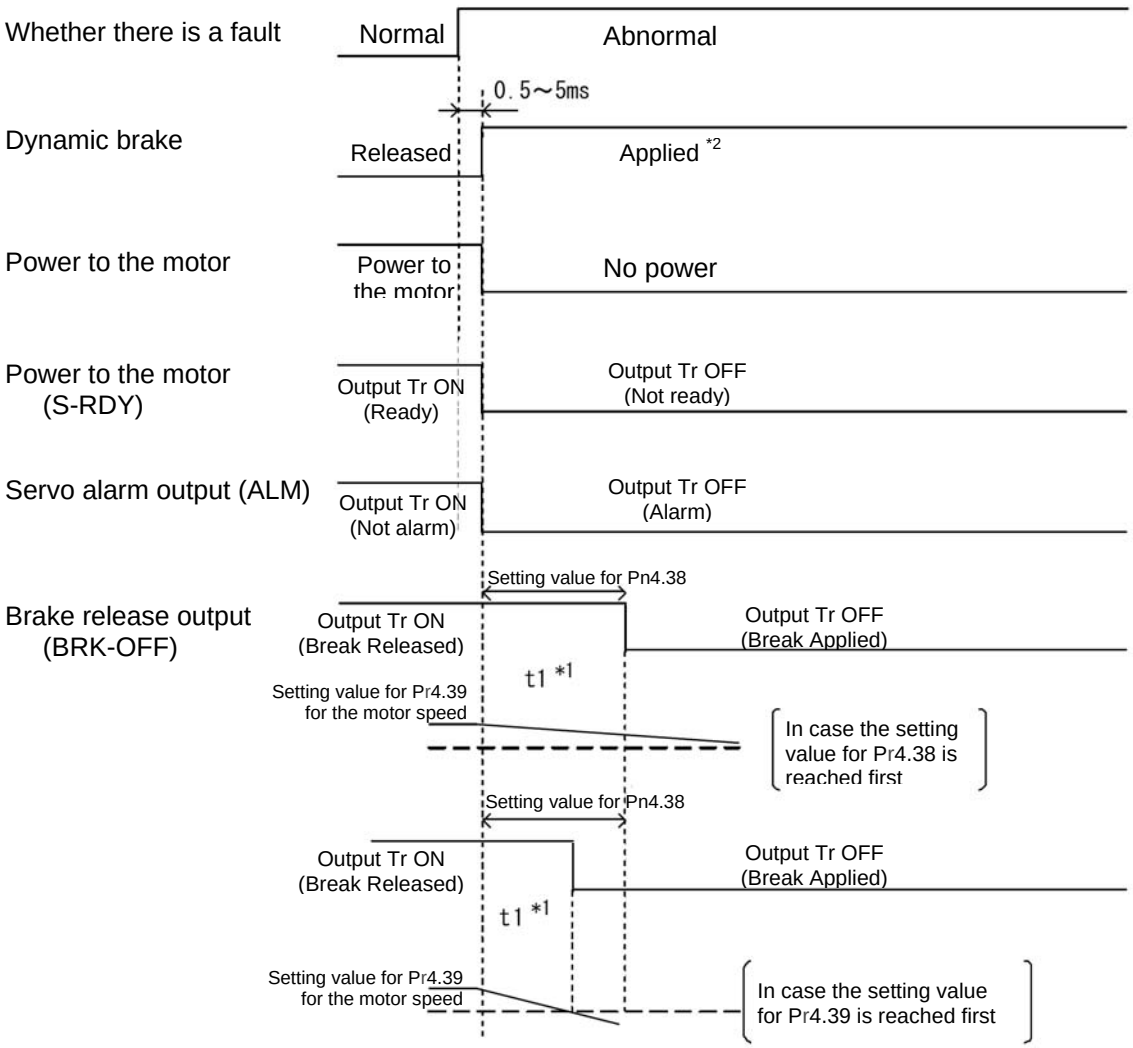
*1. t1 depends on the set value specified in Pr4.37 "Mechanical brake action at stalling setup".
*2. The dynamic brake operation at servo-off depends on the set value specified in Pr5.06 "Sequence at servo-off".
*3. The servo control is not turned on until the motor speed is approximately 30 mm/s or less.

9-2-4 Timing Chart of Servo On/Off When Motor is Operating
(This chart shows the timing for the emergency stop and trip. It is not intended for repeated use.)



*1. The time t1 will be either the value used to set Pr4.38 "Mechanical brake action at running setup" or when the motor speed is reduced to the setting for Pr4.39 "Brake release speed setup" or less, whichever comes first.
*2. If the SRV-ON signal is turned on again during the deceleration of the motor, the servo control does not transfer to the servo-on state until the motor stops.
*3. The operation of the dynamic brake during the servo-off is according to the setting value for Pr5.06 "Sequence at servo-off".
*4. The servo control is not turned on until the motor speed is approximately 30 mm/s or less.
*5. Whether electricity is turned on to the motor during the servo-off deceleration depends on the value used to set Pr5.06 "Sequence at servo-off".

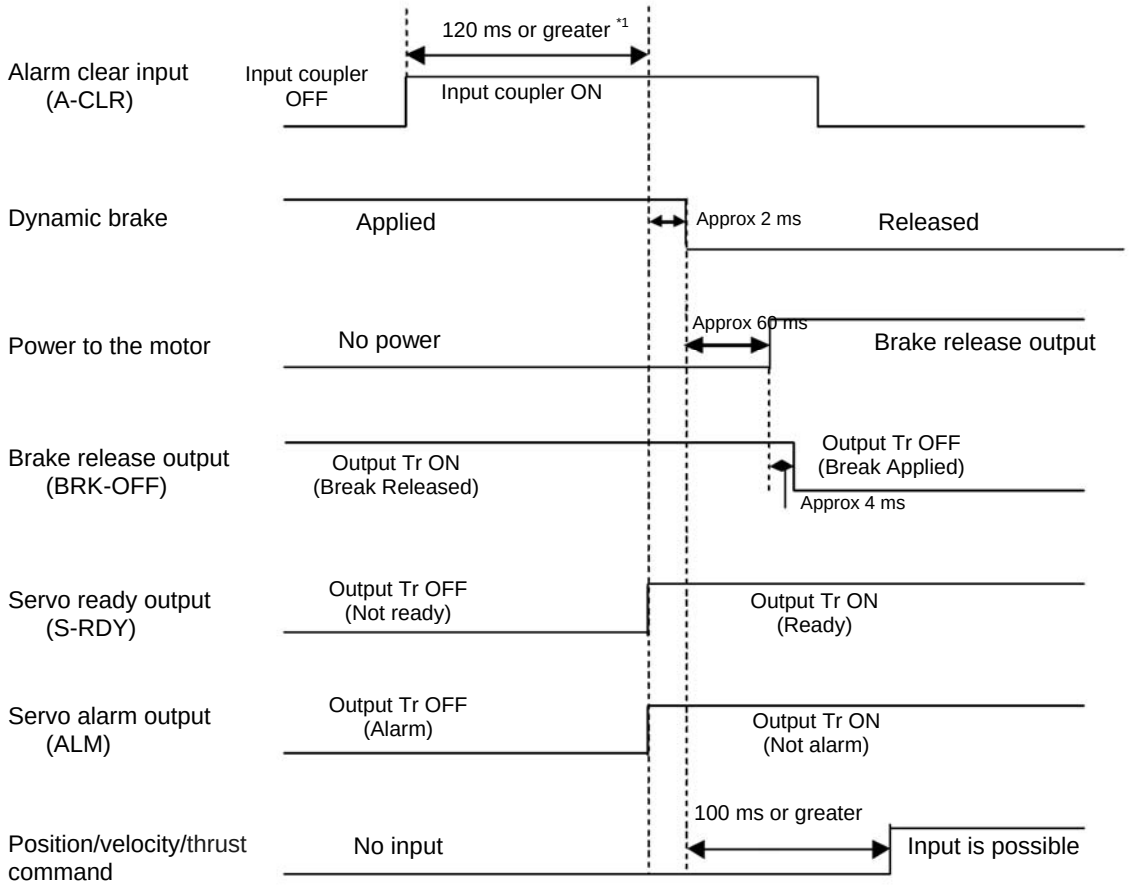
9-2-5 Timing Chart of Operations When Alarm is Issued (Servo-On Command Status)



*1. The time t1 will be either the value used to set Pr4.38 "Mechanical brake action at running setup" or when the motor speed is reduced to the setting for Pr4.39 "Brake release speed setup" or less, whichever comes first.

*2. The operation of the dynamic brake when an alarm has occurred is according to the setting value for Pr5.10 "Sequence at alarm".

9-2-6 Timing Chart of Operations When Alarm is Cleared (Servo-On Command Status)



*1. The time to recognize the alarm clear input can be changed with Pr5.16 "Alarm clear input setup". (The default setting is 120 ms.)