HIWIN® MIKROSYSTEM

E Series Servo Drive

Auto Focus Control Function User Manual

www.hiwinmikro.tw
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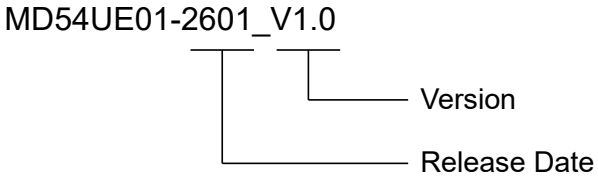
Revision History

The version of the manual is also indicated on the bottom of the front cover.



Release Date	Version	Applicable Product	Revision Contents
Jan. 9th, 2026	1.0	E2 series servo drive	First edition.

Related Documents

Through related documents, users can quickly understand the positioning of this manual and the correlation between manuals and products. Go to HIWIN MIKROSYSTEM's official website → Download → Manual Overview for details (https://www.hiwinmikro.tw/Downloads/ManualOverview_EN.htm).

Firmware Change History

Refer to “E2 Series Servo Drive User Manual” and “E2-R Series Servo Drive User Manual” for the information of servo drive firmware version.

- E2 series servo drive

Servo Drive Firmware Version	Revision Contents related to Auto Focus Control Function
3.14.8	Support auto focus control function.

- E2-R series servo drive

Servo Drive Firmware Version	Revision Contents related to Auto Focus Control Function
4.14.8	Support auto focus control function.

Preface

This manual describes the hardware configuration, setting procedure, parameters, and application functions related to E series auto focus control system. Auto focus control function inputs analog feedback signals from position sensors into the servo drive. For workpieces with varying heights, fixed interval applications can be achieved on the servo drive side.

Table of Contents

1. Servo drive specification

The models supporting auto focus control function are listed as follows:

- E1 series servo drive

  Auto focus control function is not supported.

- E2 series servo drive

Table 1.1

Type	Function	Model
Standard	AC	ED2S-V0-□□□-□-A-□□
	Advanced	ED2S-V0-□□□-□-C-□□
	GT	ED2S-V0-□□□-□-T-□□
Fieldbus	AC	ED2F-E0-□□□-□-A-□□
	Advanced	ED2F-E0-□□□-□-C-□□
	GT	ED2F-E0-□□□-□-T-□□

- E2-R series servo drive

Table 1.2

Type	Function	Model
Fieldbus	Rich	ED2F-E0-□□□-□-R-□□

Note:

For Fieldbus servo drives, only EtherCAT models support auto focus control function.

2. System architecture

2.1 Control mode

Table 2.1.1

Standard servo drive	Support internal position mode
Fieldbus servo drive	Support position mode and internal position mode

2.2 Control block diagram description

For the control block diagram before entering auto focus control system, refer to “E2 Series Servo Drive User Manual” and “E2-R Series Servo Drive User Manual.” For the control block diagram after entering auto focus control system, it is shown in Figure 2.2.1. Refer to chapter 3 for the relevant setting procedure, and refer to chapter 5 for troubleshooting for alarms.

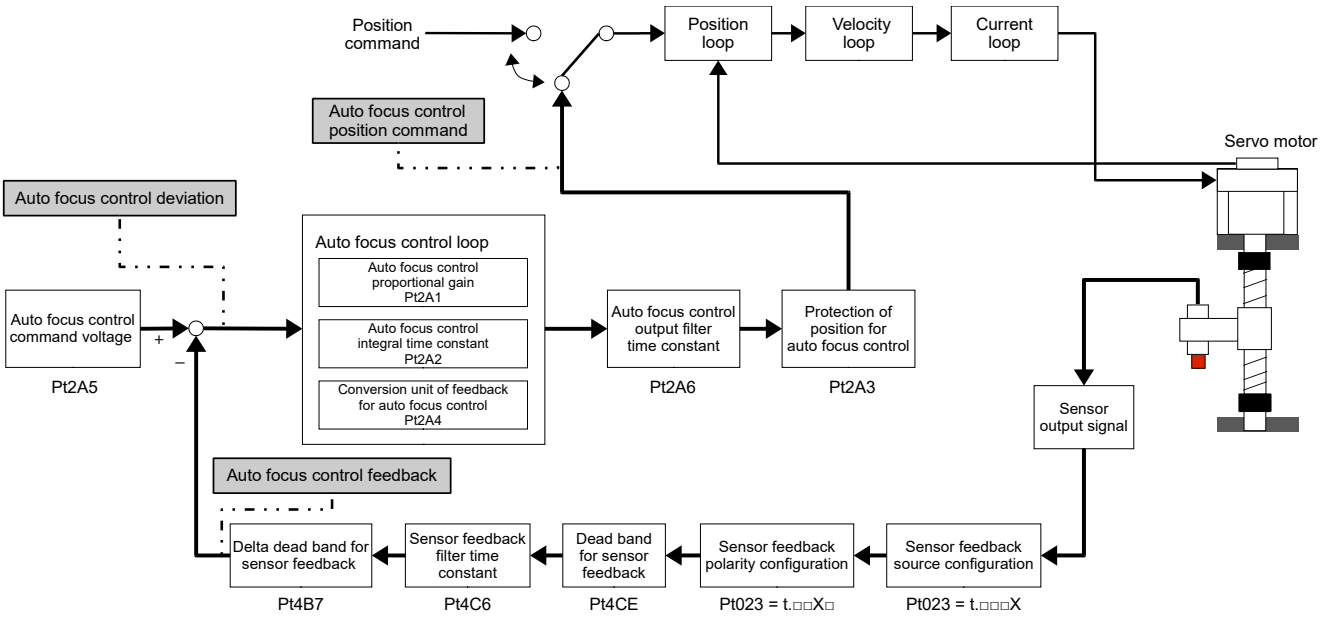


Figure 2.2.1 Control block diagram for auto focus control system

Table 2.2.1 Physical quantities that can be monitored

Physical Quantity
(38) Auto focus control feedback
(39) Auto focus control deviation
(40) Auto focus control position command

3. Setting procedure

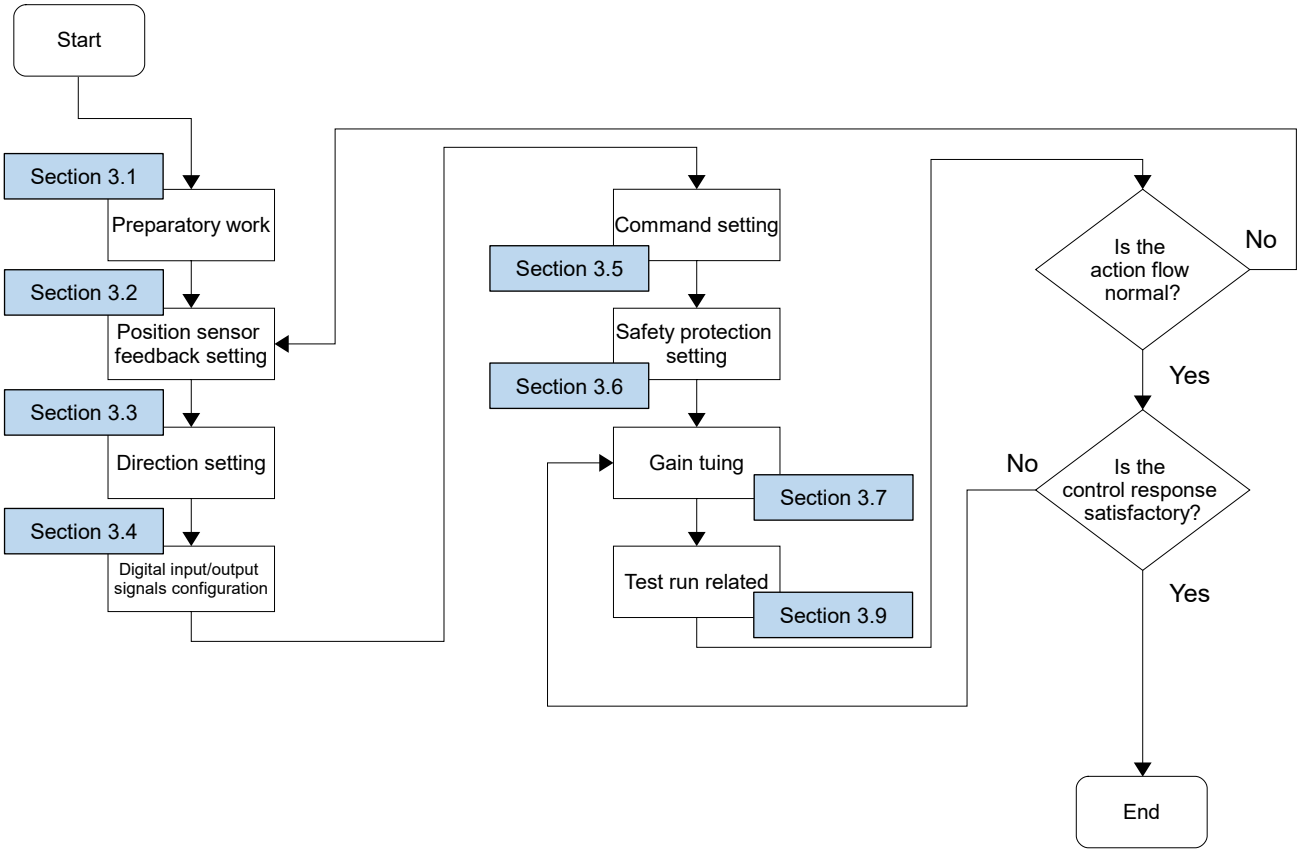


Figure 3.1 Overview of setting procedure

Refer to Figure 3.1 and the corresponding sections for the setting procedure and the description of auto focus control function. Before setting, ensure that the servo drive model supports auto focus control function. Refer to the servo drive specification in chapter 1.

3.1 Preparatory work

Before using auto focus control function, complete the following preparatory work.

■ **Complete electronic gear ratio setting**

Auto focus control function is used on linear platforms with the mechanical structure of ball screw or linear motor. Refer to section 4.3.6.3 **Electronic gear ratio setting** in "E Series Servo Drive Thunder Software Operation Manual" to complete the setting in "Electronic gear ratio setting" window  in Thunder's Configuration Wizard, as shown in Figure 3.1.1.

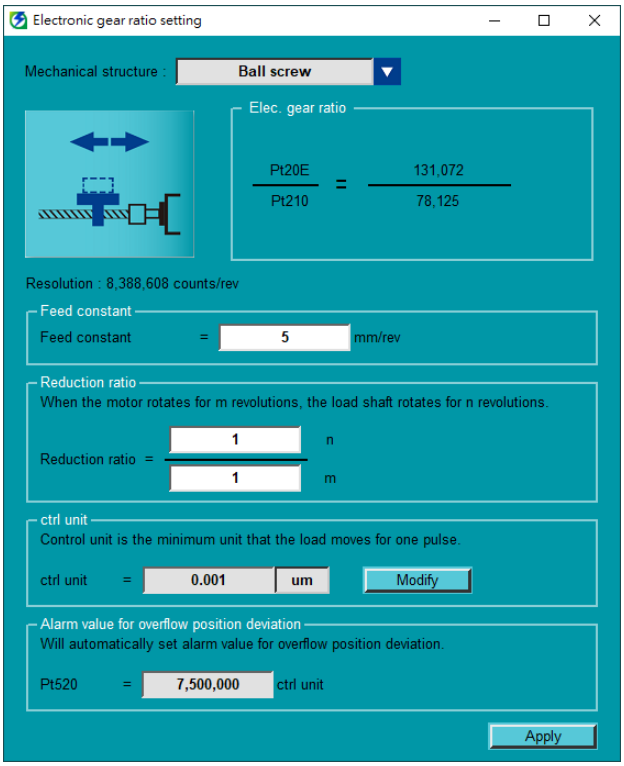


Figure 3.1.1 "Electronic gear ratio setting" window

Note
- When using rotary motor with ball screw, the feed constant must be set; otherwise, abnormal unit conversion may occur.

■ **Complete gain tuning**

Refer to chapter 10 **Tuning** in "E2 Series Servo Drive User Manual" and "E2-R Series Servo Drive User Manual."

■ Configuration of position sensor feedback

The servo drive's auto focus control function uses the channel of either the velocity command input signal (V-REF) or the torque command input signal (T-REF) as the source for position sensor feedback. Only one channel can be selected and connected.

For CN6 pin assignment of V-REF or T-REF, refer to "E2 Series Servo Drive User Manual" and "E2-R Series Servo Drive User Manual" for wiring. Set the sensor feedback source Pt023 = t.□□□X based on the actual wiring (refer to section 3.2).

After completing the connection and setting, use Scope in Thunder to observe physical quantity 38 - Auto focus control feedback to ensure that the position sensor is providing normal feedback.

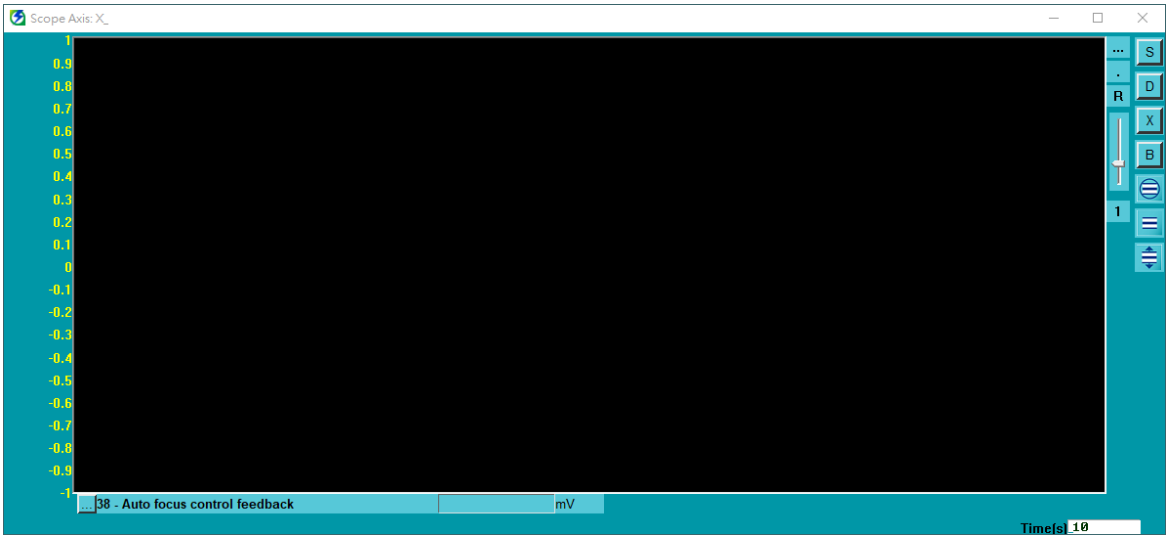


Figure 3.1.2

3.2 Position sensor feedback setting

■ Configuration of auto focus control sensor feedback source

The servo drive's auto focus control function uses the channel of either the velocity command input signal (V-REF) or the torque command input signal (T-REF) as the source for position sensor feedback. Set Pt023 = t.□□□X based on the actual wiring to enable auto focus control function.

Parameter		Description	Effective	Category
Pt023	t.□□□0 (Default)	Disable sensor feedback control function.	After power on	Setup
	t.□□□3	Enable auto focus control function and use V-REF signal as the position sensor feedback source.		
	t.□□□4	Enable auto focus control function and use T-REF signal as the position sensor feedback source.		

Parameter		Description	Effective	Category
Pt023	t.□□0□ (Default)	The analog input signal is not inverted.	After power on	Setup
	t.□□1□	V-REF signal is inverted.		
	t.□□2□	T-REF signal is inverted.		
	t.□□3□	Both V-REF signal and T-REF signal are inverted.		

⚠CAUTION

◆ When Pt023 = t.□□□3 is set to use velocity command input signal (V-REF) as the auto focus sensor feedback source, the following functions will be disabled:

1. Velocity command filter time constant (Pt307)
2. Average velocity feedforward movement time (Pt30C)
3. Velocity command input gain (Pt300)
4. Functions related to V-REF allocation (Pt207 = t.□□X□, Pt002 = t.□□X□)

◆ When Pt023 = t.□□□4 is set to use torque command input signal (T-REF) as the auto focus sensor feedback source, the following functions will be disabled:

1. T-REF filter time constant (Pt415)
2. Average torque feedforward movement time (Pt426)
3. Torque command input gain (Pt400)
4. Functions related to T-REF allocation (Pt002 = t.□□□X)

■ Conversion unit of position feedback

Set the conversion ratio between the voltage signal (V) output by the position sensor and the actual physical unit (um). Fill it in based on the position sensor specification.

Parameter	Pt2A4	Range	0~1000000	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 um/V
Description					
Conversion unit of feedback for auto focus control					

■ Sensor feedback filter time constant

In auto focus control system, the output voltage of position sensor feedback is typically an analog signal, susceptible to noise, vibration, and high-frequency interference. To ensure the accuracy of analog signal status, sensor feedback filter time constant Pt4C6 is provided to smooth the signal and enhance auto focus control stability. A larger value of Pt4C6 indicates a smoother feedback signal; however, an excessive setting may reduce feedback response.

Parameter	Pt4C6	Range	0~65535	Control Mode	Position mode
Default	100	Effective	Immediately	Unit	0.01 ms
Description					
Sensor feedback filter time constant					

■ Sensor feedback offset adjustment

If the sensor amplifier lacks offset correction, select **Analog offset** from **Tools** in Thunder main window. Click **Set zero** button in “Analog offset” window to automatically adjust the offset.

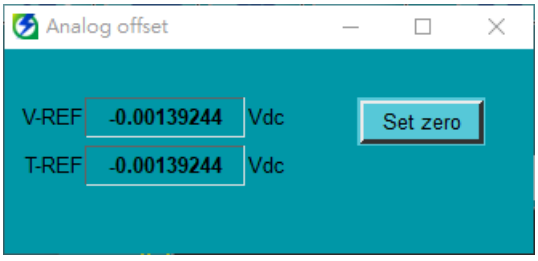


Figure 3.2.1 Offset adjustment tool in Thunder

Note:

Remember to save the automatically adjusted offset to servo drive (Save RAM to Flash).

■ Dead band for sensor feedback

After performing automatic offset adjustment, the analog voltage may still fluctuate slightly. Dead band for sensor feedback can be set to ignore analog feedback signals within this range.

Parameter	Pt4CE	Range	0~65535	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 mV
Description					
Dead band for sensor feedback					

■ Delta dead band for sensor feedback

In auto focus control system, the output voltage of position sensor feedback is typically an analog signal, susceptible to noise, vibration, and high-frequency interference. To ensure the accuracy of analog signal status, delta dead band for sensor feedback Pt4B7 is provided to ignore the change within the range and enhance auto focus control stability.

Parameter	Pt4B7	Range	0~5000	Control Mode	Position mode
Default	0	Effective	Immediately	Unit	1 mV
Description					
Delta dead band for sensor feedback					

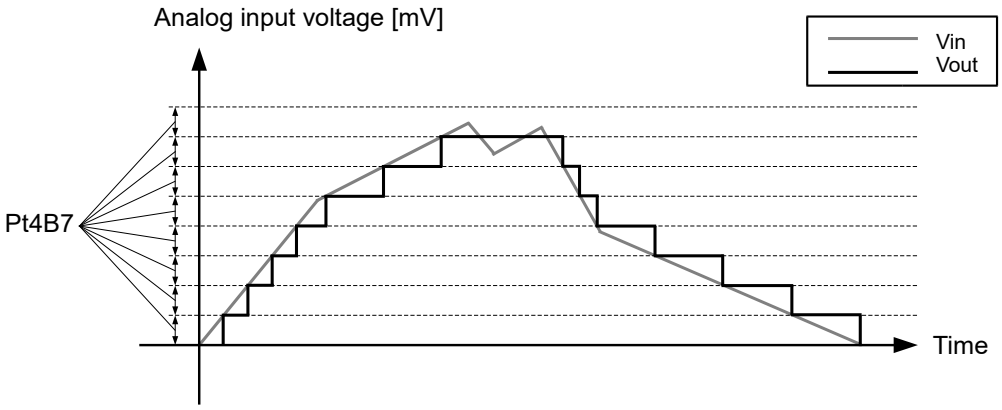


Figure 3.2.2

3.3 Auto focus control direction setting

Follow the steps below to confirm and set the direction:

1. Ensure that the motor and the load mechanism operate safely, and that the position sensor is properly installed.
2. Use the test run function in Thunder to make the motor perform point-to-point (P2P) movement within the position sensor's detection range.
   Note: Ensure that no obstacles obstruct the position sensor during the movement.
3. Use Scope in Thunder to monitor the feedback of encoder and sensor (observe physical quantities: 2 - Feedback position, 38 - Auto focus control feedback). When both accumulate in the same direction, set Pt2A0 to t.□□□0; conversely, set Pt2A0 to t.□□□1.

Parameter		Description	Effective	Category
Pt2A0	t.□□□0 (Default)	The sensor voltage is same as the encoder direction.	After power on	Setup
	t.□□□1	The sensor voltage is opposite to the encoder direction.		

3.4 Digital input/output signals configuration

Auto focus control function can be activated and monitored via the configuration of digital input/output signals.

Digital input signal configuration:

- Auto focus control function enable input (AF-ENABLE) signal

  To activate auto focus control function via an external trigger signal, set parameter Pt540 = t.□□X□ to assign AF-ENABLE signal to the desired pin. For the settings of digital input signal allocation, please refer to section 8.1.1 **Digital input signal allocation** in “E2 Series Servo Drive User Manual” and “E2-R Series Servo Drive User Manual.”

Type	Signal Name	Hardware Pin	Signal Status	Description
Input	AF-ENABLE	User-defined	Rising edge trigger	Activate auto focus control.
			Falling edge trigger	Deactivate auto focus control.

Digital output signal configuration:

- Auto focus control ready output (AF-RDY) signal

  When the servo drive enters auto focus control, digital output signal “AF-RDY” will be output. Set parameter Pt518 = t.X□□□ to assign AF-RDY signal to the desired pin. For the settings of digital output signal allocation, please refer to section 8.1.2 **Digital output signal allocation** in “E2 Series Servo Drive User Manual” and “E2-R Series Servo Drive User Manual.”

Type	Signal Name	Hardware Pin	Signal Status	Description
Output	AF-RDY	User-defined	ON	Auto focus control is ready.
			OFF	Auto focus control is off.

3.5 Auto focus control command setting

■ Auto focus control command voltage

In auto focus control system, users must set auto focus control command voltage as the target command of auto focus control based on the analog voltage value output by the sensor corresponding to the target auto focus interval. The value of Pt2A5 can be calculated with the following formula.

$$\text{Pt2A5} = \frac{\text{Target auto focus interval [um]}}{\text{Position feedback conversion unit [um/V]}} \times 1000$$

Calculation example		
Motor type	Target interval (mm)	Position feedback conversion unit (Pt2A4)
All	12000	4000
Calculation result		
$\text{Pt2A5} = \frac{12000}{4000} \times 1000 = 3000$		

Parameter	Pt2A5	Range	-32768~32767	Control Mode	Position mode
Default	10000	Effective	Immediately	Unit	1 mV
Description					
Auto focus control command voltage					

3.6 Auto focus control safety protection setting

■ Auto focus control travel distance protection function

This prevents unexpected situations during auto focus control that could cause abnormal motor movement, such as continuous movement in the same direction leading to workpiece damage. Calculate the appropriate protection threshold with the following formula based on the maximum movement range of auto focus control during actual operation.

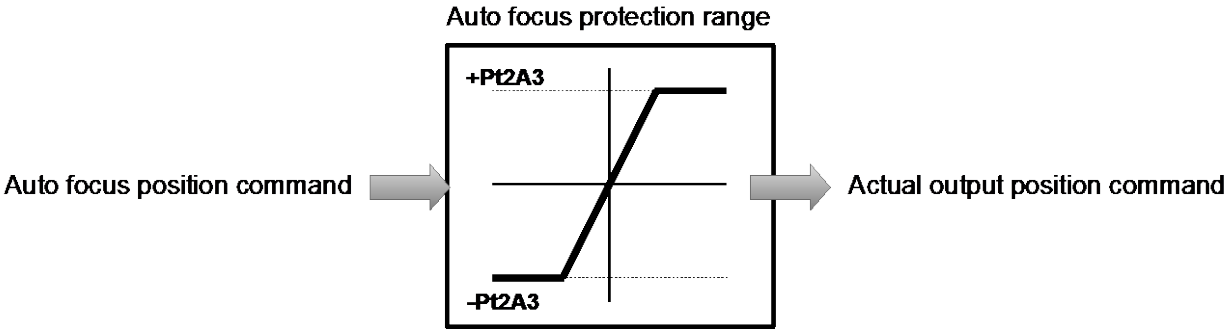


Figure 3.6.1

$$\text{Pt2A3} \geq \frac{\text{Maximum movement range [mm]}}{\text{Control unit [um]}} \times 1000 \times \text{Safety coefficient (Suggested: 1.2}\sim\text{2)}$$

Calculation example			
Motor type	Control unit (um)	Maximum movement range (mm)	Safety coefficient
All	0.1	100	1.2
Calculation result			
$\text{Pt2A3} \geq \frac{100}{0.1} \times 1000 \times 1.2 = 1200000$			

Parameter	Pt2A3	Range	0~2147483647	Control Mode	Position mode
Default	10000	Effective	Immediately	Unit	1 control unit
Description					
Protection of position for auto focus control					

Note
- When using rotary motor with ball screw, the electronic gear ratio and the feed constant must be set; otherwise, travel distance protection function may be invalid.

- Alarm value for overflow auto focus control deviation

  During auto focus control, the servo drive continuously compares the difference between auto focus control command voltage and auto focus control feedback to ensure the safety of auto focus control. If the deviation exceeds the setting value of Pt2A7, auto focus control alarm AL.d40 will occur. It is recommended to set a reasonable safety margin larger than the maximum auto focus control deviation during auto focus control.

Parameter	Pt2A7	Range	0~10000	Control Mode	Position mode
Default	3000	Effective	Immediately	Unit	1 mV
Description					
Alarm value for overflow auto focus control deviation					

3.7 Auto focus control gain tuning

The flow chart for auto focus control gain tuning is as follows.

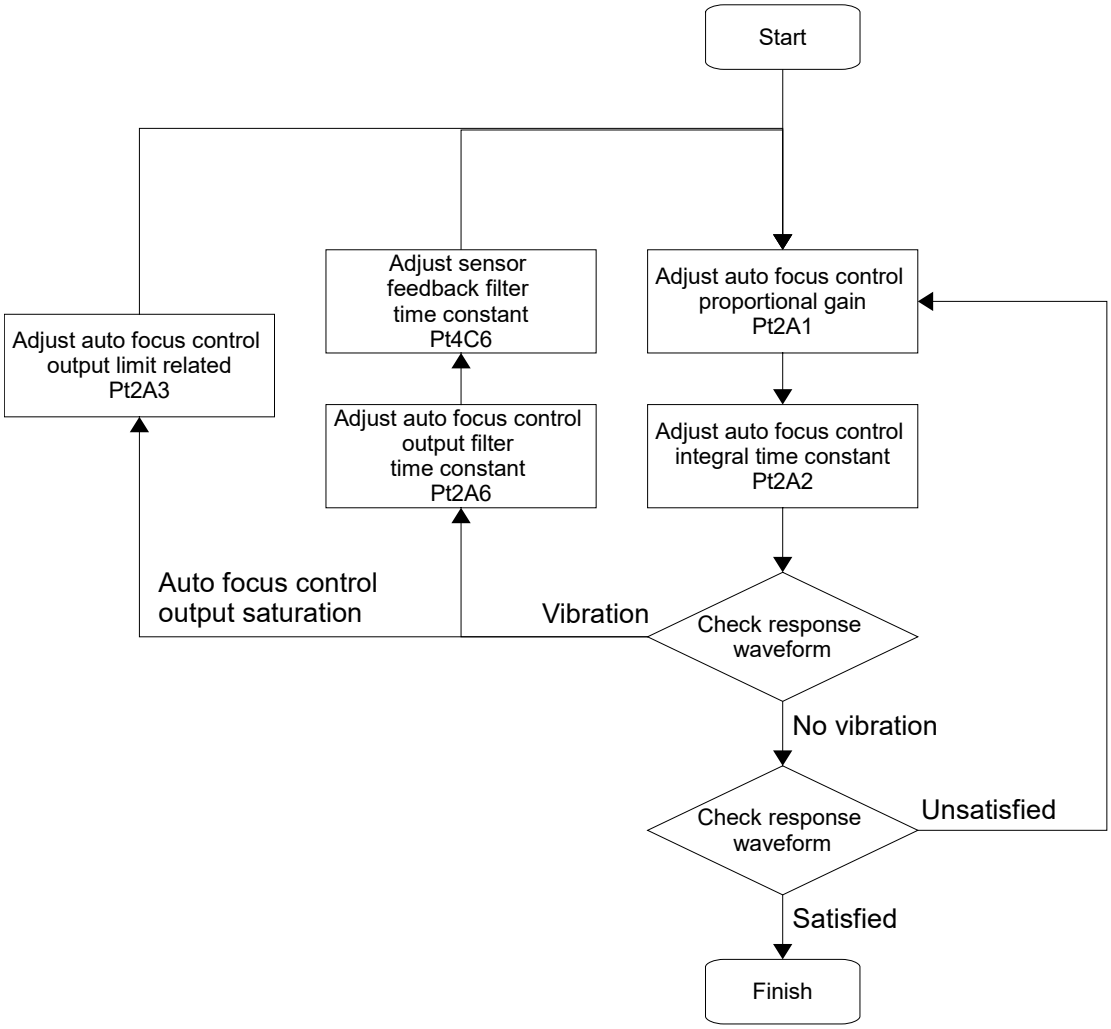


Figure 3.7.1 Flow chart for auto focus control gain tuning

- Auto focus control proportional gain

  Auto focus control proportional gain is used to adjust the responsiveness of auto focus control. A larger value results in a faster response, but an excessive setting may cause position overshoot or oscillation.

Parameter	Pt2A1	Range	0~1000	Control Mode	Position mode
Default	80	Effective	Immediately	Unit	1 %
Description					
Auto focus control proportional gain					

- Auto focus control integral time constant

  Auto focus control integral time constant is used to eliminate steady-state errors in auto focus control. A smaller value results in a faster integral response but may cause system oscillation or instability.

Parameter	Pt2A2	Range	15~100000	Control Mode	Position mode
Default	100000	Effective	Immediately	Unit	0.01 ms
Description					
Auto focus control integral time constant					

- Auto focus control output filter time constant

  If vibration occurs during auto focus control, adjusting Pt2A6 may eliminate the vibration. A larger value indicates a smoother output command; however, an excessive setting may reduce output command response.

Parameter	Pt2A6	Range	0~65535	Control Mode	Position mode
Default	100	Effective	Immediately	Unit	0.01 ms
Description					
Auto focus control output filter time constant					

3.8 Auto focus control monitoring function

■ Status monitoring for auto focus control with Fieldbus EtherCAT communication
The object dictionary list and description are as follows.

Table 3.8.1

<table>
<tr><th>Index</th><th>Sub-Index</th><th>Name</th><th>Data type</th><th>Access</th><th>PDO</th><th>Op Mode</th><th>Valid value</th><th>Unit</th></tr>
<tr><td rowspan="2">3072h</td><td rowspan="2">00h</td><td>Auto focus control status</td><td>U16</td><td>ro</td><td>-</td><td>pp
csp</td><td>0 ~ 32767</td><td>-</td></tr>
<tr><td colspan="7">Status of auto focus control
<table><tr><th>Value</th><th>Definition</th></tr><tr><td>0x0000</td><td>Auto focus control function is not enabled.</td></tr><tr><td>0x0001</td><td>Auto focus control function is initialized.</td></tr><tr><td>0x0003</td><td>Auto focus control function is enabled.</td></tr></table></td></tr>
<tr><td rowspan="2">3073h</td><td rowspan="2">00h</td><td>Auto focus control error</td><td>U16</td><td>ro</td><td>-</td><td>pp
csp</td><td>0 ~ 0xFFFF</td><td>-</td></tr>
<tr><td colspan="7">Error status of auto focus control. The status corresponding to each bit is described as follows.
(Causes of auto focus control alarm. Refer to Table 5.1.1.)
<table><tr><th>Bit</th><th>Definition</th></tr><tr><td>0</td><td>Position of auto focus control exceeds the protection threshold of Pt2A3.</td></tr><tr><td>1</td><td>Deviation of auto focus control exceeds the protection threshold of Pt2A7.</td></tr><tr><td>2</td><td>Overtravel (any overtravel signal is detected during auto focus control).</td></tr><tr><td>3~15</td><td>Reserved</td></tr></table></td></tr>
<tr><td rowspan="2">3074h</td><td rowspan="2">00h</td><td>Enable auto focus control function</td><td>U16</td><td>rw</td><td>-</td><td>pp
csp</td><td>0 ~ 1</td><td>-</td></tr>
<tr><td colspan="7">Enable auto focus control function.
0: Disable auto focus control function
1: Enable auto focus control function</td></tr>
<tr><td rowspan="2">3075h</td><td rowspan="2">00h</td><td>Auto focus control feedback</td><td>F32</td><td>ro</td><td>-</td><td>pp
csp</td><td>-3.40282e+38 ~ 3.40282e+38</td><td>mV</td></tr>
<tr><td colspan="7">Feedback of auto focus control</td></tr>
<tr><td rowspan="2">3076h</td><td rowspan="2">00h</td><td>Auto focus control deviation</td><td>F32</td><td>ro</td><td>-</td><td>pp
csp</td><td>-3.40282e+38 ~ 3.40282e+38</td><td>mV</td></tr>
<tr><td colspan="7">Deviation of auto focus control</td></tr>
<tr><td rowspan="2">3077h</td><td rowspan="2">00h</td><td>Auto focus control position command</td><td>I32</td><td>ro</td><td>-</td><td>pp
csp</td><td>-2147483648 ~ 2147483647</td><td>inc</td></tr>
<tr><td colspan="7">Position command of auto focus control</td></tr>
</table>

- Status monitoring for auto focus control with Thunder

  Physical quantities and servo signal statuses are as follows.

Table 3.8.2

Physical Quantity
(38) Auto focus control feedback
(39) Auto focus control deviation
(40) Auto focus control position command

Table 3.8.3

Servo Signal Status
(102) Auto focus control function enable input signal (AF-ENABLE)
(103) Auto focus control ready output signal (AF-RDY)

3.9 Test run

After completing the auto focus control parameter settings, users can check the performance of auto focus control via Test Run page. Follow the steps below to perform test run of auto focus control:

1. Before performing test run, complete the parameters setup related to auto focus control in section 3.1 ~ 3.7.
2. Open “Test Run” window, click **Enable**, and ensure that the light of Drive ready is on.
3. Move the motor to the position of target interval. (At the same time, observe physical quantity 39-**Auto focus control deviation** approaching 0.)
4. Set Auto focus control function enable input (AF-ENABLE) signal to ON.
5. Ensure that the light of **Auto focus control ready** is on to enter auto focus control mode.

Note:

Two conditions must be met for **Auto focus control ready**:

(1) Drive servo ready (2) Auto focus control function enabled

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4. The ways to operate auto focus control

This chapter describes the procedure examples for using auto focus control with E series servo drive.

4.1 Operate auto focus control with EtherCAT communication

1. Complete the setting procedure in chapter 3 and ensure that test run can be operated normally.
2. Use the host controller to move the motor to the position of target interval in cyclic synchronous position mode (csp). (Observe physical quantity 39-**Auto focus control deviation** approaching 0.)
3. Set object 3074h (Enable auto focus control function) to 1 to enable auto focus control function.
4. Monitor the status by reading object 3072h and ensure that the status is **Auto focus control ready**.
5. To disable auto focus control function, update the target position of the axis on the controller. Align the target position 607Ah (Target position) with the actual position 6064h (Position actual value) and set object 3074h (Enable auto focus control function) to 0.

Note:

Two conditions must be met for **Auto focus control ready**:

(1) Drive servo ready (2) Auto focus control function enabled

5. Troubleshooting

5.1 Relevant alarms

When auto focus control alarm AL.d40 occurs, check the cause of the alarm and the corrective actions via auto focus control function interface in Thunder or by reading the object 3072h. The description of the corresponding bits for object 3072h is shown in the table below.

Table 5.1.1

bit	Alarm Name	Cause	Corrective Action
0	Auto focus control position command overflow	Position of auto focus control exceeds the protection threshold of Pt2A3.	(1) Check if the position sensor feedback signal is normal. (2) The auto focus control gain is not properly tuned. Refer to the description in section 3.7 Auto focus control gain tuning. (3) Check if the protection of position for auto focus control (Pt2A3) is appropriate.
1	Auto focus control deviation overflow	Deviation of auto focus control exceeds the protection threshold of Pt2A7.	(1) Check if the position sensor feedback signal is normal. (2) The auto focus control gain is not properly tuned. Refer to the description in section 3.7 Auto focus control gain tuning. (3) Check if the alarm value for overflow auto focus control deviation (Pt2A7) is appropriate.
2	Overtravel warning triggered in auto focus control	Overtravel (any overtravel signal is detected during auto focus control)	Check if the travel distance of motor exceeds the travel distance of mechanism in auto focus control.

Note:

When Auto focus control position command overflow occurs, the alarm AL.d40 will not be triggered.