Mitsubishi Electric FA Website e-Learning MELSERVO Basic (MR-J5) Supplementary Document

[Title] How to Set Electronic Gear When Using Pulse Train Input Type Servo Amplifier

[Version] -

[Relevant Model] MR-J5-A

This document is a supplementary document for the e-Learning MELSERVO Basic (MR-J5) course which is available on Mitsubishi Electric FA Website.

The contents of this document are intended to supplement the above e-learning course. For information which is not described in this document, refer to the e-learning course.

This document describes how to set the electronic gear, which is required for using a pulse train input-type servo amplifier.

Contents

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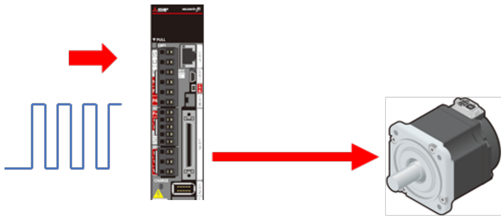
Role of electronic gear

Typically, the servo motor rotates by a specific step angle for one pulse of the encoder when one pulse is commanded to the servo amplifier. To rotate the motor one revolution, enter the number of pulses that matches the encoder resolution.

However, as the encoder resolution has become higher, the number of pulses required for one servo motor revolution has become enormous. Therefore, the electronic gear function is provided to simplify the command values by changing the number of pulses required for one revolution (= travel distance of the machine per command pulse).



$$\text{Number of command pulses} \times \frac{\text{Electronic gear numerator}}{\text{Electronic gear denominator}} = \text{Number of command pulses to the servo motor}$$

If the electronic gear is not set, the servo motor cannot rotate at a sufficient speed due to constraints of the maximum output frequency of the pulse train output type controller and the maximum input frequency of the servo amplifier. The electronic gear must be set correctly to avoid those constraints and rotate the motor at a sufficient speed.

Electronic gear function of controller

Some controllers such as the positioning module RD75D have a function equivalent to the electronic gear. (The function may have a different name, such as "Unit conversion function".) In such a case, set the electronic gear for both the controller and servo amplifier, and adjust the maximum command frequency and travel distance per command pulse.

Calculation examples are given on page 5 and later.

Basic formula for electronic gear

In this document, [cmdpls] represents the number of command pulses input to the servo amplifier and [encpls] represents the number of command pulses input to the servo motor (the number of feedback pulses from the encoder) for explanation purposes.

- When the controller has the electronic gear function

$$\text{Electronic gear on the controller side} = \frac{\text{Number of command pulses per revolution [cmdpls/rev]}}{\text{Travel distance per revolution [Position command unit/rev]}} \quad \text{... (A)}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{\text{Encoder resolution [encpls/rev]}}{\text{Number of command pulses per revolution [cmdpls/rev]}} \quad \text{... (B)}$$

Set "Number of command pulses per revolution" to any value regardless of the machine specifications here. Always assign the same value to the electronic gears on the controller side and the servo amplifier side. For "Travel distance per revolution", assign the value calculated from the machine specifications. "Position command unit" will be the unit of machine travel distance. (Example: mm, μm)
<u>When adjusting the electronic gear, change "Number of command pulses per revolution".</u>

The command pulse frequency is calculated as follows:
Command pulse frequency [cmdpls/s] = Speed command value [Position command unit/s] × Electronic gear on the controller side ... (C)

Point

- The electronic gear on the controller side is the inverse number of "Travel distance per command pulse".
- In the calculation of electronic gear, "Travel distance per command pulse" and "Number of command pulses per revolution" are used. Be careful not to mix up them.

- When the controller does not have the electronic gear function

In this case, given the position command unit is [cmdpls],

$$\text{Electronic gear on the servo amplifier side} = \frac{\text{Encoder resolution [encpls/rev]}}{\text{Travel distance per revolution [cmdpls/rev]}} \quad \text{... (D)}$$

Calculate "Travel distance per revolution [cmdpls/rev]" from the travel distance per command pulse and machine specifications (travel distance per revolution). <u>When adjusting the electronic gear, change the travel distance per command pulse</u>, and then calculate the travel distance per revolution in [cmdpls/rev] units again.

$$\text{Travel distance per revolution [cmdpls/rev]} = \frac{\text{Travel distance per revolution [Position unit/rev]}}{\text{Travel distance per command pulse [Position unit/cmdpls]}}$$

The command pulse frequency is obtained by converting the speed command value into [cmdpls/s].

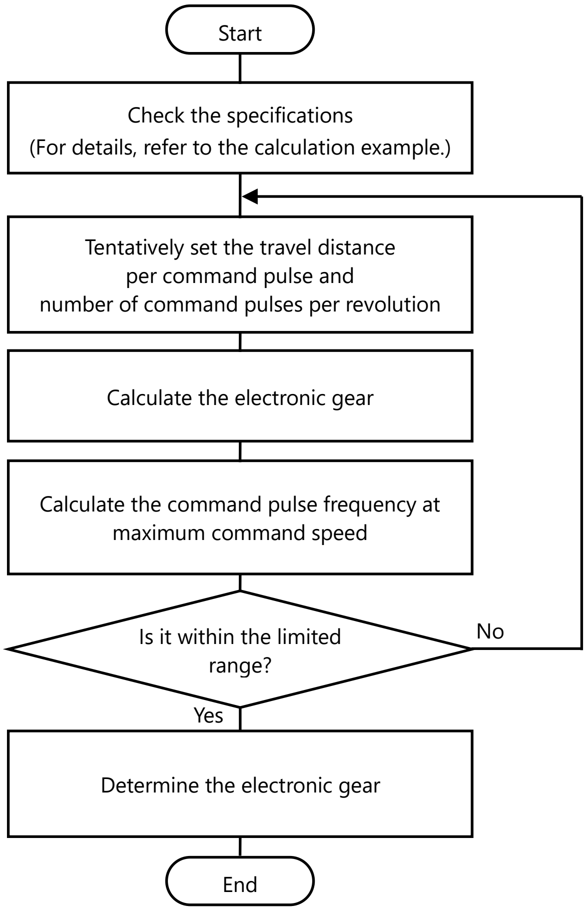
$$\text{Command pulse frequency [cmdpls/s]} = \frac{\text{Travel distance per command pulse [Position unit/cmdpls]}}{\text{Speed command value [Position unit/s]}} \quad \text{... (E)}$$

For the linear servo motor, refer to page 18.

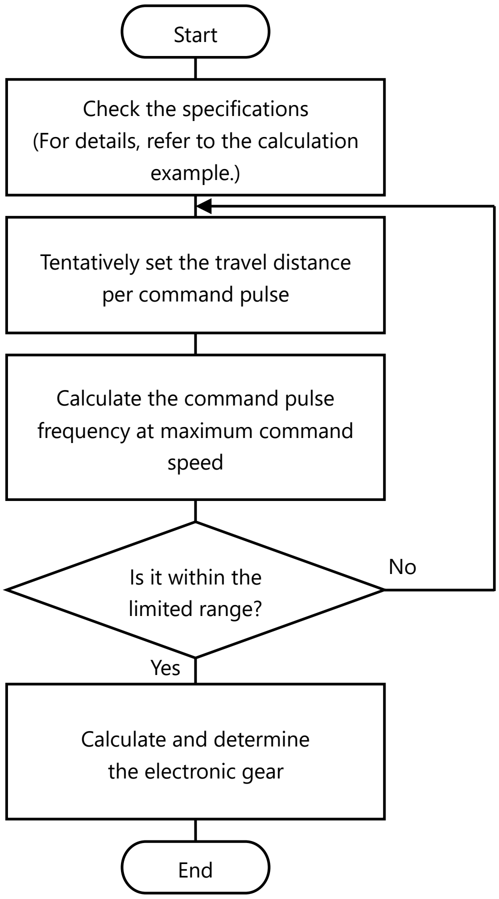
How to calculate electronic gear

Calculate the electronic gear as follows.

When the controller has the electronic gear function



When the controller does not have the electronic gear function



On the following pages, calculation examples are given for setting the electronic gear in the typical machine configurations.

Calculation examples

Case 1-1. Ball screw (1)

System configuration

Controller: RD75D

Servo amplifier: MR-J5-A

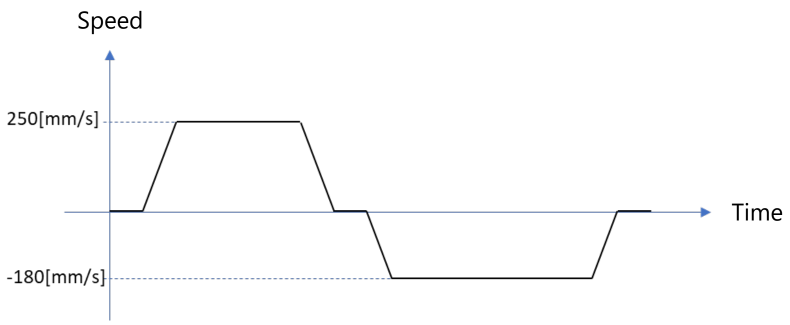
Servo motor: HK-KT

Machine specifications

Ball screw pitch: 10 [mm/rev]

Reduction ratio: 1/2

Operation pattern



1. Check the specifications

Encoder resolution	67108864 [encpls/rev]
Position command unit of the controller	[× 0.1 μm]
Maximum command speed	250 [mm/s] = 2500000 [× 0.1 μm/s] (= 15000 mm/min)
Maximum output frequency of the controller	5 [Mpps]
Maximum input frequency of the servo amplifier	4 [Mpps] (For the differential line driver)

→ Because the maximum input frequency of the servo amplifier is lower than the output frequency, the pulse frequency must be set to 4 [Mpps] or lower.

2. Tentatively set the travel distance per command pulse and number of command pulses per revolution

For the travel distance per command pulse, tentatively set 0.1 [μm/cmdpls] which is the position command unit of RD75D.

For the number of command pulses per revolution, tentatively set 100000 [cmdpls/rev].

Point

Set the number of command pulses per revolution in such a way that the controller electronic gear is 1 or larger. If the electronic gear of the controller is smaller than 1, the travel distance per pulse becomes large, which may result in poor positioning accuracy. Refer to the note on page 9.

3. Tentatively calculate the electronic gear

The travel distance per servo motor revolution is calculated as follows according to the machine specifications.

Ball screw pitch × Reduction ratio = 10 [mm/rev] × 1/2 = 5 [mm/rev] = 50000 [× 0.1 μm/rev]

Therefore, the electronic gears are calculated as follows with the formulas (A) and (B).

$$\text{Electronic gear on the controller side} = \frac{100000\ [\text{cmdpls/rev}]}{50000\ [\times 0.1\ \mu\text{m/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{50000\ [\text{cmdpls/rev}]}$$

4. Calculate the command pulse frequency

Because the maximum speed command value is 250 [mm/s], the command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 2500000\ [\times 0.1\ \mu\text{m/s}] \times \frac{100000\ [\text{cmdpls/rev}]}{50000\ [\times 0.1\ \mu\text{m/rev}]} = 5000000\ [\text{cmdpls/s}] = 5.0\ [\text{Mpps}]$$

The result is larger than 4 [Mpps], which is the maximum input frequency of the servo amplifier, indicating that these setting values cannot be used.

5. Set the number of command pulses per revolution again

Change the number of pulses per revolution from 100000 [cmdpls/rev] to 50000 [cmdpls/rev].

The electronic gears in this case are calculated as follows with the formulas (A) and (B).

$$\text{Electronic gear on the controller side} = \frac{50000\ [\text{cmdpls/rev}]}{50000\ [\times 0.1\ \mu\text{m/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{50000\ [\text{cmdpls/rev}]}$$

The maximum command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 2500000\ [\times 0.1\ \mu\text{m/s}] \times \frac{50000\ [\text{cmdpls/rev}]}{50000\ [\times 0.1\ \mu\text{m/rev}]} = 2500000\ [\text{cmdpls/s}] = 2.5\ [\text{Mpps}]$$

The result is within the limited range, indicating that the above setting values can be used.

6. Determine the electronic gear

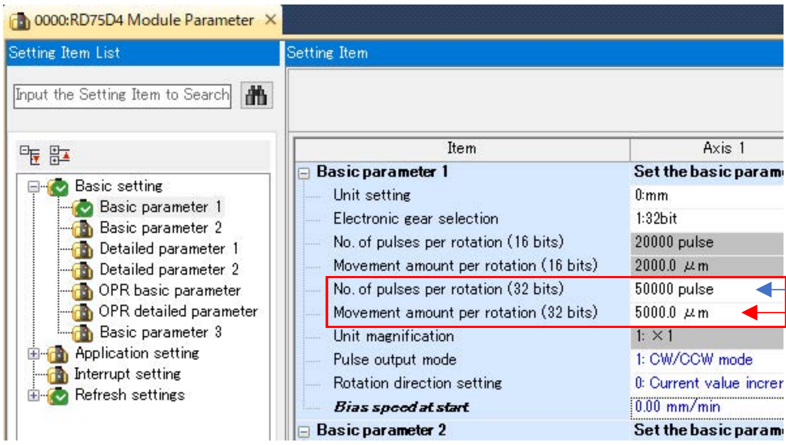
$$\text{Electronic gear on the controller side} = \frac{50000\ [\text{cmdpls/rev}]}{50000\ [\times 0.1\ \mu\text{m/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{50000\ [\text{cmdpls/rev}]}$$

(Reference)

The setting windows of GX Works3 and MR Configurator2 are as follows.

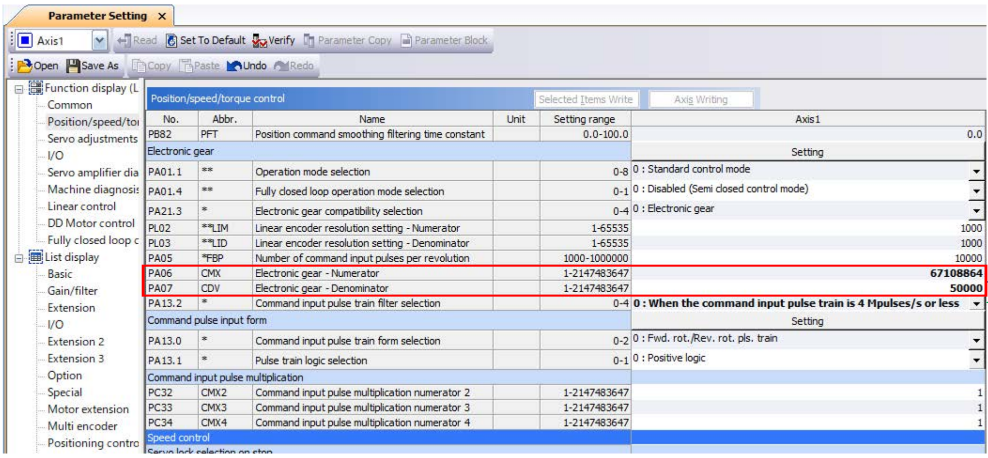
<GX Works3>



50000 in the example formula is displayed as 5000.0 because it is set in [μm] units.

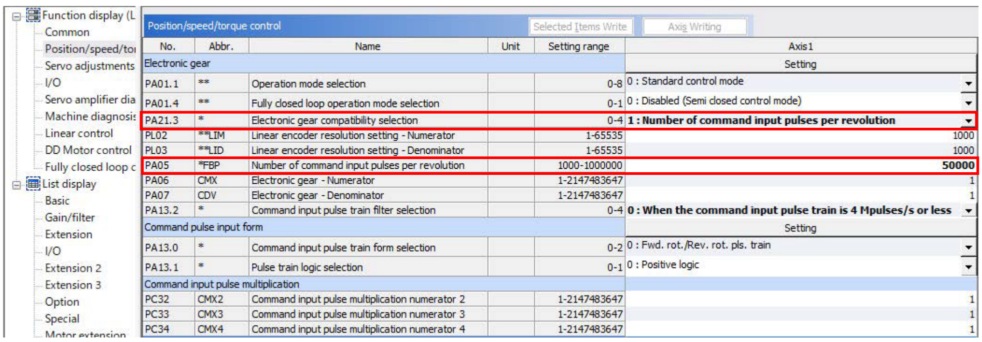
Check that the same values are set.

<MR Configurator2>



Set [Pr.PA13.2] Command input pulse train filter selection according to the maximum frequency.

The same setting is applied when [Pr.PA21.3] is changed to "1: Number of command input pulses per revolution" and "50000" is entered in [Pr.PA05].



Case 1-2. Ball screw (2)

System configuration

Controller: FX5U programmable controller built-in positioning function

Servo amplifier: MR-J5-A

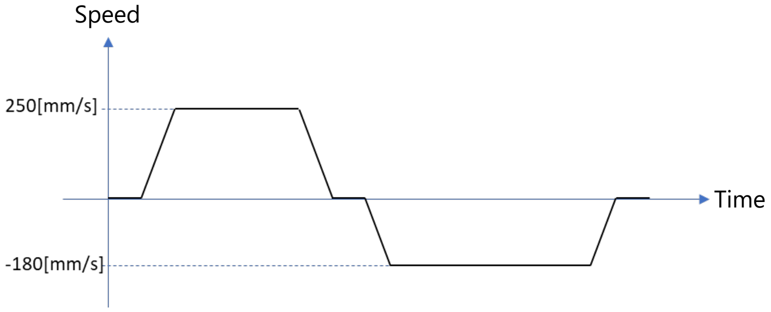
Servo motor: HK-KT

Machine specifications

Ball screw pitch: 10 [mm/rev]

Reduction ratio: 1/2

Operation pattern



* Only the controller has been changed from Case 1-1. Ball screw (1).

1. Check the specifications

Encoder resolution	67108864 [encpls/rev]
Position command unit of the controller	[μm]
Maximum command speed	250 [mm/s] = 250000 [μm/s] (= 1500 [cm/min])
Maximum output frequency of the controller	200 [kpps]
Maximum input frequency of the servo amplifier	200 [kpps] (For the open collector)

2. Tentatively set the travel distance per command pulse and number of command pulses per revolution

For the travel distance per command pulse, tentatively set 1 [μm/cmdpls] which is the position command unit of the built-in positioning function of the FX5U programmable controller.

For the number of command pulses per revolution, tentatively set 5000 [cmdpls/rev].

3. Tentatively calculate the electronic gear

The travel distance per servo motor revolution is calculated as follows according to the machine specifications.

Ball screw pitch × Reduction ratio = 10 [mm/rev] × 1/2 = 5 [mm/rev] = 5000 [μm/rev]

Therefore, the electronic gears are calculated as follows with the formulas (A) and (B).

$$\text{Electronic gear on the controller side} = \frac{5000\ [\text{cmdpls/rev}]}{5000\ [\mu\text{m/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{5000\ [\text{cmdpls/rev}]}$$

4. Calculate the command pulse frequency

Because the maximum speed command value is 250 [mm/s] = 250000 [μm/s], the command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 250000\ [\mu m/s] \times \frac{5000\ [\text{cmdpls/rev}]}{5000\ [\mu m/\text{rev}]} = 250000\ [\text{cmdpls/s}] = 250\ [\text{kpps}]$$

The result is larger than 200 [kpps], which is the maximum output frequency of the controller and maximum input frequency of the servo amplifier, indicating that the above setting values cannot be used.

5. Set the number of command pulses per revolution again

Change the number of pulses per revolution from 5000 [cmdpls/rev] to 4000 [cmdpls/rev].

The electronic gears in this case are calculated as follows with the formulas (A) and (B).

$$\text{Electronic gear on the controller side} = \frac{4000\ [\text{cmdpls/rev}]}{5000\ [\mu m/\text{rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{4000\ [\text{cmdpls/rev}]}$$

The maximum command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 250000\ [\mu m/s] \times \frac{4000\ [\text{cmdpls/rev}]}{5000\ [\mu m/\text{rev}]} = 200000\ [\text{cmdpls/s}] = 200\ [\text{kpps}]$$

The result is within the limited range, indicating that the above setting values can be used.

6. Determine the electronic gear

$$\text{Electronic gear on the controller side} = \frac{4000\ [\text{cmdpls/rev}]}{5000\ [\mu m/\text{rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{4000\ [\text{cmdpls/rev}]}$$

[Note] When the electronic gear of the controller is smaller than 1

When the electronic gear of the controller is smaller than 1, the stopping accuracy (resolution) becomes lower than the value set in "Travel distance per command pulse". The following table shows the travel distance of the machine with the electronic gear 4/5 when commands are issued at 1 [μm] intervals.

Position command value	1 [μm]	2 [μm]	3 [μm]	4 [μm]	5 [μm]
Command value after the electronic gear	4/5	8/5	12/5	16/5	20/5
Number of output pulses	0 [pls]	1 [pls]	2 [pls]	3 [pls]	4 [pls]
Actual travel distance of the machine	0 [μm]	1.25 [μm]	2.5 [μm]	3.75 [μm]	5 [μm]
Error	-1 [μm]	-0.75 [μm]	-0.5 [μm]	-0.25 [μm]	0 [μm]

This indicates that the machine is controlled in 1.25 [μm] units in practice.

Case 1-3. Ball screw (3)

System configuration

Controller: A controller which can perform the open-collector type output of pulse train (without the electronic gear)

Servo amplifier: MR-J5-A

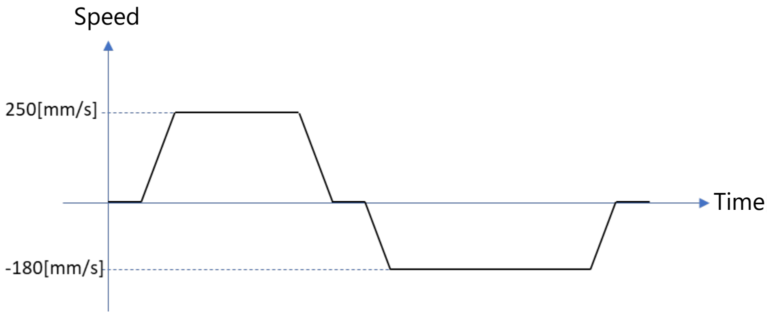
Servo motor: HK-KT

Machine specifications

Ball screw pitch: 10 [mm/rev]

Reduction ratio: 1/2

Operation pattern



* Only the controller has been changed from Case 1-1. Ball screw (1) and Case 1-2. Ball screw (2).

1. Check the specifications

Encoder resolution	67108864 [encpls/rev]
Position command unit of the controller	[pls]
Maximum command speed	250 [mm/s] = 250000 [μm/s]
Maximum output frequency of the controller	200 [kpps]
Maximum input frequency of the servo amplifier	200 [kpps] (For the open collector)

2. Tentatively set the travel distance per command pulse

For the travel distance per command pulse, tentatively set 1 [μm]. The travel distance per servo motor revolution is calculated as follows according to the machine specifications.

Ball screw pitch × Reduction ratio = 10 [mm/rev] × 1/2 = 5 [mm/rev] = 5000 [μm/rev]

3. Calculate the command pulse frequency

The maximum command pulse frequency is calculated as follows with the formula (E).

$$\text{Maximum command pulse frequency [cmdpls/s]} = \frac{250000\ [\mu m/s]}{1\ [\mu m/cmdpls]} = 250000\ [cmdpls/s] = 250\ [kpps]$$

The result is larger than the maximum output frequency of the controller and maximum input frequency of the servo amplifier, indicating the above setting values cannot be used.

4. Set the travel distance per command pulse again

For the travel distance per command pulse, change the setting value to 2 [µm]. The travel distance per servo motor revolution is 5000 [µm/rev].

The maximum command pulse frequency is calculated as follows.

$$\text{Maximum command pulse frequency [cmdpls/s]} = \frac{250000\ [\mu m/s]}{2\ [\mu m/cmdpls]} = 125000\ [cmdpls/s] = 125\ [kpps]$$

The result is within the limited range, indicating that the above setting values can be used.

5. Calculate the electronic gear

Calculate the travel distance per revolution in [cmdpls/rev] units.

$$\text{Travel distance per revolution [cmdpls/rev]} = \frac{\text{Travel distance per revolution } [\mu m/rev]}{\text{Travel distance per command pulse } [\mu m/cmdpls]}$$

$$= \frac{5000\ [\mu m/rev]}{2\ [\mu m/cmdpls]} = 2500\ [cmdpls/rev]$$

Therefore, the electronic gear on the servo amplifier is calculated as follows with the formula (D).

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [encpls/rev]}{2500\ [cmdpls/rev]}$$

Because the travel distance per pulse is 2 [µm], enter 50000 [pls] in the target position for 100 [mm] for example.

For the speed command of 250 [mm/s], enter 125 [kpps] in the command frequency.

Case 2. Conveyor

System configuration

Controller: RD75P

Servo amplifier: MR-J5-A

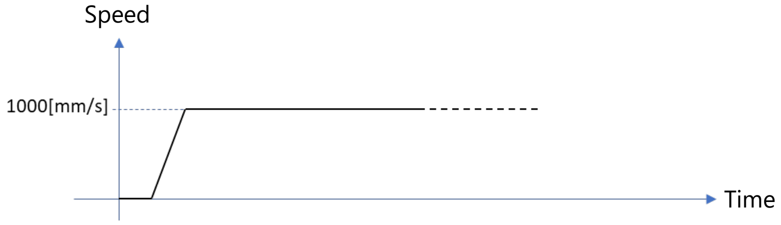
Servo motor: HK-KT series

Machine specifications

Roll outside diameter: 30 [mm]

Reduction ratio: 1/1 (Drive pully directly connected)

Operation pattern



1. Check the specifications

Encoder resolution	67108864 [encpls/rev]
Position command unit of the controller	[× 0.1 μm]
Maximum command speed	1000 [mm/s] = 10000000 [× 0.1 μm/s]
Maximum output frequency of the controller	200 [kpps]
Maximum input frequency of the servo amplifier	200 [kpps] (For the open collector)

2. Tentatively set the travel distance per command pulse and number of command pulses per revolution

For the travel distance per command pulse, tentatively set 0.1 [μm/cmdpls] which is the position command unit of RD75D.

For the number of command pulses per revolution, tentatively set 1000000 [cmdpls/rev].

3. Tentatively calculate the electronic gear

The travel distance per servo motor revolution is calculated as follows according to the machine specifications.

Roll circumference × Reduction ratio = 30π [mm/rev] × 1/1 = 94.2477961 [mm/rev] ≈ 942478 [× 0.1 μm/rev]

Therefore, the electronic gears are calculated as follows with the formulas (A) and (B).

$$\text{Electronic gear on the controller side} = \frac{1000000\ [\text{cmdpls/rev}]}{942478\ [\times 0.1\ \mu\text{m/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{1000000\ [\text{cmdpls/rev}]}$$

4. Calculate the command pulse frequency

Because the maximum speed command value is 1000 [mm/s] = 10000000 [× 0.1 μm/s], the command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 10000000\ [\times 0.1\ \mu m/s] \times \frac{1000000\ [cmdpls/rev]}{942478\ [\times 0.1\ \mu m/rev]} = 10610327.24\ [cmdpls/s] \approx 10.6\ [Mpps]$$

The result is larger than 200 [kpps], which is the maximum output frequency of the controller and maximum input frequency of the servo amplifier, indicating that the above setting values cannot be used.

5. Set the number of pulses per revolution again

Change the number of pulses per revolution from 1000000 [cmdpls/rev] to 10000 [cmdpls/rev].

The electronic gears in this case are calculated as follows with the formulas (A) and (B).

$$\text{Electronic gear on the controller side} = \frac{10000\ [cmdpls/rev]}{942478\ [\times 0.1\ \mu m/rev]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [encpls/rev]}{10000\ [cmdpls/rev]}$$

The maximum command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 1000000\ [\times 0.1\ \mu m/s] \times \frac{10000\ [cmdpls/rev]}{942478\ [\times 0.1\ \mu m/rev]} = 106103.27 \ldots\ [cmdpls/s] \approx 106.1\ [kpps]$$

The result is within the limited range, indicating that the above setting values can be used.

6. Determine the electronic gear

$$\text{Electronic gear on the controller side} = \frac{10000\ [cmdpls/rev]}{942478\ [\times 0.1\ \mu m/rev]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [encpls/rev]}{10000\ [cmdpls/rev]}$$

[Note] Error

Because the electronic gear includes some rounded values, there may be an error between the actual machine travel distance and the command value.

For example, the number of command pulses to be output is calculated as follows when a position command of 100 [m] is issued.

1000000000 [× 0.1 μm] × 10000/942478 = 10610327.24 [cmdpls]

In practice, however, the number of command pulses to be output is 10610327 [cmdpls] because the fraction is not output.

In this case, the travel distance of the conveyor is calculated as follows.

10610327 [cmdpls] × 67108864/10000 × 30π [mm]/67108864 ≈ 99999.97607 [mm] = 99.99997607 [m]

Case 3-1. Rotary table (1)

System configuration

Controller: RD75D

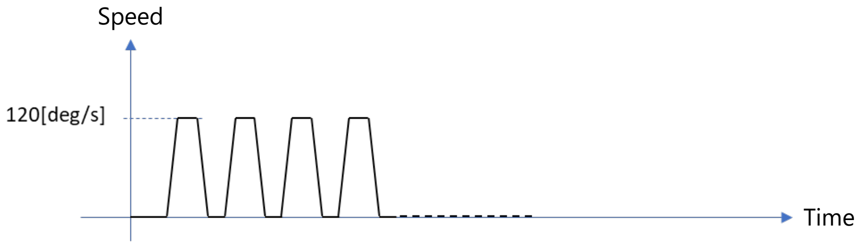
Servo amplifier: MR-J5-A

Servo motor: HK-KT series

Machine specifications

Reduction ratio: 1/10

Operation pattern



1. Check the specifications

Encoder resolution	67108864 [encpls/rev]
Position command unit of the controller	[× 0.00001 deg]
Maximum command speed	120 [deg/s] = 12000000 [× 0.00001 deg/s] = 7200 [deg/min]
Maximum output frequency of the controller	5 [Mpps]
Maximum input frequency of the servo amplifier	4 [Mpps] (For the differential line driver)

→ Because the maximum input frequency of the servo amplifier is lower than the output frequency, the pulse frequency must be set to 4 [Mpps] or lower.

2. Tentatively set the travel distance per command pulse and number of command pulses per revolution

For the travel distance per command pulse, tentatively set 0.00001 [deg/cmdpls] which is the position command unit of RD75D.

For the number of command pulses per table revolution, tentatively set 1000000 [cmdpls/rev].

3. Tentatively calculate the electronic gear

Point

For the rotary machines, read the formulas (A) and (B) as follows to prevent errors.

$$\text{Electronic gear on the controller side} = \frac{\text{Number of command pulses per motor revolution [cmdpls/rev]}}{\text{Machine rotation per motor revolution [Command unit/rev]}} \quad \text{... (A')}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{\text{Encoder resolution [encpls/rev]}}{\text{Number of command pulses per motor revolution [cmdpls/rev]}} \quad \text{... (B')}$$

The travel distance of the table per servo motor revolution is calculated as follows according to the machine specifications.

Motor 1 revolution × Reduction ratio = 360 [deg/rev] × 1/10 = 36 [deg/rev] = 3600000 [× 0.00001 deg/rev]

Therefore, the electronic gears are calculated using the formulas (A') and (B') as follows.

$$\text{Electronic gear on the controller side} = \frac{1000000\ [\text{cmdpls/rev}]}{3600000\ [\times\ 0.00001\ \text{deg/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{1000000\ [\text{cmdpls/rev}]}$$

4. Calculate the command pulse frequency

Because the maximum speed command value is 120 [deg/s], the command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 12000000\ [\times\ 0.00001\ \text{deg/s}] \times \frac{1000000\ [\text{cmdpls/rev}]}{3600000\ [\times\ 0.00001\ \text{deg/rev}]}$$

$$= 3333333.333\ \ldots\ [\text{cmdpls/s}] \approx 3.33\ [\text{Mpps}]$$

The result is smaller than 4 [Mpps], which is the maximum input frequency of the servo amplifier, indicating that the above setting values can be used.

5. Determine the electronic gear

$$\text{Electronic gear on the controller side} = \frac{1000000\ [\text{cmdpls/rev}]}{3600000\ [\times\ 0.00001\ \text{deg/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{67108864\ [\text{encpls/rev}]}{1000000\ [\text{cmdpls/rev}]}$$

Case 3-2. Rotary table (2)

System configuration

Controller: RD75D

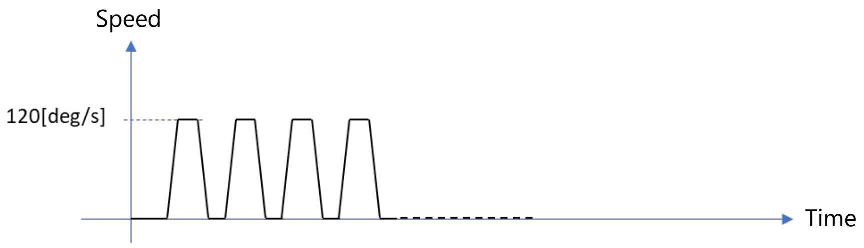
Servo amplifier: MR-J5-A

Servo motor: TM-RG2M004E30

Machine specifications

Reduction ratio: 1/1

Operation pattern



* The servo motor has been changed from the one used in Case 3-1. Rotary table (1) to the direct drive motor.

1. Check the specifications

Encoder resolution	4194304 [encpls/rev]
Position command unit of the controller	[× 0.00001 deg]
Maximum command speed	120 [deg/s] = 12000000 [× 0.00001 deg/s]
Maximum output frequency of the controller	5 [Mpps]
Maximum input frequency of the servo amplifier	4 [Mpps] (For the differential line driver)

→ Because the maximum input frequency of the servo amplifier is lower than the output frequency, the pulse frequency must be set to 4 [Mpps] or lower.

2. Tentatively set the travel distance per command pulse and number of command pulses per revolution

For the travel distance per command pulse, tentatively set 0.00001 [deg/cmdpls] which is the position command unit of RD75D.

For the number of command pulses per table revolution, tentatively set 1000000 [cmdpls/rev].

3. Tentatively calculate the electronic gear

The travel distance of the table per servo motor revolution is calculated as follows according to the machine specifications.

Motor 1 revolution × Reduction ratio = 360 [deg/rev] × 1/1 = 360 [deg/rev] = 36000000 [× 0.00001 deg/rev]

Therefore, the electronic gears are calculated using the formulas (A') and (B') as follows.

$$\text{Electronic gear on the controller side} = \frac{1000000\ [\text{cmdpls/rev}]}{36000000\ [\times\ 0.00001\ \text{deg/rev}]}$$

$$\text{Electronic gear on the servo amplifier} = \frac{4194304\ [\text{encpls/rev}]}{100000\ [\text{cmdpls/rev}]}$$

4. Calculate the command pulse frequency

Because the maximum speed command value is 120 [deg/s], the command pulse frequency is calculated as follows with the formula (C).

$$\text{Command pulse frequency [cmdpls/s]} = 12000000\ [\times 0.00001\ \text{deg/s}] \times \frac{1000000\ \text{[cmdpls/rev]}}{36000000\ [\times 0.00001\ \text{deg/rev}]}$$

$$= 333333.3333 \ldots\ \text{[cmdpls/s]} \approx 333.333$$

The result is smaller than 4 [Mpps], which is the maximum input frequency of the servo amplifier, indicating that the above setting values can be used.

5. Determine the electronic gear

$$\text{Electronic gear on the controller side} = \frac{1000000\ \text{[cmdpls/rev]}}{36000000\ [\times 0.00001\ \text{deg/rev}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{4194304\ \text{[encpls/rev]}}{1000000\ \text{[cmdpls/rev]}}$$

Case 4. Linear servo motor

System configuration

Controller: RD75D

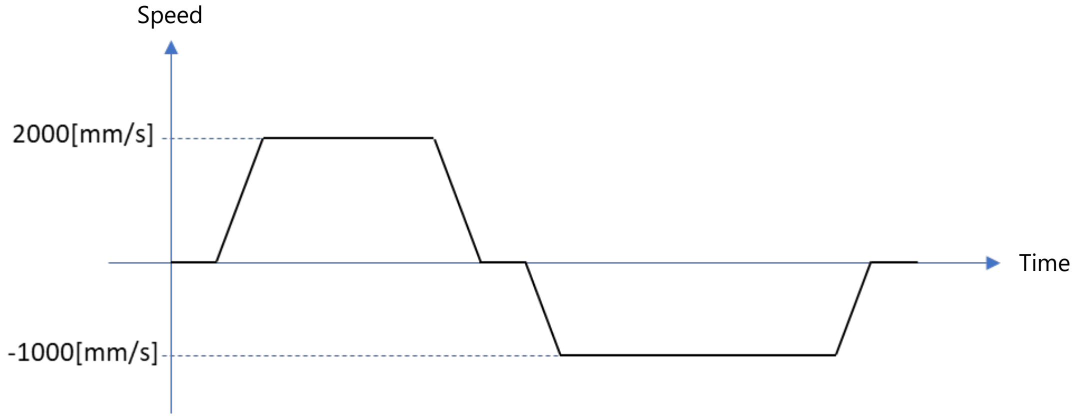
Servo amplifier: MR-J5-A

Servo motor: LM-H3 series

Machine specifications

Linear encoder resolution: 0.01 [μm]

Operation pattern



1. Check the specifications

Encoder resolution	0.01 [μm/encpls]
Position command unit of the controller	[× 0.1 μm]
Maximum command speed	2000 [mm/s] = 20000000 [× 0.1 μm/s] (= 120000 [mm/min])
Maximum output frequency of the controller	5 [Mpps]
Maximum input frequency of the servo amplifier	4 [Mpps] (For the differential line driver)

→ Because the maximum input frequency of the servo amplifier is lower than the output frequency, the pulse frequency must be set to 4 [Mpps] or lower.

2. Tentatively set the travel distance per command pulse and number of command pulses per revolution

For the linear servo motor, set only the travel distance per command pulse tentatively.

It is tentatively set to 0.1 [μm/cmdpls] which is the position command unit of RD75D here.

3. Tentatively calculate the electronic gear

For the linear servo motor, calculate the electronic gear with the following formula.

$$\text{Electronic gear on the controller side} = \frac{1}{\text{Travel distance per command pulse [Position command unit/cmdpls]}}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{\text{Travel distance per command pulse [}\mu\text{m/cmdpls]}}{\text{Linear encoder resolution [}\mu\text{m/encpls]}}$$

They are the same item in different units.

Given that the travel distance per pulse is 0.1 [μm/cmdpls] = 1 [× 0.1 μm/cmdpls],

$$\text{Electronic gear on the controller side} = \frac{1}{1\ [\times 0.1\ \mu\text{m/cmdpls}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{0.1\ [\mu\text{m/cmdpls}]}{0.01\ [\mu\text{m/encpls}]} = \frac{10\ [\mu\text{m/cmdpls}]}{1\ [\mu\text{m/encpls}]}$$

4. Calculate the command pulse frequency

Because the maximum speed command value is 2000 [mm/s] = 20000000 [× 0.1 μm/s],

$$\text{Command pulse frequency [cmdpls/s]} = 20000000\ [\times 0.1\ \mu\text{m/s}] \times \frac{1}{1\ [\times 0.1\ \mu\text{m/cmdpls}]}$$

$$= 20000000\ \text{[cmdpls/s]} = 20\ \text{[Mpps]}$$

The result is larger than the limit of 4 [Mpps], indicating that the above setting values cannot be used.

5. Set the travel distance per command pulse again

For the travel distance per command pulse, change the setting value to 1 [μm/cmdpls].

In this case,

$$\text{Electronic gear on the controller side} = \frac{1}{10\ [\times 0.1\ \mu\text{m/cmdpls}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{1\ [\mu\text{m/cmdpls}]}{0.01\ [\mu\text{m/encpls}]} = \frac{100\ [\mu\text{m/cmdpls}]}{1\ [\mu\text{m/encpls}]}$$

When the maximum speed command value is 2000 [mm/s], the command pulse frequency is calculated as follows.

$$\text{Command pulse frequency [cmdpls/s]} = 20000000\ [\times 0.1\ \mu\text{m/s}] \times \frac{1}{10\ [\times 0.1\ \mu\text{m/cmdpls}]}$$

$$= 2000000\ \text{[cmdpls/s]} = 2\ \text{[Mpps]}$$

The result is smaller than 4 [Mpps], which is the maximum input frequency of the servo amplifier, indicating that the above setting values can be used.

6. Determine the electronic gear

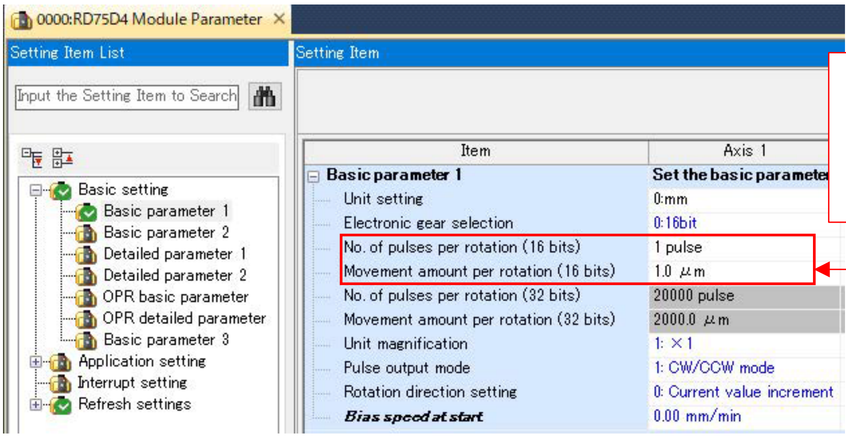
$$\text{Electronic gear on the controller side} = \frac{1}{10\ [\times 0.1\ \mu\text{m/cmdpls}]}$$

$$\text{Electronic gear on the servo amplifier side} = \frac{100\ [\mu\text{m/cmdpls}]}{1\ [\mu\text{m/encpls}]}$$

(Reference)

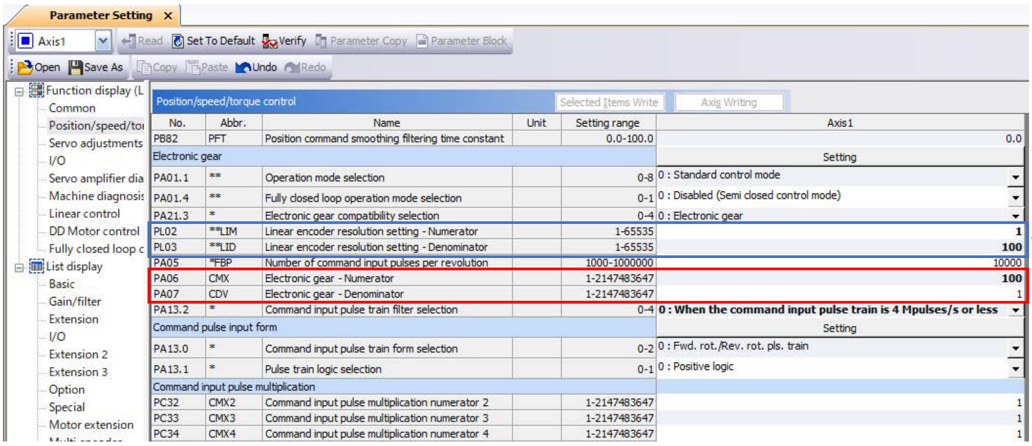
The setting windows of GX Works3 and MR Configurator2 are as follows.

<GX Works3>



10 in the example formula is displayed as 1.0 because it is set in [μm] units.

<MR Configurator2>



Point

For the linear servo motor, set the encoder resolution in [Pr.PL02/03] in [μm] units in addition to the electronic gear setting.

Revision

Version	Date	Description
-	October 2021	First edition