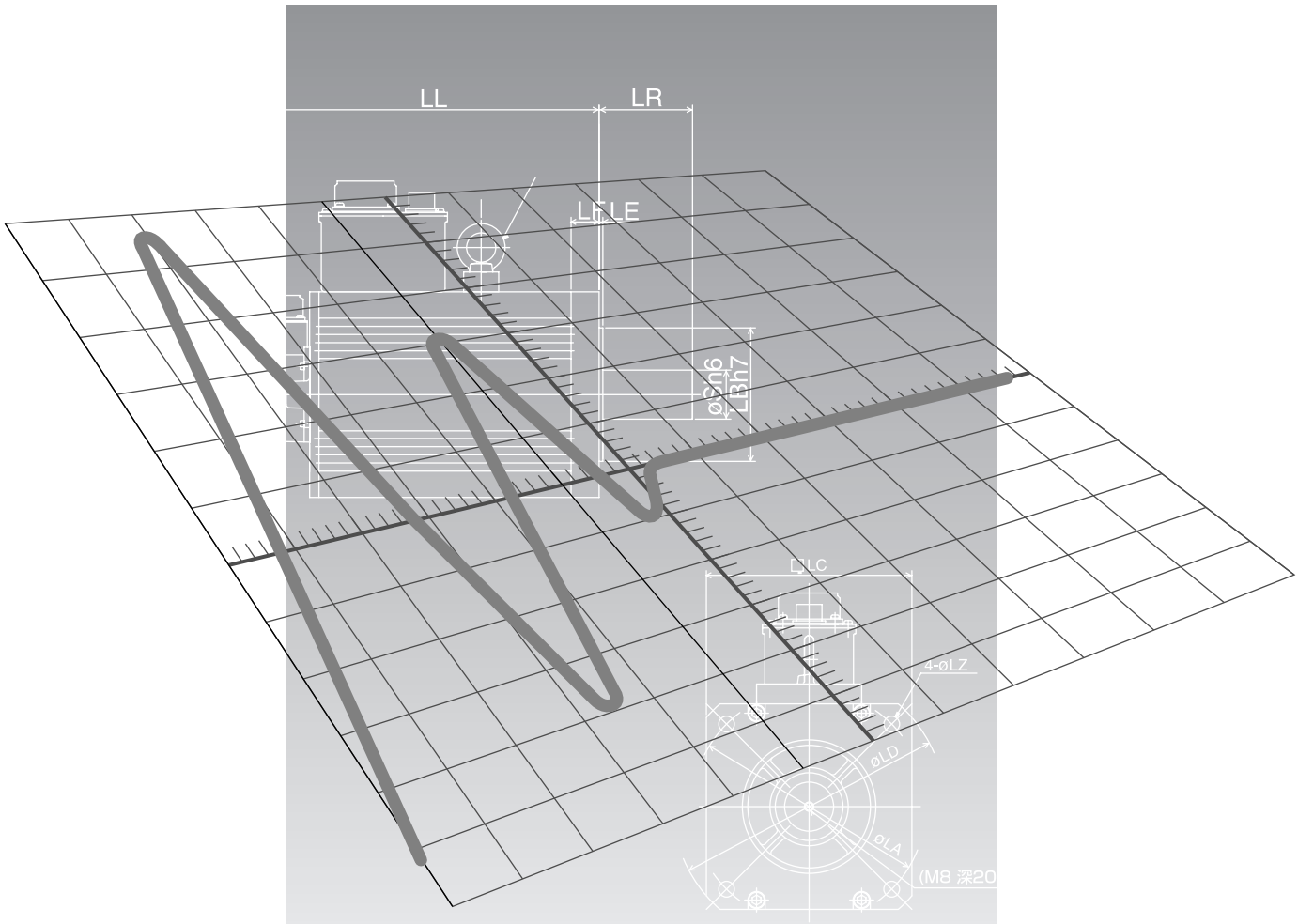
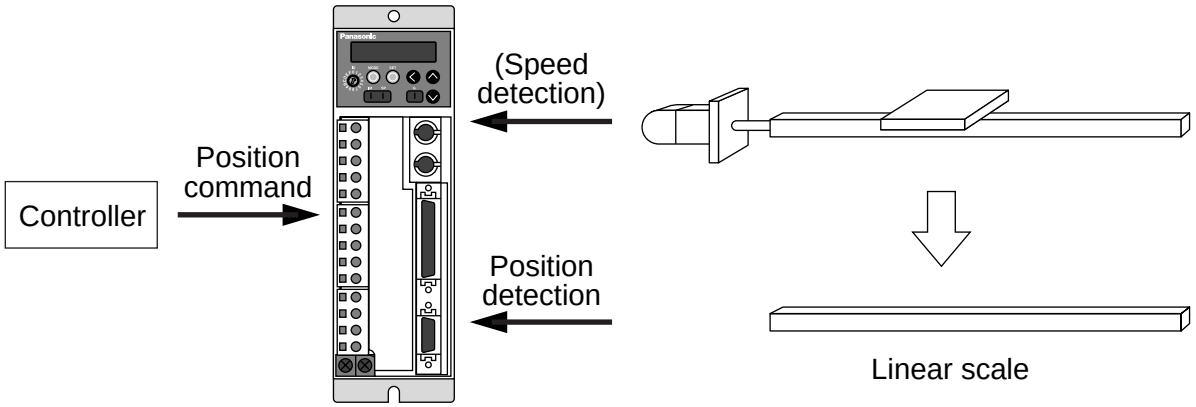


[Full-closed control mode]

Outline of Full-closed control

What is full-closed control

Full-closed control detects the position of the machine to be controlled directly using an external linear scale and feeds it back to perform position control. Full-closed control provides control that is free from influence of positional fluctuation due to, for example, an error of ball screw or temperature etc.
By building full-closed control system, a high precise positioning of sub-micron order can be obtained.



For division ratio of a linear scale, we recommend 1/16 ≦ linear scale division ratio ≦ 32.

Control mode

Full-closed control of the AIII series provides four control modes as listed below.
In order to maintain compatibility with the Matsushita A-series, full-closed control, hybrid control and external encoder control modes are given.
In AIII series, it is recommended to use second full-closed control mode. For each control mode, see also “Block Diagram by Control Mode” of Preparations volume on page 298.

Control mode	Position control	Speed control	Characteristics	Corresponding Encoders
Full-closed control	External scale	Encoder	A control in which external scale position is used as feedback for position control, and encoder (motor) speed is used as feedback for speed control. Be careful that the unit of the ordinary position control and the unit of position loop gain are different from each other.	2500 P/r 17-bit
Hybrid control	Encoder/ external scale	Encoder	A mixed control mode of full-closed control and semi-closed control. When the full-closed control mode is used, in case of low machine stiffness, compared to semi-closed control mode, there may be a case that sufficient control gain can not be obtained resulting in a failure in obtaining required operation. Hybrid control is a control mode that provides both of response performance of the semi-closed control mode and accuracy of full-closed control mode in which, while the semi-closed control is always performed, position command is corrected on the basis of a deviation between the encoder and the external scale at predetermined timing when the machine comes to a stop.	2500 P/r 17-bit
External encoder control	External scale	External scale	A control mode in which both position control and speed control uses external scale position/speed as feedback data.	2500 P/r 17-bit
Second full-closed control	External scale	Encoder	Although second full-closed control mode is the same as the full-closed control mode in the point that external scale position is used as feedback for position control and encoder (motor) speed is used as feedback for speed control, the unit of the position loop gain is the same as that of the ordinary position control mode. Torsion correction function using Pr7B and Pr7C and status feedback function using Pr7C-Pr7E are available.	Only 17-bit

Selecting among full-closed modes

Semi-closed control mode: second control mode of Pr02=06 or Pr02=10

Speed control and position control is performed on the basis of the feedback of the encoder.
A part of the function of the interface connector CN X5 is different from the ordinary position control mode.
Input the command pulse based on the encoder.

<Caution>
(1) If you set control mode setting parameter Pr02 = 9, 10, and switch to speed control, functions of I/O ports will also be switched simultaneously. Thus, refer to “List of Function Switching by Control Mode of Interface Connector CN X5” on page 160 and be careful in using.

Full-closed control mode: Pr02=7

Speed control is performed based on the feedback of the encoder, and position control is performed based on the feedback of the external scale.
Input the command pulse based on the external scale.

<Caution>
(1) Command 1 pulse equals to 1 pulse of the external scale. Be careful that the setting of the command division scale ratio is different from that of the semi-closed control mode.
(2) With respect to the setting value of the position loop gain (Pr10, 18), the value, which is actually used for control, is obtained by:
Particularly, be careful that the actual position loop gain becomes larger than the set value when the number of external scale pulses is larger than the number of the encoder pulses per 1 rotation of the encoder.

$$\text{Position loop gain (Pr10,18)} \times \frac{\text{Number of external scale per 1 rotation of motor}}{\text{Number of feedback pluses of encoder}}$$

Hybrid control mode: Pr02 = 8

During normal operation at the reference speed (Pr70) or higher speed, both speed control and position control are based on the encoder's feedback signal (as in the semi-closed control mode). If the reference speed or lower speed continued for the specified period (Pr71), high-precision positioning is performed through position correction based on the external scale's feedback signal for the specified control period (Pr72).
Normally, even if the mechanical stiffness between the motor and external scale is low, stable operation is ensured as in the semi-closed control mode. During positioning control, the servo driver corrects position data through the external scale, enabling high-precision positioning.
Set Pr70 (hybrid switching speed) and Pr71 (hybrid switching time) so that correction will start when vibration of the motor at setting deadens.
Input a command pulse based on the external scale's reference signal.

<CAUTION>
(1) Note that the command multiply division ratio of full-closed specification differs from that of semi-closed control mode because command 1 pulse is one pulse of an external scale.
(2) If the ratio of the encoder pulse to the external scale pulse is large (x20 or more), or the ratio cannot be defined by Pr74 to Pr76, particularly when moving distance is long, the internal position error data may overflow, resulting in a position error. Adjust the mechanical and control systems so that the position error for each encoder does not exceed 32767.

Outline of Full-closed control

External encoder control mode: Pr02 = 9 (Second control mode)

Execute full-closed control by using speed.
Input a command pulse according to the external scale standard.

<CAUTION>

(1) Note that the command multiply division ratio of full-closed specification differs from that of semi-closed control mode because command 1 pulse is one pulse of an external scale.

(2) In the external encoder control mode or the speed control mode in combination with the external encoder control mode, the gain switching function cannot be used. Be sure to set up the relevant parameters as listed below.

Pr30 2nd gain operation setup	1
Pr31 Position control switching mode	1
Pr36 Speed control switching mode	0

With the above parameter settings, the gain for the speed control mode, and the gain for the external encoder control mode are fixed to "Gain 1" (P10 to Pr14) and "Gain 2" (Pr18 to Pr1C), respectively.

(3) When the control mode is switched between the external encoder control mode and the speed control mode, speed data may rapidly change. To prevent a trouble during the switching time, stop the motor before switching the control mode. (Mode switching time: 1 to 5 ms)
Although speed loop gain (Pr19) when the external encoder control is selected is actually used in the control to setting [Hz], it differs from:

$$\text{Speed Loop Gain (Pr19)} \times \frac{\text{Number of External Scale Pulses per Revolution of Motor}}{\text{Number of Encoder Pulses per Revolution of Motor}}$$

Be careful because oscillation may take place, in particular, when the number of external scale pulse is greater than that of encoder pulses per revolution of the motor, or when it is too small.

(4) If you set control mode setting parameter Pr02 = 9, 10, and switch to speed control, in particular, functions of I/O ports will also be switched simultaneously. Thus, refer to “List of Function Switching by Control Mode of Interface Connector CN X5” and be careful in using.

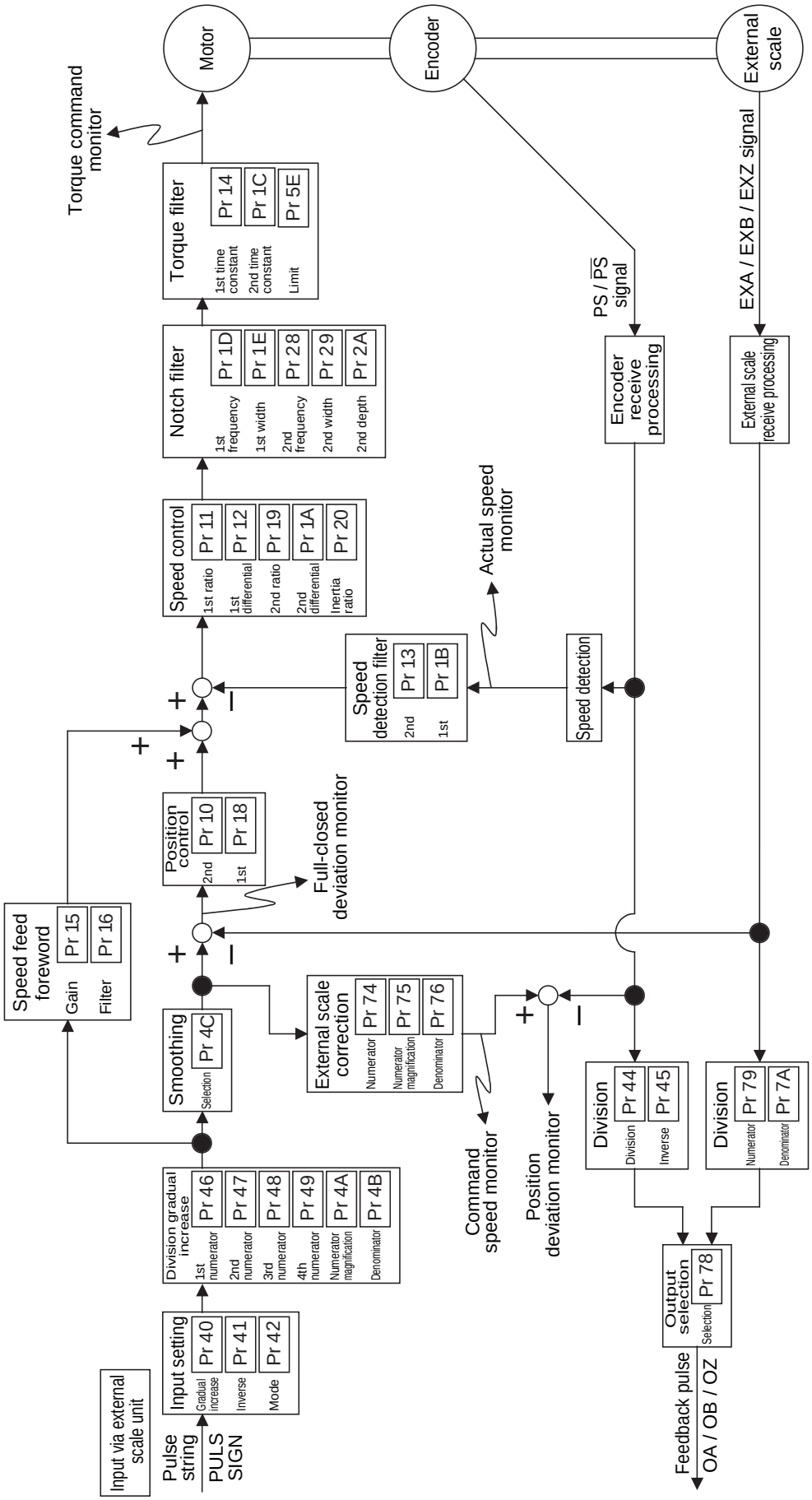
2nd full-closed control mode: Pr02 = 14

The 2nd full-closed control mode is same as normal full-closed control in that speed control is executed through feedback of the encoder, while position control is done through feedback of external scale. An improvement is that conversion of a position loop gain that needs correction can be made at the driver. A user can select the 2nd full-closed control mode only when a 17-bit absolute/incremental shared encoder is used.
Input a command pulse based on the external scale's reference signal.

Full-closed control block diagram [Full-closed control mode]

• Control mode set-up: when Pr02 is [7]

*As the output from the external scale deviation counter drops down within the range set by the Pr60, the position complete output is turned on.



CN X5 Connector

Functional selection of interface connector CN X5 by control mode

Input Circuit

Signal (symbol)	Pin No.	I/F circuit	Control mode setting (Pr02)						Parameter related to port setting
			6: Semi-closed control	7: Full-closed control	8: Hybrid control	9: Speed/external encoder control	10: Speed/semi-closed control	14: the 2nd full-closed	
SPR/TRQR	14	AI	–	–	–	Speed command	Speed command	–	Speed command enabled with Pr05=0.2
CCWTL/TRQR	16	AI	CCW torque limit	CCW torque limit	CCW torque limit	CCW torque limit	CCW torque limit	CCW torque limit	CCW torque limit enabled with Pr03=0
CWTR	18	AI	CW torque limit	CW torque limit	CW torque limit	CW torque limit	CW torque limit	CW torque limit	CW torque limit enabled with Pr03=0
PULS1.2	3,4	PI	Command pulse	Command pulse	Command pulse	–/Command pulse	–/Command pulse	Command pulse	
SIGN1.2	5,6	PI	Command sign	Command sign	Command sign	–/Command sign	–/Command sign	Command sign	
SRV-ON	29	SI	Servo on	Servo on	Servo on	Servo on	Servo on	Servo on	
GAIN	27	SI	P action (2nd gain) changeover	P action (2nd gain) changeover	P action (2nd gain) changeover	1st gain fixed /2nd gain fixed	P action (2nd gain) changeover	P action (2nd gain) changeover	Pr30=0:P action changeover Pr30=1 and Pr31= 2, Pr36=2, Pr3A=2:2nd gain change over
DIV	28	SI	Command div/ multi changeover 1	Command div/ multi changeover 1	Command div/ multi changeover 1	Command div/ multi changeover 1	Command div/ multi changeover 1	–	
ZEROSPD	26	SI	Speed zero clamp	Speed zero clamp	Speed zero clamp	Speed zero clamp	Speed zero clamp	–	Speed zero clamp enabled with Pr06=1
CL//INTSPD2	30	SI	Counter clear	Counter clear	Counter clear	Internal speed selection 2/ counter clear	Internal speed selection 2/ counter clear	Counter clear	Counter clear input: level/edge selection with Pr4D
INH/INTSPDI/SC-ERR	33	SI	Command pulse input disable	Scale error	Scale error	Internal speed selection 1/ scale error	Internal speed selection 1/ command pulse input disable	Command pulse input disable	Command pulse input disable is active with Pr43=0
C-MODE	32	SI	Control mode changeover	–	–	Control mode changeover	Control mode changeover	–	
CWL/SMOOTH	8	SI	Smoothing filter	Smoothing filter	Smoothing filter	CW drive disable /smoothing filter	CW drive disable /smoothing filter	CW drive disable	CW drive disable is active with Pr04=0
CCWL/DIV2	9 3	SI	Command div/ multi changeover 2	Command div/ multi changeover 2	Command div/ multi changeover 2	CCW drive disable/ command div/ multi changeover 2	CCW drive disable/ command div/ multi changeover 2	CCW drive disable	CCW drive disable is active with Pr04=0
A-CLR	1	SI	Alarm clear	Alarm clear	Alarm clear	Alarm clear	Alarm clear	Alarm clear	
S-RDY+,-	35,34	SI	Servo ready	Servo ready	Servo ready	Servo ready	Servo ready	Servo ready	
Mode specific precautions						Set to: Pr30=1, Pr31=1, Pr36=0			
Precautions common to modes			1) In the above control modes, you cannot use frequency characteristics analysis from auto gain tuning or PANATERM®. If you wish to use it, execute the control mode at 0: position control mode. In this case, be careful because functions of the above ports will also be switched. 2) Pr50, 51 can set speed command input gain/reverse and Pr5C/5D can set torque command input gain/reverse. 3) Pr77=1 disables scale error input.						

Output Circuit

Signal (symbol)	Pin No.	I/F circuit	Control mode setting(Pr02)						Parameter related to port setting
			6: Semi-closed control	7: Full-closed control	8: Hybrid control	9: Speed/external encoder control	10: Speed/semi-closed control	14: the 2nd full-closed	
ALM+,-	37,36	SO1	Servo alarm	Servo alarm	Servo alarm	Servo alarm	Servo alarm	Servo alarm	
COIN+,-	39,38	SO1	Positioning complete	Positioning complete	Positioning complete	Speed reached/ positioning complete	Speed reached/ positioning complete	Positioning complete	Pr60 sets positioning compte; Pr62 sets reached speed
BRK-OFF+,-	11,10	SO1	External brake release	External brake release	External brake release	External brake release	External brake release	External brake release	
ZSP	12	SO2	Zero speed detect	Zero speed detect	Zero speed detect	Zero speed detect	Zero speed detect	Zero speed detect	Pr0A selects output type
TLC	40	SO2	Torque limited	Torque limited	Torque limited	Torque limited	Torque limited	Torque limited	Pr09 selects output type
IM	42	AO	Torque monitor	Torque monitor	Torque monitor	Torque monitor	Torque monitor	Torque monitor	Pr08 selects the range of command torque/ positional deviation/ external scale deviation
SPM	43	AO	Speed monitor	Speed monitor	Speed monitor	Speed monitor	Speed monitor	Speed monitor	Pr07 selects the range of actual speed/ command speed
OA+,-	21,22	PO1	Encoder Phase A	Encoder phase A (external encoder phase A)	Encoder phase A (external encoder phase A)	Encoder phase A (external encoder phase A)	Encoder Phase A	Encoder phase A (external encoder phase A)	Pr78 selects between encoder/ external encoder
OB+,-	48,49	PO1	Encoder Phase B	Encoder phase B (external encoder phase B)	Encoder phase B (external encoder phase B)	Encoder phase B (external encoder phase B)	Encoder Phase B	Encoder phase B (external encoder phase B)	Pr78 selects between encoder/ external encoder Pr45 adjusts phase
OZ+,-	23,24	PO1	Encoder Phase Z	Encoder phase Z (external encoder phase Z)	Encoder phase Z (external encoder phase Z)	Encoder phase B (external encoder phase B)	Encoder Phase Z	Encoder phase B (external encoder phase B)	Pr78 selects between encoder/ external encoder
CZ	19	PO2	Encoder Phase Z	Encoder phase Z (external encoder phase Z)	Encoder phase B (external encoder phase Z)	Encoder phase Z (external encoder phase Z)	Encoder Phase Z	Encoder phase Z (external encoder phase Z)	Pr78 selects between encoder/ external encoder
Precautions common to modes			1) In the above control modes, you cannot use frequency characteristics analysis from auto gain tuning or PANATERM®. If you wish to use it, execute the control mode at 0: position control mode. In this case, be careful because functions of the above ports will also be switched.						

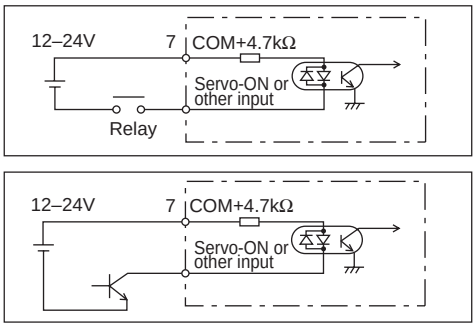
CN X5 Connector

Interface Circuit

Input Circuit

SI SI Connecting to sequence input signals

- Connect to a contact of switch and relay, or a transistor of an open collector output.
- Use a switch or relay for micro current so that insufficient contact can be avoided.
- Lower limit of the power supply (12 to 24V) should not be less than 11.4V in order to secure the appropriate level of primary current of the photo coupler.



PI PI Command pulse input circuit

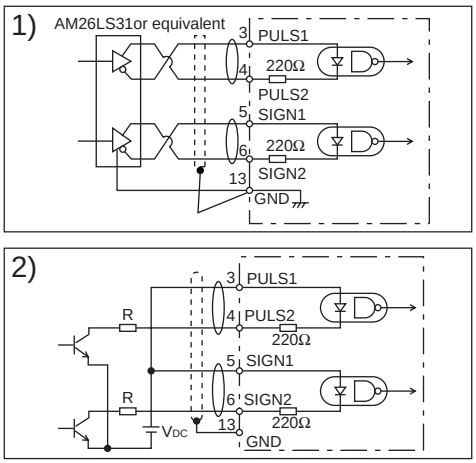
1) Line Driver I/F
- This is a good signal transmission method that is less sensitive to noises. We recommend you to use this to maintain the reliability of signals.

2) Open Collector I/F
- This uses an external control power supply(V_{DC}).
- This requires a current-limiting resistor (R) corresponding to the capacity of the V_{DC} value.

V_{DC}	R value
12V	1kΩ 1/2W
24V	2kΩ 1/2W

$$\frac{V_{DC} - 1.5}{R + 220} \fallingdotseq 10mA$$

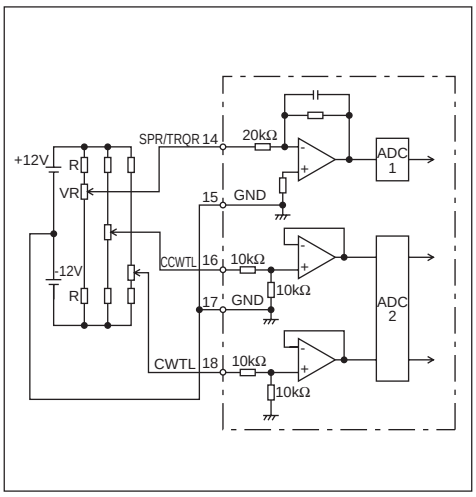
shows a pair of twisted wires.



Max. input voltage DC24V
Rated current 10mA

AI AI Analogue Command Input

- There are three analogue command inputs of SPR/RTQR (14 pins), CCWTL (16 pins) and CWTL (18 pins).
- The maximum permissible input voltage is ±10V. For the input impedance of these inputs, see the right figure.
- If you make a simplified circuit comprising a variable resistor (VR) and resistor (R), refer to the right figure. When the variable range of each input is -10V to +10V, the VR should be a B type resistor of 2kΩ (min.1/2W). The R should be 200Ω (min.1/2W).
- The A/D converters for these inputs should have the following resolution.

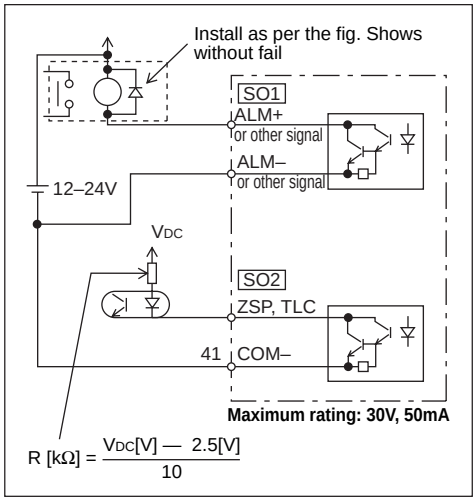


1) ADC1 (SPR and TRQR) : 16 bits (including one bit for sign)
2) ADC2 (CCWTL and CWTL) : 10 bits (including one bit for sign)

Output Circuit

SO1 SO2 Sequence output circuit

- This comprises a Darlington driver with an open collector. This is connected to a relay or photo coupler.
- There exists a collector-to-emitter voltage V_{CE}(SAT) of approx. 1V at transistor ON, because of Darlington connection of the out put transistor. Note that normal TTLIC can't be directly connected since this does not meet VIL requirement.
- This circuit has an independent emitter connection, or an emitter connection that is commonly used as the minus (–) terminal (COM–) of the control power.
- Calculate the value of R using the formula below so as the primary current of the photo coupler become approx. 10mA.

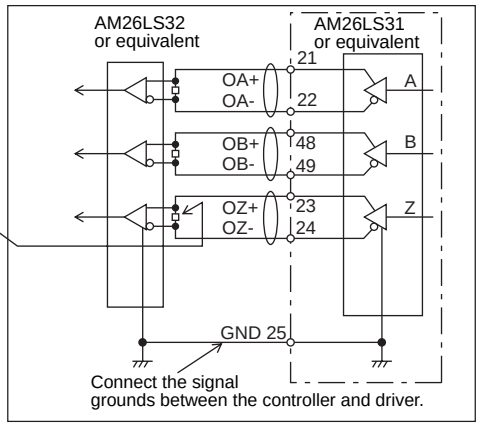


For the recommended primary current value, check the data sheet on the equipment and photo-coupler used.

PO1 Line Driver (Differential Output) Output

- Provides differential outputs of encoder signals (A, B and Z phases) that come from the scalar.
- Receive these signals with a line receivers. In this case, install a resistor of approx. 330Ω between the inputs.
- These outputs are non-insulated signals.

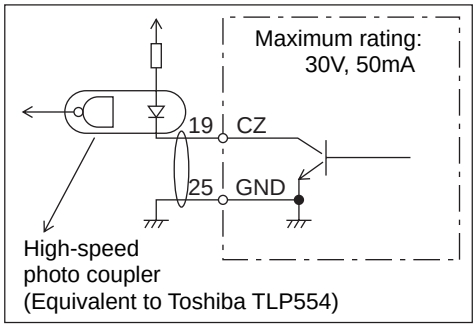
shows a pair of twisted wires.



PO2 Open Collector Output

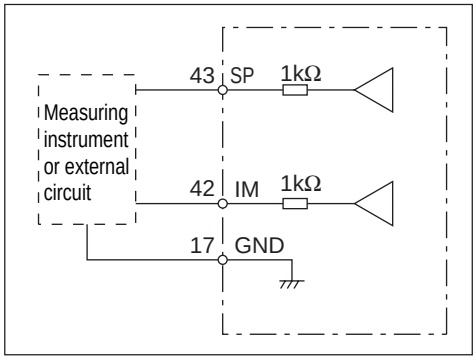
- Outputs Z-phase signals among those from the encoder. The outputs are non-insulated.
- Receive these signal with high-speed photo coupler at controller side, since these Z-phase signal width is normally narrow.

shows a pair of twisted wires.



AO Analogue Monitor Output

- This output is the speed monitor signal (SP) or torque monitor signal (IM).
- The signal range is approx. 0 to ± 9V.
- The output impedance is 1kΩ. Pay attention to the input impedance of your measuring instruments and external circuits connected.



<Resolution>

1) Speed monitor signal (SP): 8r/min./LSB calculated from 6V/3000r/min (Pr07 = 3)
2) Torque monitor signal (IM): 0.4%/LSB calculated from 3V/rated value (100%)

CN X5 Connector

Connector CN X4

Power supply for the external scale should be prepared by the user. Alternatively, encoder power supply shown below can be used (250 mA max.).

Application	Connector pin No.	Function 7-Wire
Encoder power supply output	1, 2	E0V
	3, 4	+5V power source
Battery (+) (for absolute encoder)	5	Battery (+)
Battery (–) (for absolute encoder)	6	Battery (–)
Encoder/external scale signal input (phase A)	7	EXA
	8	$\overline{\text{EXA}}$
Encoder/external scale signal input (phase B)	9	EXB
	10	$\overline{\text{EXB}}$
Encoder/external scale signal input (phase Z)	11	EXZ
	12	$\overline{\text{EXZ}}$
Encoder signal I/O (Serial signal)	17	PS
	18	$\overline{\text{PS}}$
Frame ground	20	FG

<NOTE>

"0 V" of the encoder power supply output is connected to the ground terminal of the control circuit that is connected to Connector X5 .

<Requests>

1) Pins Nos. 13, 14, 15, 16 and 19 (not listed above) must not be connected.
2) When you use the absolute encoder or absolute/incremental-shared encoder as an incremental encoder, you do not have to connect battery between 5- and 6-pin.

Connector CN X5

When the Pr02 control mode is set to one of 6-10 and full-closed control mode is selected, some pin functions are changed. For pin function changes, see the table below and pages 160 and 161 "Functional selection of interface connector CN X5 by control mode".

Input Signals and their Functions

Signal	Pin No.	Symbol	Function	I/F circuit
Control signal power supply	**7**	**COM +**	Positive terminal of control signal power supply (12 ~ 24 V)	–
	41	**COM –**	Negative terminal of control signal power supply (12 ~ 24 V)	
Signal ground	**13,15 17,25**	**GND**	Driver circuit signal ground.	–
Frame ground	**50**	**FG**	This is a signal ground internal to the driver.	–
Serve on input	**29**	**SRV-ON**	Enables Servo-on when it is connected to COM–.	SI page 162
Control mode changeover input	**32**	**C-MODE**	With Pr02 (control mode setting) set to 3, 4, 5, 9, and 10, when connection with COM- is open and then the 1st control mode shorts, the 2nd control mode will be selected.	SI page 162
Alarm clear input	**31**	**A-CLR**	Clears the alarm condition and returns to operation mode when connected to COM–. (This pin is active only when there is an alarm that can be cleared.) See page 216 "Protective functions" in "Encountering Difficulties?"	SI page 162

<table>
<tr><th>Signal</th><th>Pin No.</th><th>Symbol</th><th>Function</th><th>I/F circuit</th></tr>
<tr><td>CCW drive disable input</td><td>9</td><td>CCWL/
DIV2</td><td>Serves as the command div./multi. changeover 2 input with selection of semi-closed control, full-closed control, hybrid control or external encoder control. For selection of command div./multi., see the table "Command div./multi. numerator selection" shown below.
<table>
<tr><th colspan="2">CN X5 connector pin No.</th><th rowspan="2">Command div./multi.setting</th></tr>
<tr><th>Pin 28 DIV</th><th>Pin 9 DIV2(CCWL)</th></tr>
<tr><td>Open</td><td>Open</td><td>1st command div./multi. numerator (Pr46) x 2 command div./multi. numerator scale factor (Pr4A) / Command div./multi. denominator (Pr4B)</td></tr>
<tr><td>Short circuit</td><td>Open</td><td>2nd command div./multi. numerator (Pr47) x 2 command div./multi. numerator scale factor (Pr4A) / Command div./multi. denominator (Pr4B)</td></tr>
<tr><td>Open</td><td>Short circuit</td><td>3rd command div./multi. numerator (Pr48) x 2 command div./multi. numerator scale factor (Pr4A) / Command div./multi. denominator (Pr4B)</td></tr>
<tr><td>Short circuit</td><td>Short circuit</td><td>4th command div./multi. numerator (Pr49) x 2 2 command div./multi. numerator scale factor (Pr4A) / Command div./multi. denominator (Pr4B)</td></tr>
</table>
When performing auto gain tuning, frequency response analysis by PANATERM®, functions as CCW drive disable input regardless of setting of Pr02 (control mode setting).
When this pin is disconnected from COM–, CCW torque is not generated in any mode other than above-mentioned.
(Active only when Pr04 is set at 0.)</td><td>SI
page 162</td></tr>
<tr><td>CW drive disable input</td><td>8</td><td>CWL/
SMOOTH</td><td>Enables or disables Smoothing filter while the control is either semi-closed control, full-closed control, hybrid control or external encoder control - enables the smoothing filter when connected to COM–.
When performing auto gain tuning, frequency response analysis by PANATERM®, functions as CW drive disable input regardless of setting of Pr02 (control mode setting).
When this pin is disconnected from COM–, CW torque is not generated in any mode other than above-mentioned.
(Active only when Pr04 is set at 0.)</td><td>SI
page 162</td></tr>
<tr><td>Gain changeover input</td><td>27</td><td>GAIN</td><td>Input of the gain changeover timing when the gain changeover function is active.
Connecting this pin to COM– while the gain changeover function is not active (Pr30, 2nd gain operation setting), the speed driver operates only in proportional mode (P action).</td><td>SI
page 162</td></tr>
<tr><td>Reserved for manufacturer</td><td>1
2</td><td>–</td><td>Not available for user
Leave this pin open (NC).</td><td>–</td></tr>
<tr><td>CW torque limit input</td><td>18</td><td>CWTL</td><td>Limits the CW torque in proportion to the negative input (0 to –10 V). (Rated torque at approx. –3 V)</td><td>SI
page 162</td></tr>
<tr><td>CCW torque limit input</td><td>16</td><td>CCWTL
/TRQR</td><td>Limits the CCW torque in proportion to the positive input (0 to +10 V). (Rated torque at approx. +3 V).
With the speed/torque control is selected (Pr02 (control mode setting) is set to 5, torque control), this pin serves as the torque command input (approx.+3 V/rated torque).</td><td>SI
page 162</td></tr>
<tr><td>Speed zero clamp input</td><td>26</td><td>ZEROSPD</td><td>Speed command is set to zero when this pin is disconnected from COM–.
Active when Pr06 (ZEROSPD input select) is 1.
External speed command input for speed control.</td><td>SI
page 162</td></tr>
<tr><td>Speed command input</td><td>14</td><td>SPR/TRQR</td><td>The gain and polarity of the command are set by the Pr50 (speed command input gain) and Pr51 (speed command input reverse), respectively. The input is the torque command when torque control or position torque control is selected.
The gain and polarity of the command are set by the Pr5C (torque command input gain) and Pr5D (torque command input reverse), respectively.</td><td>SI
page 162</td></tr>
</table>

CN X5 Connector

<table>
<tr><th>Signal</th><th>Pin No.</th><th>Symbol</th><th>Function</th><th>I/F circuit</th></tr>
<tr><td>Command dive./multi. changeover input</td><td>28</td><td>DIV</td><td>For the semi-closed control, full-closed control, hybrid control and external encoder control, refer to the table, "Command div./multi. numerator selection" shown below.
<table>
<tr><th colspan="2">CN X5 connector pin No.</th><th rowspan="2">Command div./multi.setting</th></tr>
<tr><th>Pin 9 DIV2(CCWL)</th><th>Pin 28 DIV</th></tr>
<tr><td>Open</td><td>Open</td><td>1st command div./multi. numerator (Pr46) / Command div./multi. denominator (Pr4B) x 2 command div./multi. numerator scale factor (Pr4A)</td></tr>
<tr><td>Open</td><td>Short circuit</td><td>2nd command div./multi. numerator (Pr47) / Command div./multi. denominator (Pr4B) x 2 command div./multi. numerator scale factor (Pr4A)</td></tr>
<tr><td>Short circuit</td><td>Open</td><td>3rd command div./multi. numerator (Pr48) / Command div./multi. denominator (Pr4B) x 2 command div./multi. numerator scale factor (Pr4A)</td></tr>
<tr><td>Short circuit</td><td>Short circuit</td><td>4th command div./multi. numerator (Pr49) / Command div./multi. denominator (Pr4B) x 2 2 command div./multi. numerator scale factor (Pr4A)</td></tr>
</table>
When this pin is connected to COM–, command div./multi. numerator is changed from Pr46 (1st command div./multi. numerator) to Pr47 (2nd command div./multi. numerator).</td><td>SI page 162</td></tr>
<tr><td>Command pulse input disable</td><td>33</td><td>INH/ INTSPD1 /SC-ERR</td><td>Scale error input during full-closed control, hybrid control or external encoder control. Disconnecting this pin from COM- causes trip due to scale error (Err28). When designing an external protection circuit, use this input. Pr77=1 ignores scale error input. Disconnecting this pin from COM– during semi-closed control or position control ignores the position command pulse. This is active when Pr43 (command pulse input disable) is 0.
During the speed control mode, this pin acts as the internal speed select 1 input. See the table "Internal speed selection" below.
<table>
<tr><th>CN X5 connector pin No.</th><th colspan="3">Pr05 set value</th></tr>
<tr><td>Pin 33 INTSPD1 (INH, SC-ERR)</td><td>0</td><td>1</td><td>2</td></tr>
<tr><td>Open</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 1st speed (Pr53)</td><td>Speed setting 1st speed (Pr53)</td></tr>
<tr><td>Short circuit</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 2st speed (Pr54)</td><td>Speed setting 2st speed (Pr54)</td></tr>
<tr><td>Open</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 3st speed (Pr55)</td><td>Speed setting 3st speed (Pr55)</td></tr>
<tr><td>Short circuit</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 41st speed (Pr56)</td><td>Analog speed command (CN X5 pin 14)</td></tr>
</table></td><td>SI page 162</td></tr>
<tr><td>Counter clear</td><td>30</td><td>CL/ INTSPD2</td><td>Connecting this pin to COM– clears the deviation counter.
Pr4D (counter clear input mode) selects the level and falling edge. This pin serves as the internal speed select 2 input during speed control mode. See the table below, "Internal speed selection".
<table>
<tr><th>CN X5 connector pin No.</th><th colspan="3">Pr05 set value</th></tr>
<tr><td>Pin 30 INTSPD2 (INH, SC-ERR)</td><td>0</td><td>1</td><td>2</td></tr>
<tr><td>Open</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 1st speed (Pr53)</td><td>Speed setting 1st speed (Pr53)</td></tr>
<tr><td>Open</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 2st speed (Pr54)</td><td>Speed setting 2st speed (Pr54)</td></tr>
<tr><td>Short circuit</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 3st speed (Pr55)</td><td>Speed setting 3st speed (Pr55)</td></tr>
<tr><td>Short circuit</td><td>Analog speed command (CN X5 pin 14)</td><td>Speed setting 41st speed (Pr56)</td><td>Analog speed command (CN X5 pin 14)</td></tr>
</table></td><td>SI page 162</td></tr>
</table>

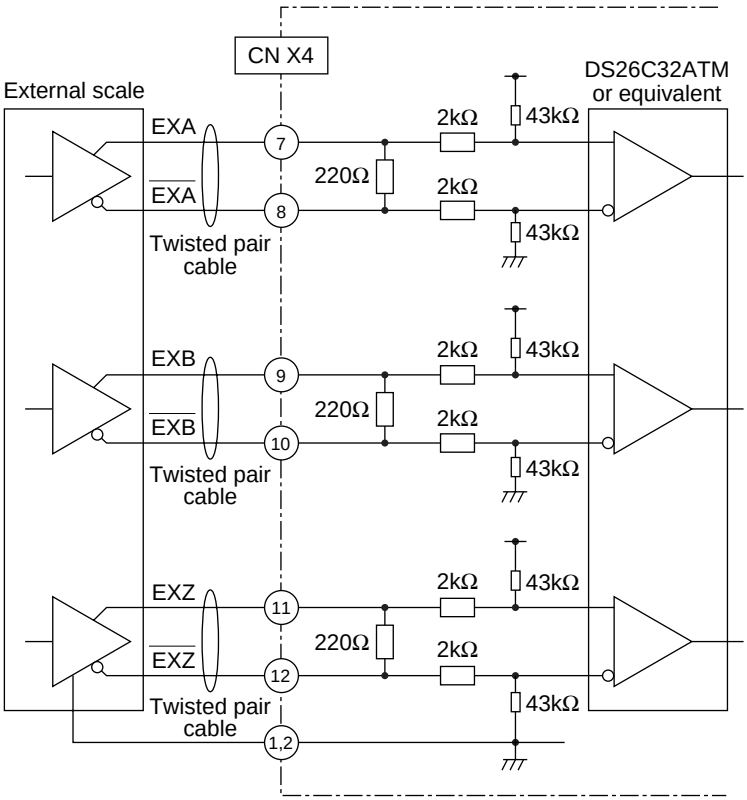
Signal	Pin No.	Symbol	Function	I/F circuit
Command pulse input	**3**	**PULS1**	Enter a position command pulse. The driver receives the pulse through a high-speed photo-coupler. Input impedance is 220Ω. Through Pr42, one of three input formats is selected: 1) 2-phase input (phase A (PULS)/phase B (SIGN)); 2) CW (PULS)/CCW (SIGN) pulse input; and 3) command pulse (PULS) input/sign (SIGN) input.	PI page 162
	4	**PULS2**		
Command sign input	**5**	**SIGN1**		
	6	**SIGN2**		
Absolute encoder battery	**44**	**BATT+**	Connect the absolute encoder backup battery to this pin. Leave this pin open when the battery is directly connected to the driver. Recommended battery: ER6V 3.6 V (Toshiba Battery)	–
	45	**BATT–**		

Output Signals and their Functions

Signal		Pin No.	Symbol	Function	I/F circuit
Servo alarm output		**37** **36**	**ALM+** **ALM–**	Turns off as the error is detected and protection starts.	SO1 page 163
Servo ready output		**35** **34**	**S-RDY+** **S-RDY–**	Turns on as control/main power supply are established without alarm condition.	SO1 page 163
Positioning complete /speed achieved output		**39** **38**	**COIN+** **COIN–**	In full-closed control/hybrid control/external encoder control, the output signal turns ON when a value of the external scale deviation counter falls within the range set by Pr60 (positioning completion range). It also turns ON when a value of the deviation counter falls within the range set by Pr60 in semi-closed control/position control. In speed control, the signal turns ON when the motor actual speed reaches speed set by Pr62 (Reached Speed).	SO1 page 163
External brake release output		**11** **10**	**BRK-OFF+** **BRK-OFF–**	This output signal controls the external mechanical brake. Configure the external circuit which releases the brake when this signal turns on.	SO1 page 163
Torque limiting output		**40** **(41)**	**TLC** **(COM–)**	Selects the signal output by Pr09 (TLC output select). With the default setting, outputs this signal at 0.	SO1 page 163
Zero speed detect output		**12** **(41)**	**ZSP** **(COM–)**	Selects the signal output by Pr0A (ZSP output select). With the default setting, outputs this signal at 1.	SO1 page 163
Pulse output	Phase A	**21**	**OA+**	• Output the divided encoder differential output or external scale differential output pulse through the line driver. • Logical relationship between phase A pulse and phase B pulse can be selected by Pr45 (pulse output logic reverse).	PO1 page 163
		22	**OA–**		
	Phase B	**48**	**OB+**		PO1 page 163
		49	**OB–**		
	Phase Z	**23**	**OZ+**		PO1 page 163
		24	**OZ–**		
	Phase Z	**19**	**CZ**	Open collector signal output with respect to common GND.	PO1
Speed monitor signal		**43**	**SP**	Selects the analog signal to be monitored by using Pr07 (speed monitor select). Factory setting is 3 which outputs motor actual speed in approx. 6 V/3000 rpm/min. Positive voltage is for CCW and negative voltage for CW. The output impedance is 1 kΩ.	AO page 163
Torque motor signal		**42**	**IM**	Selects the analog signal to be monitored by using Pr08 (torque monitor select). Factory setting is 0 which outputs command torque of approx. 3 V/rated torque to the motor. Positive voltage is for CCW and negative voltage for CW. The output impedance is 1 kΩ.	AO page 163
Reserved for manufacturer		**46** **47**	**TX+** **TX–**	Not available for the user. Leave this pin open.	–
Reserved for manufacturer		**20**	**–**	Not available for the user. Leave this pin open.	–

Connections to external scale CN X4

External scale interface specification



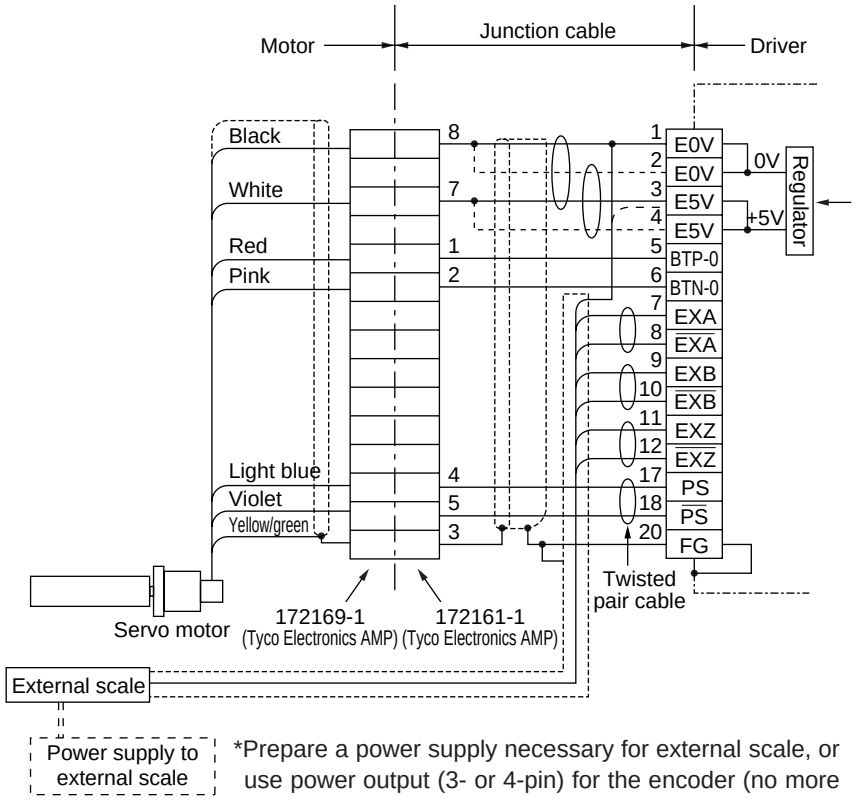
*Connect a signal land to pin 1 or 2.

External scale connection CN X4

Connect the signals from the external scale to the encoder connector CN X4.

1) Use shielded twisted pair cable of 0.18 mm^2 conductors for connecting to the encoder and external scale.
2) The maximum length of the cable must be 20 m. If 5 V supply is to be fed through a longer cable, additional cable should be connected in parallel to reduce voltage drop.
3) Connect together the shields (sheathes) of the lead wires from the motor and those from encoder. The sheath of the driver lead wires must be connected to the FG (pin 20) of the CN X4.
4) In the case of Cannon plug specification, connect a sheath of shield on the motor side of the encoder cable to terminal J.
5) Signal cables must be well separated (30 cm or more) from power lines (L1, L2, L3, L1C (r), L2C (t), U, V, W and ⏚). Do not run these signal wires in a duct together with power cables.
6) Leave blank pins on the CN X4 NC.
7) Power supply for the external scale should be prepared by the user. Alternatively, encoder power supply can be used (250 mA max.).

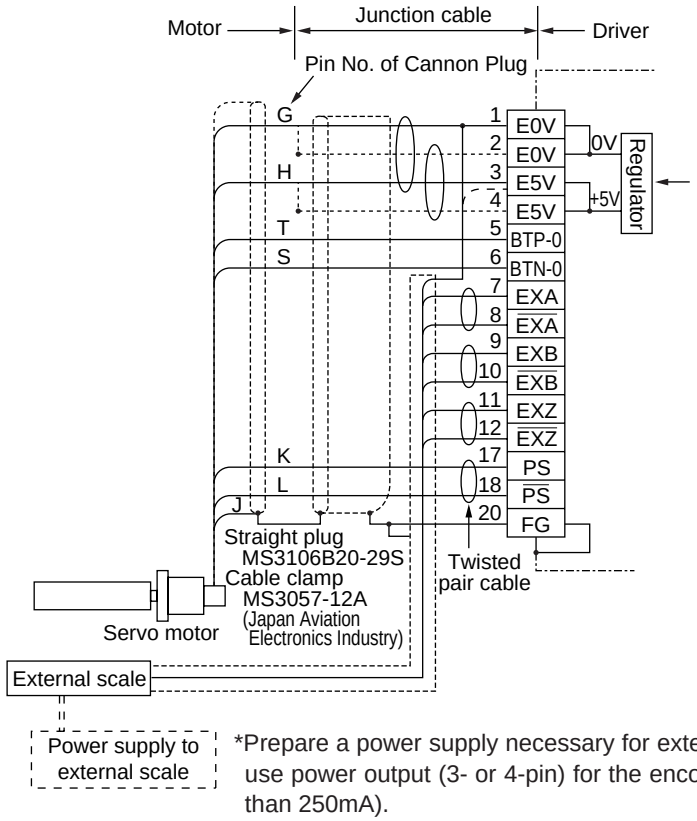
Example: 7-core absolute encoder (motor connector: Tyco Electronics AMP)



*Prepare a power supply necessary for external scale, or use power output (3- or 4-pin) for the encoder (no more than 250mA).

Note: Pins 5 and 6 should be left unused the encoder is incremental type.

Example: 7-core absolute encoder (Motor Connector: Cannon Plug)



*Prepare a power supply necessary for external scale, or use power output (3- or 4-pin) for the encoder (no more than 250mA).

Note: Pins 5 and 6 should be left unused the encoder is incremental type.

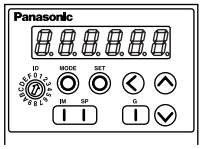
Parameter Setting

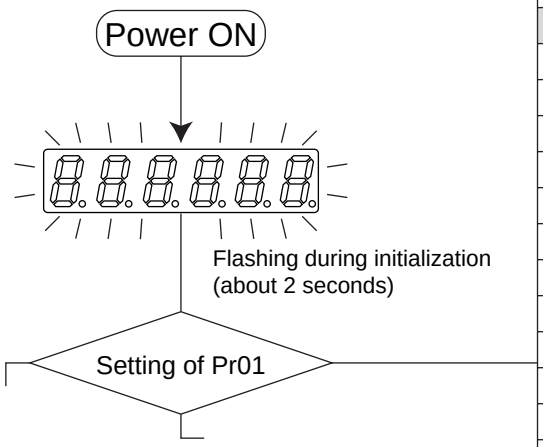
Parameters for Function Selection

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Function/Description
00	**Axis address**	0 – 15 [1]	In communications with a host device such as a personal computer that uses RS232C/485 with multiple axes, you should identify to which axis the host accesses and use this parameter to confirm axis address in terms of numerals.
01	**LED display at power up**	0 – 15	In the initial condition after turning ON the control power, the following data displayed on the 7-segment LED can be selected.
02	**Control mode**	0 – 14	Select the control mode of the servo driver.

• At power on, settings of the rotary switch ID on the front panel (0 – F) will be programmed into parameters of the driver.
• Settings of Pr00 can be changed only by means of the rotary switch ID.



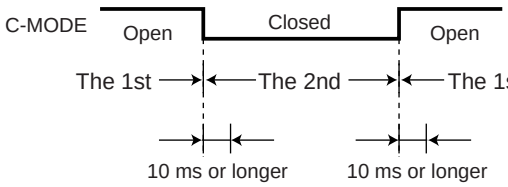


Setting value	Description
0	Positional deviation
[1]	Motor revolving speed
2	Torque output
3	Control mode
4	I/O signal status
5	Error cause/record
6	Software version
7	Alarm
8	Regenerative load ratio
9	Overload load ratio
10	Inertia ratio
11	Feedback pulse sum
12	Command pulse sum
13	External scale deviation
14	External scale feedback pulse sum
15	Motor auto recognition

See page 56 "Front Panel Key Operations and Display".

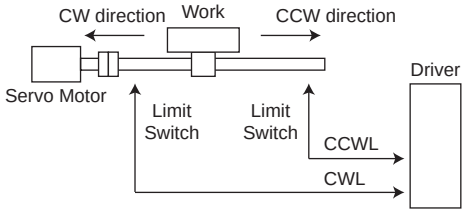
Setting value	Control mode	
	The 1st Mode	The 2nd Mode*1
0	Position control	–
[1]	Speed control	–
2	Torque control	–
3	Position	Speed control
4	Position	Torque control
5	Speed	Torque control
6	Semi-closed control	–
7	Full-closed control	–
8	Hybrid control	–
9	Speed	External encoder control
10	Speed	Semi-closed control
11	High-stiff equipment position control	–
12	Low-stiff equipment position control	–
13	Low-stiff equipment speed control	–
14	Second full-closed control	–

*1 A special control mode focused on the full-closed specification. For details, refer to “Full-Closed Control” volume on Page 000.
*2 When composite mode (Pr02 = 3,4,5,9,10) is set, you can switch the 1st and 2nd modes with the control mode switch input (C-MODE).



<Caution>
Enter a command after 10ms or longer have passed since C-MODE was entered.
Do not enter any command on position, speed or torque.

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Function/Description</th></tr>
<tr><td>03</td><td>Torque limit selection</td><td>0 – 1
[1]</td><td>The parameter is used to disable analog torque limit input (CCWTL, CWTL) signals.
0: Enabled
1: Disabled
If you do not use torque limit functions, set “1” to Pr03.
With Pr03 set to “0” and torque limit input (CCWTL, CWTL) open, no torque will be generated, and thus the motor does not rotate.</td></tr>
<tr><td>04</td><td>Overtravel input inhibit</td><td>0 – 1</td><td>In the case of linear driving, in particular, to prevent mechanical damage due to overtraveling of work, you should provide limit switches on both ends of the axis, as shown below, whereby driving in a direction of switch action is required to be inhibited.
 

<table>
<tr><th>Setting value</th><th>CCWL/CWL Input</th><th colspan="2">Action</th></tr>
<tr><th></th><th></th><th>Input</th><th>Connection with COM-</th><th></th></tr>
<tr><td rowspan="4">0</td><td rowspan="4">Enable</td><td rowspan="2">CCWL (CN X5-9 pin)</td><td>Connected</td><td>Normal condition in which the limit switch on CCW side is not operating.</td></tr>
<tr><td>Open</td><td>CCW direction inhibited, CW direction allowed</td></tr>
<tr><td rowspan="2">CWL (CN X5-8 pin)</td><td>Connected</td><td>Normal condition in which the limit switch on CW side is not operating.</td></tr>
<tr><td>Open</td><td>CW direction inhibited, CCW direction allowed</td></tr>
<tr><td>[1]</td><td>Disable</td><td colspan="3">Both CCWL and CWL inputs are ignored and they normally operate as no overtravel inhibit being set.</td></tr>
</table>
<Cautions>
1. When you set 0 to Pr04 and do not connect both CCWL and CWL inputs to COM- (off), abnormal condition in which limits are exceeded in both CCW and CW directions is detected, and the driver will then trip due to “abnormal overtravel input inhibit“.
2. You can set whether or not to activate the dynamic brake when slowdown occurs because CCW or CW overtravel input inhibit has been enabled. For details, refer to descriptions on Pr66 (DB deactivation at overtravel input inhibit).
3. Work may repeat vertical motion as a result of absence of upward torque after you turned off the limit switch on the upper side of work on the vertical axis. In such a case, you should not use this function, and instead execute limit processing on the host controller side.</td></tr>
<tr><td>07</td><td>Speed monitor (SP) selection</td><td>0 – 9</td><td>The parameter selects/sets a relationship between voltage output to the speed monitor signal output (SP: CN X5 43-pin) and the actual motor speed or command speed.
<table>
<tr><th>Setting value</th><th>SP Signals</th><th>Relationship between Output Voltage Level and Speed</th></tr>
<tr><td>0</td><td rowspan="5">Motor Actual Speed</td><td>6V / 47 r/min</td></tr>
<tr><td>1</td><td>6V / 187 r/min</td></tr>
<tr><td>2</td><td>6V / 750 r/min</td></tr>
<tr><td>[3]</td><td>6V / 3000 r/min</td></tr>
<tr><td>4</td><td>1.5V / 3000 r/min</td></tr>
<tr><td>5</td><td rowspan="5">Command Speed</td><td>6V / 47 r/min</td></tr>
<tr><td>6</td><td>6V / 187 r/min</td></tr>
<tr><td>7</td><td>6V / 750 r/min</td></tr>
<tr><td>8</td><td>6V / 3000 r/min</td></tr>
<tr><td>9</td><td>1.5V / 3000 r/min</td></tr>
</table></td></tr>
</table>

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Function/Description</th></tr>
<tr><td>08</td><td>Torque monitor (IM) selection</td><td>0 – 12</td><td>The parameter selects/sets a relationship between voltage output to the torque monitor signal output (IM: CN X5 42-pin) and generated torque of the motor or number of deviation pulses.
<table>
<tr><th>Setting value</th><th>IM Signals</th><th>Relationship between output level and torque or number of deviation pulses</th></tr>
<tr><td>[0]</td><td>Torque</td><td>3V / rated (100%) torque</td></tr>
<tr><td>1</td><td rowspan="5">No. of Deviation Pulses</td><td>3V / 31Pulse</td></tr>
<tr><td>2</td><td>3V / 125Pulse</td></tr>
<tr><td>3</td><td>3V / 500Pulse</td></tr>
<tr><td>4</td><td>3V / 2000Pulse</td></tr>
<tr><td>5</td><td>3V / 8000Pulse</td></tr>
<tr><td>6</td><td rowspan="5">No. of full-closed deviation pulse</td><td>3V / 31Pulse</td></tr>
<tr><td>7</td><td>3V / 125Pulse</td></tr>
<tr><td>8</td><td>3V / 500Pulse</td></tr>
<tr><td>9</td><td>3V / 2000Pulse</td></tr>
<tr><td>10</td><td>3V / 8000Pulse</td></tr>
<tr><td>11</td><td rowspan="2">Torque</td><td>3V / 200% torque</td></tr>
<tr><td>12</td><td>3V / 400% torque</td></tr>
</table></td></tr>
<tr><td>09</td><td>TLC output selection</td><td>0 – 5</td><td>The parameter allocates functions of output in torque limits (TLC: CN X5 40-pin).
<table>
<tr><th>Setting value</th><th>Functions</th><th>Remarks</th></tr>
<tr><td>[0]</td><td>Output in torque limit</td><td rowspan="6">For functional details of respective outputs listed left, refer to "Wiring to Connector CN X5" on page 78.</td></tr>
<tr><td>1</td><td>Output of zero-speed detection</td></tr>
<tr><td>2</td><td>Output of an alarm due to either of over-regeneration/overload/absolute battery</td></tr>
<tr><td>3</td><td>Output of over-regeneration alarm</td></tr>
<tr><td>4</td><td>Output of overload alarm</td></tr>
<tr><td>5</td><td>Output of absolute battery alarm</td></tr>
</table></td></tr>
<tr><td>0A</td><td>ZSP output selection</td><td>0 – 5</td><td>The parameter allocates functions of zero speed detection output (ZSP: CN X5 12-pin).
<table>
<tr><th>Setting value</th><th>Functions</th><th>Remarks</th></tr>
<tr><td>0</td><td>Output in torque limit</td><td rowspan="6">For functional details of respective outputs listed left, refer to "Wiring to Connector CN X5" on page 78.</td></tr>
<tr><td>[1]</td><td>Output of zero-speed detection</td></tr>
<tr><td>2</td><td>Output of an alarm due to either of over-regeneration/overload/absolute battery</td></tr>
<tr><td>3</td><td>Output of over-regeneration alarm</td></tr>
<tr><td>4</td><td>Output of overload alarm</td></tr>
<tr><td>5</td><td>Output of absolute battery alarm</td></tr>
</table></td></tr>
<tr><td>0B</td><td>Absolute encoder set up</td><td>0 – 2</td><td>Listed below are settings when you use the absolute encoder:
<table>
<tr><th>Setting value</th><th>Description</th></tr>
<tr><td>0</td><td>To use the absolute encoder as absolute.</td></tr>
<tr><td>[1]</td><td>To use the absolute encoder as incremental.</td></tr>
<tr><td>2</td><td>To use the absolute encode as absolute. In this case, multi-rotation excess counter is ignored.</td></tr>
</table></td></tr>
<tr><td>0C</td><td>Baud rate of RS232C</td><td>0 – 2</td><td>
<table>
<tr><th>Setting value</th><th>Baud Rate</th></tr>
<tr><td>0</td><td>2400bps</td></tr>
<tr><td>1</td><td>4800bps</td></tr>
<tr><td>[2]</td><td>9600bps</td></tr>
</table></td></tr>
<tr><td>0D</td><td>Baud rate of RS485</td><td>0 – 2</td><td>
<table>
<tr><th>Setting value</th><th>Baud Rate</th></tr>
<tr><td>0</td><td>2400bps</td></tr>
<tr><td>1</td><td>4800bps</td></tr>
<tr><td>[2]</td><td>9600bps</td></tr>
</table></td></tr>
</table>

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
10	**1st position loop gain**	0 – 32767 [63]*	1/s	• The parameter defines responsiveness of the position control system. Higher position gain would shorten time of positioning.
11	**1st Velocity loop gain**	1 – 3500 [35]*	Hz	• The parameter defines responsiveness of the speed loop. You need to set this speed loop gain high so as to improve responsiveness of the entire servo system by increasing position loop gain.
12	**1st Velocity loop integration time constant**	1 – 1000 [16]*	ms	• This parameter is an integration element of a speed loop and acts to drive quickly the subtle speed deviation into zero. The smaller the setting is, the faster deviation will be zeroed. • Setting of “1000” will remove effects of integration.
13	**1st speed detection filter**	0 – 6 [0]*	–	• The parameter sets in 6 phases (0 to 5) a time constant of the low-pass filter inserted after the block of converting an encoder signal into a speed signal. • Setting this parameter high would increase a time constant, thereby reducing noise of the motor. However, usually use the factory setting (0).
14	**1st torque filter time constant**	0 – 2500 [65]*	0.01ms	• The parameter sets a time constant of the primary delay filter inserted into the torque command unit. • It effects the control of vibration because of the torsion resonance.
15	**Velocity feed forward**	–2000 – 2000 [300]*	0.1%	• The parameter defines volume of speed feed forward under position control. Setting it to 100% would make positional deviation in operation at a constant rate almost 0. When you set it higher, positional deviation will decrease and responsiveness will be improved. Be careful, however, as overshooting is apt to occur.
16	**Feed forward filter time constant**	0 – 6400 [50]*	0.01ms	• The parameter sets a time constant of the primary delay filter inserted into the speed feed forward unit. • Inclusion of the feed forward function would cause speed overshooting/undershooting. Thus, this filter may make improvement when a positioning completion signal is chattering.
18	**2nd position loop gain**	0 – 32767 [73]*	1/s	• A position loop, speed loop, speed detection filter, and torque command filter, respectively, has 2 pairs of gains or time constants (the 1st and 2nd). • Each function/content is similar to the 1st gain/time constraint, described earlier. • For details on switching of the 1st and 2nd gains or time constants, refer to Adjustment volume on page 186. * Pr11 and Pr19 will be set in terms of (Hz) when Pr20 inertia ratio has been set correctly.
19	**2nd Velocity loop gain**	1 – 3500 [35]*	Hz	
1A	**2nd Velocity loop integration time constant**	1 – 1000 [1000]*	ms –	
1B	**2nd speed detection filter**	0 – 6 [0]*		
1C	**2nd torque filter time constant**	0 – 2500 [65]*	0.01ms	
1D	**1st notch frequency**	100 – 1500 [1500]	Hz	• The parameter sets frequency of the resonance suppression notch filter. • You should set it about 10% lower than the resonance frequency of the mechanical system that has been found by the frequency characteristics analysis facility of the setup assisted software “PANATERM®”. • Setting this parameter ”1500” would disable the function of notch filter.
1E	**1st notch width selection**	0 – 4 [2]	–	• The parameter sets width of the resonance suppression notch filter in 5 steps. The higher the setting is, the greater the width is. • Normally, use a factory setting.

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
20	**Inertia ratio**	0 – 10000 [100]	%	• Defines the ratio of load inertia to the motor's rotor inertia. Pr20 = (rotor inertia / load inertia) x 100[%] • When you execute auto gain tuning, load inertia will be estimated and the result will be reflected in this parameter. Pr11 and Pr19 will be set in terms of (Hz) when inertia ratio has been set correctly. When Pr20 inertia ratio is greater than the actual ratio, setting of the speed loop gain will increase. When Pr20 inertia ratio is smaller than the actual ratio, setting of speed loop gain will decrease.
26 *1	**Disturbance torque compensation gain**	0 – 200 [0]	%	• When the control mode is HP, LP, LS or UPF, a gain, in which the torque command is multiplied by a disturbance torque estimate value, is set. • By setting 100 [%], a torque compensation that clears the disturbance torque is applied. • When Pr21 real time auto tuning mode setting is altered, Pr26 changes to 0 (disabled).
27 *1	**Disturbance torque observer filter selection**	0 –255	–	• Cut-off frequency of the filter for disturbance torque observer is set. **Set value** / **Cutoff Frequency** [0]* / Disturbance Observer Disabled 1 – 255 / Enabled, filter cutoff frequency [Hz] = 3.7 x setting A larger value provides stronger disturbance suppression; but a larger operation noise is emitted. When using this function, it is necessary to set Pr20 inertia ratio correctly. When Pr.21 real time auto tuning mode setting is altered, Pr27 changes to 0(disabled). Also, while the real time auto tuning is enabled (Pr21 is not 0 or 7), Pr27 is fixed to 0 and the disturbance observer is disabled.
28	**2nd notch frequency**	100 – 1500 [1500]	Hz	• Defines the notch frequency of the second resonance suppression notch filter. • The unit is [Hz]. Match the notch frequency with the machine's resonance frequency. 100 to 1499: Filter enabled 1500: Filter disabled
29	**2nd notch width selection**	0 – 4 [2]	–	• Select the notch width of the second resonance suppression notch filter. • Increasing the set value enlarges the notch width.
2A	**2nd notch depth selection**	0 – 99 [0]	–	• Select the notch depth of the second resonance suppression notch filter. • Increasing the set value reduces the notch depth and the phase delay.

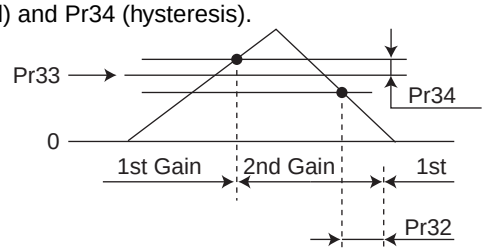
*1: Enabled only in the 2nd full-closed control

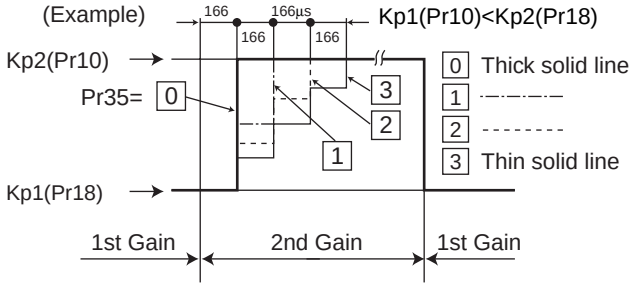
Parameters for Switching to 2nd Gains

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
30	**2nd gain action set up**	0 – 1	–	• The parameter selects switching of PI/P operation and the 1st/2nd gain switching. **Setting value** / **Gain Selection/Switching** 0 / The 1st Gain (Possible to switch PI/P) *1 [1]* / Possible to switch the 1st/2nd gain *2 *1 Switching of 1 PI/P operation is done through gain switching input (GAIN CN X5 27-pin). **GAIN input** / **Operation of speed loop** Open with COM– / PI operation Connect to COM–. / P operation *2 For conditions of switching between the 1st and 2nd gains, refer to "Adjustment upon switching gain" of Adjustment volume on page 202.

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Unit</th><th>Function/Description</th></tr>
<tr><td>31</td><td>Position control switching mode</td><td>0 –10</td><td>–</td><td>• The parameter selects conditions of switching the 1st and 2nd gains in position control mode.
<table>
<tr><th>Setting value</th><th>Conditions for Switching Gains</th></tr>
<tr><td>0</td><td>Fixed to the 1st gain.</td></tr>
<tr><td>1</td><td>Fixed to the 2nd gain.</td></tr>
<tr><td>2</td><td>The 2nd gain is selected with gain switching input (GAIN) turned ON (Pr30 needs setting of 1).</td></tr>
<tr><td>3 *3</td><td>Torque command variation is greater than setting of Pr33 (position control switching level) and Pr14, and the 2nd gain is selected.</td></tr>
<tr><td>4 *3</td><td>Fixed to the 1st gain.</td></tr>
<tr><td>5 *3</td><td>Command speed is greater than setting of Pr33 (position control switching level) and Pr14, and the 2nd gain is selected.</td></tr>
<tr><td>6 *3</td><td>Positional deviation is greater than setting of Pr33 (position control switching level) and Pr14, and the 2nd gain is selected.</td></tr>
<tr><td>7 *3</td><td>Position command is present and the 2nd gain is selected.
The 2nd gain is selected when the command pulse is 1 or higher in 166ms.</td></tr>
<tr><td>8 *3</td><td>The 2nd gain is selected with positioning not complete.
The 2nd gain is selected when a value of the positional deviation counter is greater than Pr60 (positioning completion range).</td></tr>
<tr><td>9 *3</td><td>Motor actual speed is greater than setting of Pr33 (position control switching level) and Pr34, and the 2nd gain is selected.</td></tr>
<tr><td>[10]* *3</td><td>Switching to the 2nd gain with position command present.
Switching to the 1st gain when absence of position command continues for Pr32 (x 166ms) and speed falls below Pr33 - Pr34 [r/min].</td></tr>
</table>
*3 For levels to be switching and timing, refer to "Adjustment upon switching gain" of Adjustment volume on page 202.</td></tr>
<tr><td>32</td><td>Position control switching delay time</td><td>0 – 10000
[30]*</td><td>x 166µs</td><td>• The parameter sets delay time of deviation from switching conditions set with Pr31 to actual return to the 1st gain.</td></tr>
<tr><td>33</td><td>Position control switching level</td><td>0 – 20000
[50]*</td><td>–</td><td>• The parameter is enabled when Pr31 is set to 3 – 8, and sets a determination level when No.1 and No.2 gain are switched.</td></tr>
<tr><td>34</td><td>Position control switching hysteresis</td><td>0 – 20000
[33]*</td><td>–</td><td>• The parameter sets width of hysteresis to be provided above and under the judgment level set with Pr33 mentioned above.
• The following figure shows definitions of the above-mentioned Pr32 (delay), Pr33 (level) and Pr34 (hysteresis).
 

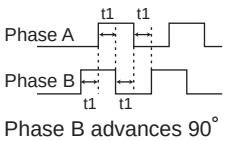
<Caution>
Settings of Pr33 (level) and Pr34 (hysteresis) are enabled as an absolute value (positive/negative).</td></tr>
<tr><td>35</td><td>Position gain switching time</td><td>0 – 10000
[20]*</td><td>(Setting +1)
x 166µs</td><td>• The parameter sets stepped switching time only for position loop gain upon switching gains when the 2nd gain switching function has been enabled.
 

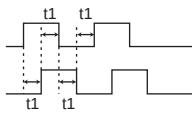
• Switching time should be provided only when a small position loop gain is switched to a large position loop gain (Kp1 –> Kp2). (This is to alleviate impact on the machine due to rapid change of gain.)
• You should set a value smaller than a difference of Kp2 and Kp1.</td></tr>
</table>

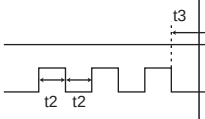
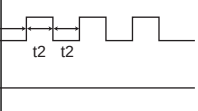
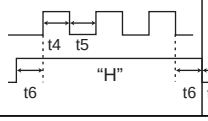
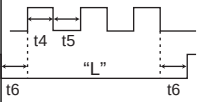
Parameter Setting

Parameters for Position Control

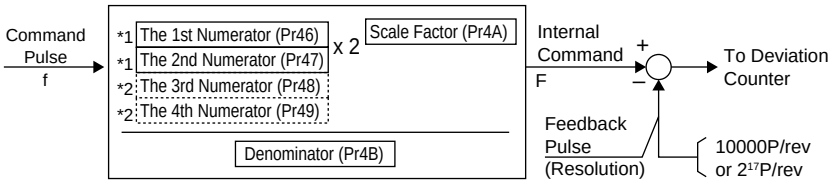
Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Function/Description</th></tr>
<tr><td>40</td><td>Command pulse multiplier set up</td><td>1 – 4</td><td>• The parameter sets a multiply when “2-phase pulse input” has been selected as a command pulse form with Pr42 (command pulse input mode setting).
<table>
<tr><th>Setting value</th><th>Multiply when 2-phase pulse is input</th></tr>
<tr><td>1</td><td>x 1</td></tr>
<tr><td>2</td><td>x 2</td></tr>
<tr><td>3 or [4]</td><td>x 4</td></tr>
</table></td></tr>
<tr><td>41</td><td>Command pulse logic inversion</td><td>0 – 3</td><td>• Each of logics of 2 pulse command input (PULS, SIGN) systems can be individually set inside the driver.
<table>
<tr><th>Setting value</th><th>“PULS” Signal Logic</th><th>“SIGN” Signal Logic</th></tr>
<tr><td>[0]</td><td>Non-inverting</td><td>Non-inverting</td></tr>
<tr><td>1</td><td>Inverting</td><td>Non-inverting</td></tr>
<tr><td>2</td><td>Non-inverting</td><td>Inverting</td></tr>
<tr><td>3</td><td>Inverting</td><td>Inverting</td></tr>
</table></td></tr>
<tr><td>42</td><td>Command pulse input mode</td><td>0 – 3</td><td>• The parameter sets an input form of a command pulse to be given from the host device to the driver. Three types of forms listed in the following table can be set. Make selection in accordance with specifications of the host device.
<table>
<tr><th>Setting value</th><th>Command pulse form</th><th>Signal Name</th><th>CCW Command</th><th>CW Command</th></tr>
<tr><td>0 or 2</td><td>90° phase difference Two-phase pulse (Phase A + Phase B)</td><td>PULS
SIGN</td><td> 

Phase B advances 90° ahead of phase A.</td><td> 

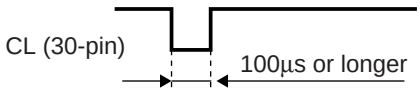
Phase B delays 90° from phase A</td></tr>
<tr><td>[1]</td><td>CW pulse train
+
CCW pulse train</td><td>PULS
SIGN</td><td> 
</td><td> 
</td></tr>
<tr><td>3</td><td>Pulse train
+
symbols</td><td>PULS
SIGN</td><td> 
</td><td> 
</td></tr>
</table>
Allowed maximum input frequency and required minimum time width of command pulse input signal
<table>
<tr><th rowspan="2">Input I/F of PULS/SIGN signals</th><th rowspan="2">Allowed maximum input frequency</th><th colspan="6">Required minimum time width [μs]</th></tr>
<tr><th>t1</th><th>t2</th><th>t3</th><th>t4</th><th>t5</th><th>t6</th></tr>
<tr><td>Line driver interface</td><td>500kpps</td><td>2</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Open collector interface</td><td>200kpps</td><td>5</td><td>2.5</td><td>2.5</td><td>2.5</td><td>2.5</td><td>2.5</td></tr>
</table>
Pulse rise/fall time of command pulse input signal should be set to no more than 0.1μs.</td></tr>
<tr><td>43</td><td>Command pulse inhibit input invalidation</td><td>0 – 1</td><td>• The parameter selects enable/disable of command pulse inhibit input INH: CN X5 33-pin).
<table>
<tr><th>Setting value</th><th>INH Input</th></tr>
<tr><td>0</td><td>Enable</td></tr>
<tr><td>[1]</td><td>Disable</td></tr>
</table>
With INH input, connection with COM- will be open, and command pulse input will be inhibited. If you do not use INH input, set 1 to Pr43. You no longer need to connect INH (CN 1/F 33-pin) and COM- (41-pin) external to the driver.</td></tr>
</table>

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Function/Description</th></tr>
<tr><td>44</td><td>Output pulses per single turn</td><td>1 – 16384
[2500]</td><td>The parameter sets number of pulses per one revolution of encoder pulse to be output to the host device. The pulse will be set in dividing.
You should directly set in this parameter the number of pulses per revolution needed for your device/system in terms of [Pulse/rev].</td></tr>
<tr><td>45</td><td>Pulse output logic inversion</td><td>0 – 1</td><td>In a relationship of phases of output pulse from the rotary encoder, Phase B pulse is behind pulse A when the motor rotates in CW direction. (Phase B pulse advances ahead of phase A pulse, when the motor rotates in CCW direction.)
Inversion of logic of phase B pulse with this parameter could invert a phase relation of phase B pulse to phase A pulse.
<table>
<tr><th rowspan="2">Setting value</th><th></th><th>IWhen Motor is Rotating in CCW direction</th><th>IWhen Motor is Rotating in CW direction</th></tr>
<tr><td>A pulse(OA)</td><td rowspan="2">  </td><td rowspan="2">  </td></tr>
<tr><td>[0]</td><td>B pulse(OB)
Non-inverting</td></tr>
<tr><td>1</td><td>B pulse(OB)
Inverting</td><td>  </td><td>  </td></tr>
</table></td></tr>
<tr><td>46</td><td colspan="3">Related to command pulse multiply division function (Pr46 to 4B)</td></tr>
<tr><td></td><td>1st numerator of command pulse ratio</td><td>1 – 10000
[10000]</td><td rowspan="6">Command pulse multiply division (electronic gear) function
Purpose of Use
1) To arbitrarily set rotation/movement of the motor per unit input command pulse.
2) In the case predetermined motor speed cannot be achieved because of limited pulse oscillation capacity (highest possible output frequency) of the host device, multiply function should be used to increase seeming command pulse frequency.
• Block Diagram of Multiply Division Unit:
 

• An upper limit of computed value of a numerator will be 2621440. Note that even when you set a value higher than this, it will become invalid and 2621440 will be a numerator.
*1: Select the 1st or 2nd numerator by means of command multiply division switching (DIV:CN X5 28-pin).
<table>
<tr><td>DIV Off</td><td>Select the first numerator (Pr46).</td></tr>
<tr><td>DIV ON</td><td>Select the second numerator (Pr47).</td></tr>
</table>
*2: 3rd and 4th numerators are used for special specifications such as full-closed specification. For further information, refer to “Full-Closed Control” volume on page 156.
<Examples of Setting>
• It is basic to have a relation “a motor rotates once with command input (f) for resolution of an encoder” when the multiply division ratio is 1.
Therefore, to rotate the motor once as an example of the case in which the encoder has resolution of 10000P/r, f=5000Pulse at multiply of 2 and f=40000Pulse at 1/4 division should be input.
• Pr46, Pr4A and Pr4B should be set so that internal command after multiply division will be equal to resolution of the encoder (i.e., 10000 or 2^{17}).
$F = f \times \frac{Pr46 \times 2\ Pr4A}{Pr4B} = 10000 \text{ or } 2^{17}$
F: Number of internal command pulses for one revolution of the motor
f: Number of command pulses for one revolution of the motor</td></tr>
<tr><td>47</td><td>2nd numerator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>48</td><td>3rd numerator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>49</td><td>4th numerator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>4A</td><td>Multiplier of numerator of command pulse ratio</td><td>0 – 17
[0]</td></tr>
<tr><td>4B</td><td>Denominator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
</table>

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Function/Description</th></tr>
<tr><td>46
(Continued)</td><td colspan="3">Related to command pulse multiply division function (Pr46 to 4B)</td></tr>
<tr><td></td><td>1st numerator of command pulse ratio</td><td>1 – 10000
[10000]</td><td rowspan="6">(Continued)
<table>
<tr><th>Resolution of Encoder</th><th>2^{17} (131072)</th><th>10000 (2500P/r x 4)</th></tr>
<tr><td>Example 1:
When command input (f) is set to 5000 per revolution of the motor]</td><td>$\frac{\text{Pr46 } [1] \times 2^{\text{Pr4A } [17]}}{\text{Pr4B } [5000]}$</td><td>$\frac{\text{Pr46 } [10000] \times 2^{\text{Pr4A } [0]}}{\text{Pr4B } [5000]}$</td></tr>
<tr><td>Example 2:
When command input (f) is set to 40000 per revolution of the motor]</td><td>$\frac{\text{Pr46 } [1] \times 2^{\text{Pr4A } [15]}}{\text{Pr4B } [10000]}$</td><td>$\frac{\text{Pr46 } [2500] \times 2^{\text{Pr4A } [0]}}{\text{Pr4B } [10000]}$</td></tr>
</table></td></tr>
<tr><td>47</td><td>2nd numerator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>48</td><td>3rd numerator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>49</td><td>4th numerator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>4A</td><td>Multiplier of numerator of command pulse ratio</td><td>0 – 17
[0]</td></tr>
<tr><td>4B</td><td>Denominator of command pulse ratio</td><td>1 – 10000
[10000]</td></tr>
<tr><td>4C</td><td>Smoothing filter</td><td>0 – 7</td><td>A smoothing filter is a primary delay filter inserted after command multiply division unit of command pulse input unit.
Purpose of Smoothing Filter:
• Basically, it is to alleviate stepped movement of the motor when a command pulse is rough.
• Following are the specific examples in which a command pulse becomes rough:
1) When a multiply ratio is set for command multiply division (10 times or higher)
2) When command pulse frequency is low in some cases
• A time constant of the smoothing filter should be set in 8 steps with Pr4C.
<table>
<tr><th>Setting value</th><th>Time constant</th></tr>
<tr><td>0</td><td>No filter function</td></tr>
<tr><td>[1]</td><td>Small time constant</td></tr>
<tr><td>⟆</td><td>↓</td></tr>
<tr><td>7</td><td>Great time constant</td></tr>
</table></td></tr>
<tr><td>4D</td><td>Counter clear input</td><td>0 – 1</td><td>The parameter sets clear conditions of counter clear input signal for clearing the deviation counter (CL: CNX5 30-pin).
<table>
<tr><th>Setting value</th><th>Clear Conditions</th></tr>
<tr><td>[0]</td><td>Clear at level (*1).</td></tr>
<tr><td>1</td><td>Clear at edge (falling edge).</td></tr>
</table>
*1: Minimum time width of CL signal
 
</td></tr>
</table>

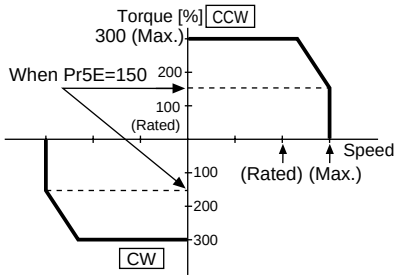
Parameters for Speed Control

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
57	**JOG speed set up**	0 – 500 [300]	r/min	The parameter directly sets JOG speed in JOG run in “motor trial run mode” in terms of [r/min]. For details on JOG function, refer to “Trial Run (JOG)” of Preparations volume on page 68.

Parameters for Torque Control

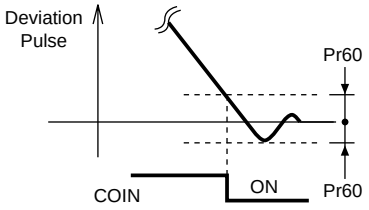
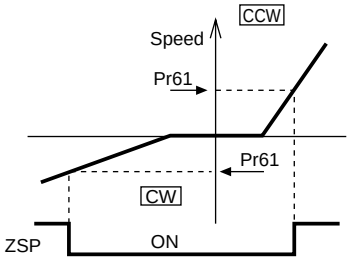
Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
5E	**Torque limit**	0 – 500	%	• This function limits maximum torque of the motor through setting of parameters within the driver. • In normal specifications, torque about 3 times higher than the rated is allowed for an instant. This parameter limits the maximum torque, however, if the triple torque may cause a trouble in the strength of motor load (machine). • Setting should be given as a % value to rated torque. • The right figure shows a case in which the maximum torque is limited to 150%. • Pr5E limits maximum torque in both CW and CCW directions simultaneously.  **<Caution>** You cannot set this parameter to a value above a factory setting of the system parameter (i.e., a factory set parameter that cannot be changed through of PANATERM® and panel manipulation) “Maximum Output Torque Setting”. A factory setting may vary depending on a combination of an driver and motor. For further information, refer to “Pr5E Setting of Torque Limit” of Preparations volume on page 55.

Parameter Setting

Parameters for various sequences

Default setting is shown by [ ]

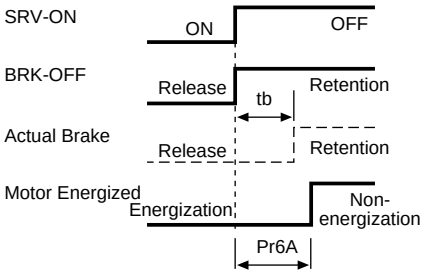
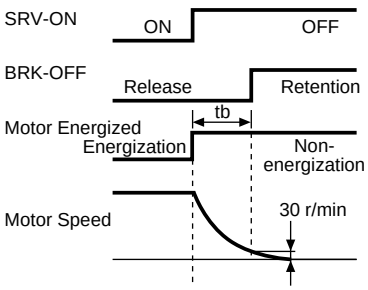
<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Unit</th><th>Function/Description</th></tr>
<tr><td>60</td><td>In-position range</td><td>0 – 32767
[131]</td><td>Pluse</td><td>• The parameter sets timing to output a positioning completion signal (COIN: CN X5 39-pin) when movement of the motor (work) is complete after input of a command pulse ends.
• A positioning completion signal (COIN) is output when the number of pulses of the deviation counter is within ± (setting).
• A basic unit of deviation pulse is “resolution” of an encoder you will use. Thus, be careful because it varies depending on an encoder, as shown below:
1) 17-bit encoder: 2^{17} = 131072
2) Encoder of 2500 P/rev: 4 x 2500 = 10000
<Cautions>
1.Setting Pr60 too small might extend time till COIN signal is output or cause chattering upon output.
2.Setting of “Positioning Completion Range” will have no effect on final positioning precision.
 
</td></tr>
<tr><td>61</td><td>Zero speed</td><td>0 – 20000
[50]</td><td>r/min</td><td>• The parameter directly sets timing to an output zero speed detection output signal (ZSP: CN X5 12-pin) in terms of [r/min].
• A zero speed detection signal (ZSP) is output when motor speed falls below the speed set with this parameter Pr61.
• Setting of Pr61 acts on both CW and CCW directions, irrespective of rotating direction of the motor.
• There is hysteresis of 10rpm. The parameter should be set to 10 or greater.
 
</td></tr>
<tr><td>63</td><td>Position error set up</td><td>1 – 32767
[25000]</td><td>–</td><td>The parameter sets a detection level of “protection against excessive positional deviation” function when it is determined that positional deviation is excessive, by using the number of residual pulses.
• Calculate a setting value following the expression shown below:
$\text{Setting value} = \frac{\text{Positional deviation excess determination level [PULSE]}}{256}$
<Note>
Note that setting this Pr63 too small, in particular, when positional gain is set low might activate protection against excessive positional deviation even though there was no abnormality.</td></tr>
<tr><td>64</td><td>Position error invalidation</td><td>0 – 1</td><td>–</td><td>This parameter disables “protection against excessive positional deviation”.
<table>
<tr><th>Setting value</th><th>Protection against excessive positional deviation</th></tr>
<tr><td>[0]</td><td>Enabled</td></tr>
<tr><td>1</td><td>Disabled. Operation will continue without determining abnormality, even though positional deviation pulses exceed the judgment level set with Pr63.
If you make a mistake in phase sequence or wiring of the encoder, runaway may occur. You should install a safeguard against runaway in the device.</td></tr>
</table></td></tr>
</table>

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Unit</th><th>Function/Description</th></tr>
<tr><td>65</td><td>Undervoltage error response at main power-off</td><td>0 – 1</td><td>–</td><td>The parameter sets whether to enable the “protection against main power source under-voltage” function when you shut down the main power of main and control power supplies.
<table>
<tr><th>Setting value</th><th>Main Power Source Under-voltage Protection Action</th></tr>
<tr><td>[0]</td><td>In this case, if you shut off the main power during Servo ON, it will be SERVO-OFF without a trip. Then, when the main power supply turns ON again, it will be recovered to Servo ON.</td></tr>
<tr><td>1</td><td>Shutting off main power during Servo ON will activate abnormal main power supply under-voltage (alarm code No.13) and cause a trip.</td></tr>
</table>
Refer to the timing chart “At Power ON” of Preparations volume on page 40.</td></tr>
<tr><td>66
*1</td><td>Dynamic breke inhibition at overtravel limit</td><td>0 – 1</td><td>–</td><td>The parameter sets driving conditions at decelerated operation after overtravel input inhibit (CCWL: connector CN X5 9-pin or CWL: connector CN X5 8-pin) has been activated and enabled.
<table>
<tr><th>Setting value</th><th>Driving Conditions from Deceleration to Stop</th></tr>
<tr><td>[0]</td><td>The motor decelerates and stops as the dynamic brake (DB) is operated. The motor will be in free condition after it stops.</td></tr>
<tr><td>1</td><td>Free running, the motor decelerates and stops. The motor will be in free condition after it stops.</td></tr>
</table></td></tr>
<tr><td>67</td><td>Error response at main power-off</td><td>0 – 7</td><td>–</td><td>The parameter sets:
(1) Driving conditions during deceleration and after stopping; and
(2) Processing to clear content of the deviation counter
after the main power source is shut off.
<table>
<tr><th rowspan="2">Setting value</th><th colspan="2">Driving Conditions</th><th rowspan="2">Content of Deviation Counter</th></tr>
<tr><th>During Deceleration</th><th>After Stopped</th></tr>
<tr><td>[0]</td><td>DB</td><td>DB</td><td>Clear</td></tr>
<tr><td>1</td><td>Free Run</td><td>DB</td><td>Clear</td></tr>
<tr><td>2</td><td>DB</td><td>Free</td><td>Clear</td></tr>
<tr><td>3</td><td>Free Run</td><td>Free</td><td>Clear</td></tr>
<tr><td>4</td><td>DB</td><td>DB</td><td>Retention</td></tr>
<tr><td>5</td><td>Free Run</td><td>DB</td><td>Retention</td></tr>
<tr><td>6</td><td>DB</td><td>Free</td><td>Retention</td></tr>
<tr><td>7</td><td>Free Run</td><td>Free</td><td>Retention</td></tr>
</table>
DB: Activation of dynamic brake</td></tr>
<tr><td>68</td><td>Error response action</td><td>0 – 3</td><td>–</td><td>The parameter sets driving conditions during deceleration or following stop, after any of protective functions of the driver has been activated and alarm has been generated.
<table>
<tr><th rowspan="2">Setting value</th><th colspan="2">Driving Conditions</th><th rowspan="2">Content of Deviation Counter</th></tr>
<tr><th>During Deceleration</th><th>After Stopped</th></tr>
<tr><td>[0]</td><td>DB</td><td>DB</td><td>Clear</td></tr>
<tr><td>1</td><td>Free Run</td><td>DB</td><td>Clear</td></tr>
<tr><td>2</td><td>DB</td><td>Free</td><td>Clear</td></tr>
<tr><td>3</td><td>Free Run</td><td>Free</td><td>Clear</td></tr>
</table>
(DB: Activation of dynamic brake)
See also “When Abnormality (Alarm) Occurs (Serve ON Command State)” of the timing chart, Preparations volume on page 41.</td></tr>
</table>

*1: Enabled only in the 2nd full-closed control

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
69	**Sequence at Servo-OFF**	0 – 7 [0]	–	• The parameter sets: 1) Driving conditions during deceleration or after stop 2) Processing to clear the deviation counter following Servo off (SRV-ON signal: CN X5 29-pin turns On ‡ Off). • A relationship between setting of Pr69 and driving conditions/deviation counter processing conditions is similar to that of Pr67 (Sequence at Main Power Off). • See also “Serve On/Off Operation When the Motor Stops” of the timing chart of Preparations volume on page 42.
6A	**Mechanical brake delay at motor standstill**	0 – 100 [0]	2ms	The parameter sets time till non-energization of motor (servo free) after the brake release signal (BRK-OFF) turns off (brake retained), at Serve Off while the motor stops. • In order to prevent minor movement/drop of the motor (work) due to operation delay time of the brake (tb): Setting of Pr6A ≧ tb. • See “Serve On/Off Operation When the Motor Stops” of the timing chart on page 42.  See also “Serve On/Off Operation When the Motor Stops” of the timing chart of Preparations volume on page 43.
6B	**Mechanical brake delay at motor in motion**	0 – 100 [0]	2ms	Unlike Pr6A, the parameter sets time till brake release signal (BRK-OFF) turns off (brake retained) after motor non-energization (servo-free), at Servo off while the motor is rotating. • This should be set to prevent deterioration of the brake due to revolutions of the motor. • At Servo off while the motor is rotating, time tb in the right figure will be either set time of Pr6B or time till the motor rotational speed falls below approximately 30r/min, whichever is smaller. • See “Serve On/Off Operation When the Motor is Rotating” of the timing chart of on page 43.  See also “Serve On/Off Operation When the Motor Stops” of the timing chart of Preparations volume on page 42.

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Unit</th><th>Function/Description</th></tr>
<tr><td>6C</td><td>External regenerative resister set up</td><td>0 – 3</td><td>–</td><td>This parameter is set depending on whether to use regeneration resistance built in the driver, or to provide a regeneration resistance in the external (connect between RB1 and RB2 of connector CN X 2 in types A to D, and between terminal blocks P and B2 in types E - G).
<table>
<tr><th>Setting value</th><th>Regeneration Resistance to Use</th><th>Protection against Regeneration Resistance Overload</th></tr>
<tr><td>[0]</td><td>Built-in resistance</td><td>According to built-in resistance, (about 1% duty) protection against regeneration resistance overload works.</td></tr>
<tr><td>1</td><td>External resistance</td><td>This is activated with operating limits of the external resistance at 10% duty.</td></tr>
<tr><td>2</td><td>Built-in resistance</td><td>This is activated with operating limits of the external resistance at 100% duty.</td></tr>
<tr><td>3</td><td>External resistance</td><td>Regeneration resistance does not work, and a built-in condenser accommodates all regenerated power.</td></tr>
</table>
<Request>
When you use an external regeneration, you must install external safeguards such as a temperature fuse, etc.
Otherwise, as protection of regeneration resistance would be lost, causing abnormal heat generation and burnout.
<Caution>
Be careful not to touch an external regeneration resistance.
While you are using an external resistance, it may become hot and scald you. For type A, only external regeneration resistance is used.</td></tr>
<tr><td>6D</td><td>Main power-off detection time</td><td>0 – 32767 [35]</td><td>2ms</td><td>The parameter sets time to detect shut-off when shut-off of main power supply continues.</td></tr>
</table>

Parameters for Full-closed Control

Default setting is shown by [ ]

Parameter No.	Parameter Name	Setting range	Unit	Function/Description
70 *2	**Hybrid switching speed**	1 – 20000 [10]	r/min	• Speed for determining the timing of switching from ordinary semi-closed control to hybrid control after stoppage is set.
71 *2	**Hybrid shifting delay time**	0 – 10000 [0]	2ms	• When a status that the speed is less than a value set by Pr70 (hybrid switching speed) continues for a period longer than the time set by this parameter, the mode shifts to hybrid control.
72 *2	**Hybrid control period**	1 – 10000 [10]	2ms	• Cycle for adding correction pulse of the hybrid control is set.
73	**Hybrid error limit excess**	1 – 10000 [100]	Resolution of external scale	• Defines the allowable difference between the current motor position and the current position of the external scale, when an external scale is used for control.
74	**Numerator of external ratio**	1 – 10000 [1]	–	• Defines the numerator of the ratio of encoder pulse to external scale pulse. • The actual numerator is the nth power of the numerator of the external scale pulse ratio (Pr74) multiplied by 2. (n = Set value) • The upper limit of the actual numerator calculation is 131072. If the calculated value exceeds this limit, it becomes invalid, and the actual numerator is set to 131072. This parameter must be changed during Servo-OFF.

*2: Enabled only in the Hybrid control

Default setting is shown by [ ]

<table>
<tr><th>Parameter No.</th><th>Parameter Name</th><th>Setting range</th><th>Unit</th><th>Function/Description</th></tr>
<tr><td>75</td><td>Multiplier of numerator of external scale ratio</td><td>0 – 17
[17]</td><td>2^n</td><td>• Defines the numerator of the ratio of encoder pulse to external scale pulse.
• The actual numerator is the nth power of the numerator of the external scale pulse ratio (Pr74) multiplied by 2. (n = Pr75 Set value)
• The upper limit of the actual numerator calculation is 131072. If the calculated value exceeds this limit, it becomes invalid, and the actual numerator is set to 131072.
• This parameter must be changed during Servo-OFF.</td></tr>
<tr><td>76</td><td>Denominator of external scale ratio</td><td>1 – 10000
[10000]</td><td>–</td><td>• Defines the denominator of the ratio of encoder pulse to external scale pulse.
• This parameter must be changed during Servo-OFF.</td></tr>
<tr><td>77</td><td>Scale error cancel</td><td>0 – 3</td><td>–</td><td>• The parameter sets enable/disable of scale error input (X5 SC-ERR:33-pin) and EXZ input disconnection detection in full-closed control, hybrid control, external encoder control mode, and the 2nd full-closed control.
<table>
<tr><th>Setting value</th><th>SC-ERR</th><th>EXZ disconnection</th></tr>
<tr><td>0</td><td>Enabled</td><td>Enabled</td></tr>
<tr><td>[1]</td><td>Disabled</td><td>Enabled</td></tr>
<tr><td>2</td><td>Enabled</td><td>Disabled</td></tr>
<tr><td>3</td><td>Disabled</td><td>Disabled</td></tr>
</table></td></tr>
<tr><td>78</td><td>Pulse output selection</td><td>0 – 1
[0]</td><td>–</td><td>• In full-closed control, hybrid control, external encoder control, or 2nd full-closed control mode, original signal for the pulse output signal (X5 0A+: 21-pin, 0A-: 22-pin, 0B+: 48pin, 0B-: 49-pin) is selected.
0: External scale (EXA, EXB, EXZ-phase) 1: Encoder (A, B, Z-phase)
In a control mode other than the above, this parameter is disabled and encoder (A, B, Z-phase) outputs pulses.</td></tr>
<tr><td>79</td><td>Numerator of external scale pulse output ratio</td><td>1 – 10000
[10000]</td><td>–</td><td>• Defines the numerator of the pulse output scale ratio when Pr78 (Pulse output selection) is set to "0".
• Set up this parameter so that the scale ratio is "1" or less.</td></tr>
<tr><td>7A</td><td>Denominator of external scale pulse output ratio</td><td>1 – 10000
[10000]</td><td>–</td><td>• The parameter sets a denominator of division ratio of pulse output when Pr78 pulse output selection is 0.
• Set up this parameter so that the scale ratio is "1" or less.</td></tr>
<tr><td>7B
*1</td><td>Torsion correction gain</td><td>–2000
– 2000
[0]</td><td>1/s</td><td>• Difference (torsion amount) between the motor and load position is filtered through a high-pass filter detemined by Pr7C; and the obtained value is multiplied by this gain and is sbtracted from the speed command.
Note) When using Pr7B, set Pr7D and Pr7E to 0.</td></tr>
<tr><td>7C
*1</td><td>Torsion/ Differential speed detection filter</td><td>0 – 255
[0]</td><td>3.7Hz</td><td>• Defines the high-pass filter's response to the torsion multiplied by the Pr7B set value, and the low-pass filter's response to the differential speed multiplied by the Pr7E set value.
0: Disabled 1 to 255: Enabled
• The filter's cutoff frequency is (Set value x 3.7 [Hz]).</td></tr>
<tr><td>7D</td><td>Torsion feedback gain</td><td>–2047
– 2047
[0]</td><td>–</td><td>• Difference (torsion amount) between the motor and load position is multiplued by this gain/256; and the obtained value is added to the torque command (2000 = rated torque).
Note) When using Pr7D and Pr7E, set Pr7B to 0.</td></tr>
<tr><td>7E</td><td>Differential speed feedback gain</td><td>–2047
– 2047
[0]</td><td>–</td><td>• Difference (differential speed) between the motor and load speed is filtered through a low-pas filter determined by Pr7C; and the obtained value is multiplied by this gain/2 and is added to torque command (2000 = rated torque).
Note) When using Pr7D and Pr7E, set Pr7B to 0.</td></tr>
</table>

*1: Enabled only in the 2nd full-closed control
*2: Enabled only in the Hybrid control