# Oasis Focuser Clutch Electronic Focuser

### **User Manual**

Version 2.2

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We dedicate to providing high quality products and services for amateurs of astronomical observation and photograph

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## **1. Product Introduction**

#### 1.1. Features

Oasis Focuser is an electronic focuser with clutch mechanism, designed for astronomical observation and photography amateurs. In the past, we have found that the telescope's focusing knob can no longer be used when an electronic focuser is attached to the telescope by means of a coupling. This is an inconvenience for users. For example, when the user wants to focus quickly or to retract the telescope focuser. Then we came up with the idea of designing a better focus controller.

The main goal of the product design is to achieve the clutch function, and also to add the Bluetooth function, and to improve the size and appearance of the electronic focuser. Finally we achieved these goals on it after lots of validation, testing and optimization works. It also has some other excellent features. The features of this product are described as follows:

- Clutch function Easy and fast switching between motor and manual focusing.
- Bluetooth function Mobile devices such as mobile phones can be used to control the focuser via Bluetooth
- Small size Round appearance with small size
- High precision Micron precision for each motor step
- Ability to drive heavy load Testing indicates that it can driver net loads more than 5Kg
- Excellent backlash compensation performance Gears and rigid components provide excellent backlash compensation performance
- Easy to install Easy to install or uninstall focuser body. Only one screw needs to be used to install or uninstall focuser body. And it can be installed on many telescope focusers.
- High integrated Except for the ambient temperature probe, all functions and components (including motor, controller board etc.) are implemented and integrated in the single compact focuser body.

In addition, this product has the following features:

- 1. Support USB HID device interface. Device driver installation is not required for Windows, Linux and macOS operation systems.
- 2、 Support ASCOM interface
- 3、Support INDI
- 4、Support INDIGO
- 5. Has two temperature sensors, one monitors board temperature, the other monitors ambient temperature
- 6、 Has beep generator for tips or alarms

Since August 2024, we public and began to deliver the second generation of Oasis Focuser - Oasis

Focuser Rose. Compared to the first generation Oasis Focuser, the Oasis Focuser Rose has the following improvements:

- 1. **Convenient power supply** It can be powered by either the USB Type-C port or the 12V DC port.
- 2. **Stall detection** Motor stall detection feature prevents the telescope focuser and the gears from being damaged in case the telescope focuser moves out of the minimum or maximum range or in other cases that are not expected.
- Built-in heating module The built-in heating module allows the focuser to work in low ambient temperature conditions for North China, Europe, North America users when capturing in winters. The heating module can be controlled at a constant temperature when heating so it's easy to use.
- 4. Gear locator The gear locator helps user to install the gear in the right place.
- 5. **Improved reliability** Motor is upgraded to improve reliability. PCB is re-designed to improve reliability of power module, USB/DC/Temperature sockets etc.
- 6. **Better connection method** The connection method of the fixed-part and the rotatable part is improved. The connection of the fixed-part and the rotatable part is more stable.
- 7、 More compact dimensions Compared to the first generation, the second generation Oasis focuser body has a 14.5mm reduction in the length and a 4mm reduction in the diameter of the rotatable part.

### 1.2. Specifications

	First Generation	Second Generation (Rose)
USB port	Туре В	Туре С
Power supply	DC 12V	USB 5V or DC 12V
Bluetooth	Supported Supported	
On-board temperature	Supported	Supported
Ambient temperature	Supported	Supported
Steps per motor revolution	14400 steps	14400 steps
Stall detection	Not supported	Supported
Built-in heating	Not Supported	Supported, up to 50°C
Main assembly dimension	77mm x Φ40mm	62 5mm x Φ36mm
Main assembly weight	170g	137g
Working temperature range	-10°C ~ 50°C	-30°C ~ 50°C
Power consumption	~62mA, 12V (Idle) ~280mA, 12V (Motor running)	See Table 1-2
Maximum load capacity	5Kg	5Kg

#### Table 1-1 Specification of Oasis Focuser

	USB Power Supply (5V)	DC Power Supply (12V)	
Idle	~190mA	~62mA	
Motor running	~390mA	~260mA	
Heating on maximum allowed power	~510mA	~530mA	
Motor running and	~740mA	~720mA	
Heating on maximum allowed power	- 740IIIA	~730MA	

Table 1-2 Power consumption of Oasis Focuser Rose

## 2. Packing list

### 2.1. Oasis Focuser first generation packing list

The components included in Oasis Focuser first generation suit are shown as Figure 2-1.



Figure 2-1 Packing List

Descriptions of each component are shown below.

Name	Description
	The main component of this product, which integrates the motor, the
Main Assembly	control board and other functional modules. It also includes a small
	gear.
	Tightening the clamp to connect Oasis focuser main assembly and
0.Lowe	telescope focuser. The number on the clamp indicates the inner
	diameter of the clamp. Depending on the model of telescopes, the
	clamp in the focuser suits may be different.
Clamp Connection Screw	Used to connect clamp and focuser main assembly.
Clamp Tightening Screw	Used to tightening clamp onto telescope housing
	Installed on telescope focuser shaft. Depending on the model of the
Gears	telescopes, the gear in the focuser suits may be different.
Gear Setscrew	Used to install gear onto the shaft of telescope focuser.
Clutch Locking Screw	Tightening this screw when Oasis focuser is in engagement state.
Hex Keys	Three hex keys for screw and setscrew tightening and loosen.
Temperature Probe	It can be connected to the temperature probe socket of the body to

	monitor ambient temperature.
USB 2.0 Cable	2-meter long USB 2.0 cable for data communication between Oasis
	focuser and computers.

### 2.2. Oasis Focuser Rose packing list

The components included in Oasis Focuser Rose (second generation) suit are shown as Figure 2-2.



#### Figure 2-2 Packing List

Descriptions of each component are shown below.

Name	Description
	The main component of this product, which integrates the motor, the
Main Assembly	control board, heating module and other functional modules. It also
	includes a small gear.
	Tightening the clamp to connect Oasis focuser main assembly and
01	telescope focuser. The number on the clamp indicates the inner
o i amp	diameter of the clamp. Depending on the model of telescopes, the
	clamp in the focuser suits may be different.
Gear Locator	Used to help user install the gear in the right position.
M3 Clamp Screw	Used to connect clamp and focuser main assembly.
M4 Clamp Screw	Used to tightening clamp onto telescope housing.
0	Installed on telescope focuser shaft. Depending on the model of the
Gear	telescopes, the gear in the focuser suits may be different.
Gear Setscrew	Used to install gear onto the shaft of telescope focuser.
Clutch Locking Screw	Tightening this screw when Oasis focuser is in engagement state.
Hex Keys	Three hex keys for screw and setscrew tightening and loosen.
Temperature Probe	It can be connected to the temperature probe socket of the body to
	monitor ambient temperature.



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USB Type A-C Cable	USB Type A-C cable for data communication between Oasis focuser
	and computers. It can also be used for power supply.

Oasis focuser uses two gears instead of a coupling to driver telescope focuser. The two gears have different sizes and teeth numbers. The bigger gear is installed on telescope focuser small shaft, and the smaller gear is installed on the shaft of the Oasis focuser motor. The two gears can be meshed or not meshed by rotate Oasis focuser body. When gears are not meshed, the knob on the other side of telescope focuser can be used to do manually focus.



Figure 3-1 Meshed



Oasis focuser uses a bolt to indicate engaged (ON) and disengaged (OFF) states. It is important to note that when engaging the bolt indicator does not need to be rotated to the right edge of the sliding groove completely, but only needs to be sure that the two gears have been meshed. There will still be a small gap between the bolt indicator and right edge of the sliding groove, which is designed so.



Figure 3-3 Figure 3-4 The position of the bolt in the sliding groove indicates the engaged or disengaged state.

## 4. Hardware installation

To install Oasis Focuser onto telescopes, please refer to the following document: *Oasis\_Focuser\_Installation\_Reference\_Manual\_EN.pdf* 

This document can be downloaded at the following address:

https://www.astroasis.com/download/files/focuser/Oasis\_Focuser\_Installation\_Reference\_Manual\_EN.pdf

## 5. Software installation and usage

### 5.1. Ports

Oasis focuser first generation body has three ports on the rear cover. They are 12V power input, USB Type-B data communication port and the ambient temperature probe port, as shown in Figure 5-1.



Figure 5-1

Oasis focuser Rose (second generation) body has three ports on the rear cover. They are 12V power input, USB Type-C data communication port and the ambient temperature probe port, as shown in Figure 5-2.



Figure 5-2

### 5.2. ASCOM driver installation

Oasis focuser can be connected to a PC via a USB cable and is implemented as an HID device, which is automatically recognized on a Windows, Linux or macOS PC without the need to install device driver.

In order to use Oasis focuser in applications that support ASCOM, please download and install the ASCOM driver for it.

Please follow the steps below to download and install the ASCOM driver and test the focuser:

- 1. Download Oasis focuser ASCOM driver at <u>https://www.astroasis.com/en/download</u> and install the driver after download completes.
- 2. For Oasis Focuser first generation, connect 12V power supply to the focuser and connect it to Windows PC using USB Type-B cable; for Oasis Focuser Rose, the 12V power supply is not necessary and you can just connect the focuser to Windows PC using USB Type-C cable. When the focuser is powered on you can hear two beep sounds which indicates the focuser has started successfully.
- 3. Switch Oasis focuser to "ON", i.e., the engaged state. In this state, the two gears are meshed together so that the telescope focuser can be driven when the motor is running.
- 4. Open an astronomical application software that supports ASCOM interface, such as Sharpcap, Sequence Generator Pro, NINA etc.
- 5、Take Sequence Generator Pro as an example. After ASCOM driver is successfully installed, there will be "Oasis Focuser" item in the ASCOM focuser drop-down selection list. Select "Oasis Focuser" and then click "Setup" button, the setup dialog will appear as shown in figure 5-3.

Enter the number of steps in the IN/OUT input box and click on IN or OUT, then with a beep you will see the telescope being driven and the fine-tuning knob on the other side will move.

Oasis Focuser Setup - Version 2.0.0.1.s2.0.0.f2.0.1         ×						
33.01°C (Board) 2	26.81°C (Ambie	nt)			$\wedge$ $\sim$	
OasisFocuserRos	e		~		ASCOM ASTROASIS	
Friendly name:				Set		
Bluetooth name:	OasisFocuse	rRose		Set		
Heating:	25 🔹 °C	🗌 Tu	n on	Set		
Current position:	40000	Set Z	ero			
Target position:	1 🔹	Go	То	Sync		
	In	In				
	100 🗘	1000	* *	Stop		
	Out	Οι	ıt			
	Fine tuning	Coarse	tuning			
Enable stall determine the stall determine	on Maxin	capacity: osition:	500mA 80000		Apply	
Beep on power	up Backl	ash dir:	IN	~	Eactory Reset	
🛃 Beep on move	Backl	ash:	0	-	Tacioly Reset	
Enable Bluetoot	h Motor	speed:	1x	$\sim$	ОК	
Link board Tem	p. to ambient T	emp.	Trace	on	Cancel	

#### Figure 5-3

You can also perform other operations in this setup dialog.

#### 5.3. Stall detection

Oasis Focuser Rose has stall detection feature. This feature prevents the telescope focuser and the gears from being damaged in case the telescope focuser moves out of the minimum or maximum range or in other cases that are not expected.

The stall detection feature can be enabled or disabled through the "Enable stall detection" checkbox in the Oasis Focuser ASCOM driver setup dialog, as shown in Figure 5-4.

When the stall detection feature is enabled and the focuser detects that the motor is stalled, the motor will be stopped from driving immediately and the focuser will enter the protection state. The alarm information and the "Clear stall" button will be displayed in the ASCOM Setup dialog, as shown in Figure 5-5. When motor stall is detected and the focuser enters the protection state, you need to manually click the "Clear stall" button to exit the protection state, otherwise you will not be able to continue the electronic focusing.

If you encounter incorrect stall detection that prevents you from focusing properly, try disable the stall detection feature.

🔏 Oasis Focuser Setup - Version 2.0.0.1.s2.0.0.f2.0.1 🛛 🗙							×	
33.01°C (Board) 2	26.81°C (A	mbient)					$\mathcal{A}$	18
OasisFocuserRos	e			~		4	scom <mark>A</mark>	stroasis
Friendly name:					Set			
Bluetooth name:	OasisFo	cuserR	ose		Set			
Heating:	25 🛟	°C	🗌 Tur	n on	Set			
Current position:	40000		Set Z	ero				
Target position:	1	<b>▲</b> ▼	Gol	Го	Sync	:		
	In		In					
	100	•	1000	-	Stop			
	Out		Ou	t				
	Fine tunir	ng C	oarse	tuning				
🔄 Enable stall dete	ection L	ISB cap	acity:	500mA	~			
Reverse directio	n N	lax posi	ition:	80000	÷		App	bly
Beep on power u	up E	acklasi	n dir:	IN	~		Factory	Reset
Beep on move	E	acklasi	n:	0	-		O	<
<ul> <li>Enable Bluetooti</li> <li>Link board Temp</li> </ul>	n N b. to ambie	ent Tem	eed: p.	1x	on		Can	cel

Figure 5-4

Oasis Focuser Setup - Version 2.0.0.1.s2.0.0.f2.0.1         ×							
34.61°C (Board) 25.	44°C (Ambient)		$\land$ $\checkmark$				
OasisFocuserRose		~	ASCOM ASTROASIS				
Friendly name:		Se	t				
Bluetooth name: C	DasisFocuser	Se	t				
Heating: 2	25 🚔 °C 🗌 Tui	rn on Se	t				
Current position: 4	0000 Set Z	'ero					
Target position: 1	Go	To Syr					
	in in		Stall detected!				
1	00 🚖 80000	) 🖨 🛛 Sto	p Clear Stall				
	Out Ou	ıt					
F	ine tuning Coarse	tuning					
	-	-					
Enable stall detect	tion USB capacity:	500mA 🗸					
Reverse direction	Max position:	80000 🖨	Apply				
Beep on power up	Backlash dir:	IN ~	Factory Reset				
Beep on move	Backlash:	0 -	ОК				
Enable Bluetooth	Motor speed:	1x V	Cancel				
Link board Temp. 1	to ambient Temp.	Irace on	Cancer				

Figure 5-5

### 6. Notes for installation and use

Here are some notes for installation.

1. As there is only limited space around the telescope focuser knob, it is recommended that the clamp be installed at a particular angle as shown in Figure 6-1, otherwise the clamp may touch the telescope focuser shell and the installation may not be stable.



Figure 6-1

- 2. When switching from disengaged mode to engaged mode, sometimes the gears may not be meshed perfectly although the gears seem already meshed. This can lead to bigger backlash.In this case, there are two methods to correct the engagement.
  - The first method is to turn the knob at the other side of the focuser slightly by one hand, while turning the Oasis focuser too by another hand, so that the two gears will have chance to mesh perfectly. Please refer to the clip from the following video starting at 5:12. https://youtu.be/KLGeKOnrQnY
  - 2) The second method is to use the move command in the ASCOM setup dialog or in software that supports ASCOM to make the motor (and the gear on motor shaft) move a few steps and then turn the Oasis focuser to engage again. The above operations may be performed repeatedly until the gears are meshed perfectly.

Measuring backlash can be used to check if gears have been meshed perfectly after Oasis focuser is switched from disengaged mode to engaged mode. For the way of backlash measurement, please refer to <u>Backlash measurement</u>.

3. If the focuser is engaged and the focuser needs to be in the engaged state for a long time, please use the red thumb screw to lock the focuser in engaged state. The installation position of the red thumb screw is shown in Figure 6-2.



Figure 6-2

### 7. Position and steps measurement

Oasis focuser uses a motor that has a large reduction ratio. To implement the clutch function, it uses two gears to driver telescope focuser. The gears have different number of teeth which also increases the reduction ratio. Large reduction ratio generates large drive force so Oasis focuser can drive large loads. At the same time, large reduction ratio makes very small focuser movement for each motor step. This helps to improve the focusing accuracy. Oasis focuser can achieve micron level accuracy on most telescope focusers.

In order to understand the relationship between the focuser movement and motor steps, we have made some measurements. Users can also do this on their own equipment. Although this is not necessary, this is useful for you to understand how your equipment work and how to let them work better.

We performed measurement using an Oasis focuser with a SkyRover 102 APO Pro. The steps are as follows:

- 1、 Switch Oasis focuser into disengaged mode
- Turn the focusing knob to move the telescope focuser to the position 10mm scale. In the Oasis focuser ASCOM setup dialog set the current position to zero steps.
- 3、 Switch Oasis focuser into engaged mode
- 4. Click on the "OUT" button in the ASCOM setup dialog and move the telescope focuser to 90mm scale.
- 5、 Record the current position (steps) of Oasis focuser in ASCOM setup dialog.

Based on our measurement we found that it took 87900 steps to move telescope focuser from position 10mm to position 80mm. After simple calculation we can know that it takes about 125 steps per 0.1mm movement.

In the same way we measured the relationship between Sharpstar 107PH focuser movement and the number of motor steps. We found it takes about 159 steps per 0.1mm movement.

### 8. Backlash measurement

Many applications have backlash compensation feature when using electronic focusers. When backlash compensation feature is enabled, the backlash is "transparent" to the user and the user does not have to consider the backlash when moving telescope focuser from direction in to direction out or vice versa. He only needs to send a move command to the focuser with the number of steps that he actually wants the focuser to move.

Usually, before using the backlash compensation feature in an application the user needs to set a backlash value which is measured in steps. The application allows this value to be not exactly the same as the actual backlash value (this may depend on particular backlash compensation mode), but can be larger than the actual backlash. Of course, if the value is set too large it may also affect focusing accuracy.

When using backlash compensation feature in an application, if the backlash compensation value set is smaller than the actual backlash, it will lead to insufficient compensation and bad focusing result. If a value much larger than the actual backlash is set, then too many movement steps may also cause cumulative errors, which also affects the focusing result. It is therefore necessary to measure the actual backlash for your equipments.

The same electronic focusers with different telescope focuser may have different backlash. Therefore, knowing the backlash value of your equipment can help to select proper backlash compensation value in applications and achieve the desired focusing result when backlash compensation feature is enabled.

The backlash value of the electronic focuser and your equipment can be obtained by means of a measurement. This can be done as follows:

- 1、 Open the Oasis focuser setup dialog in an application that supports ASCOM interface
- 2. As Oasis focuser firmware itself has backlash compensation feature too, you need to disable this feature first before measuring backlash. To disable backlash compensation feature in firmware, enter 0 in the *Backlash* field of the setup dialog, as shown in Figure 8-1.

Oasis Focuser Setup - Version 2.0.0.1.s2.0.0.f2.0.1		×
33.01°C (Board) 26.81°C (Ambient)		$\wedge$ 💋
OasisFocuserRose ~		ASCOM ASTROASIS
Friendly name:	Set	
Bluetooth name: OasisFocuserRose	Set	
Heating: 25 🔹 °C 🗌 Turn on	Set	
Current position: 40000 Set Zero		
Target position: 1 🚖 Go To	Sync	
In In		
100 🚖 1000 🜩	Stop	
Out Out		
Fine tuning Coarse tuning		
Enable stall detection USB capacity: 500mA		
Reverse direction Max position: 80000		Apply
Beep on power up Backlash dir: IN		Factory Reset
Beep on move Backlash: 0	-	ОК
Link board Temp. to ambient Temp.	e on	Cancel

Figure 8-1

- 3. Click the IN (or OUT) button to move the focuser in a certain direction to ensure that there is a noticeable rotation of the fine-tuning knob.
- 4. Enter a small number of steps (i.e., the estimated backlash value) in the IN/OUT input box. For e.g., set the number of steps to 100. Then click the OUT (or IN) button to move focuser in the opposite direction.
- 5、 Determine the backlash value:
  - If the fine-tuning knob does not rotate after moving the focuser in the opposite direction in step 4, we can know the backlash is greater than the value entered in step 4. Repeat steps 3 and 4 until you can observe that the fine-tuning knob starts to rotate after moving the focuser in the opposite direction. Then the backlash is approximately equal to the last value entered in step 4.
  - If the fine-tuning knob rotates after moving the focuser in the opposite direction in step 4, we can know the backlash is less than or approximately equal to the value entered in step 4. Then you can decrease the value entered in step 4 and repeat steps 3 and 4.

The backlash measured on SkyRover 102 APO Pro and on Sharpstar 107PH are around 200 steps. Based on the results of <u>Position and steps measurement</u>, we can know the backlash value on SkyRover Backlash does not need to be measured precisely, because the value entered for **Overshoot** backlash compensation can be a few larger than the actual backlash value. For examples if the measured backlash is approximately 300 steps, then the value entered for backlash compensation can be between 500 and 600.

When moving in the opposite direction, if the number of steps is less than the backlash, the electronic focuser cannot drive the telescope focuser, i.e., the fine-tuning knob will not rotation. This is the idea of above measurement method. However, this does not take into account the backlash of the telescope focuser itself (Most telescope focusers do not have large backlash). If you want to measure the overall backlash of your equipment, one of the good ways is to use an application that supports automatic focusing based on star FWHM calculations.

Measuring backlash by looking at the knob can also be used to quickly determine if the gears are meshed properly. If the backlash is significantly higher than expected, please try to rotate the Oasis focuser body again to mesh the gears properly.

### 9. Auto-focusing

Let's take NINA as an example to explain how to use Oasis Focuser for auto-focusing. Other software works in a similar way. Since the purpose of this chapter is only to explain how to use NINA for auto-focusing, the basic usage of NINA will not be described in detail here. Please refer to the relevant user manual for the detailed usage of NINA.

### 9.1. Auto-focusing in NINA

- 1. Complete the preliminary preparations, such as connecting the camera and Oasis Focuser, turning on the mount to track stars, etc.
- 2、Enter "Options->Equipment->Focuser" Autofocus page, as shown in Figure 9-1.

Autofocus				
Use filter offsets	OFF	Autofocus step size	125	
Autofocus initial offset steps	4	Default autofocus exposure time	<b>3</b> s	
Autofocus method	Star HFR 🔹	Disable guiding during AF	ON	
Curve fitting strategy	Hyperbolic 🗸	Focuser settle time	<b>1</b> s	
Number of attempts	1	Number of exposures per point	1	
Use brightest n stars	0	Inner crop ratio	1	
Outer crop ratio	1	Backlash compensation method	Overshoot	•
Binning	1	Backlash IN/OUT	0	600
R <sup>2</sup> threshold	0.9			



The explanations of some parameters are as follows:

Autofocus step size: Motor steps between two points.

Autofocus initial offset steps: This is typically good at the default value of 4 for Star HFR.

Autofocus method: Select "Star HFR" for Deep-Sky-Object astrophotography.

Curve fitting strategy: Select "Hyperbolic" or other curve fitting strategy as needed.

**Backlash compensation method:** Select "Overshoot". "Backlash compensation Method" can only be changed when the focuser is disconnected.

**Backlash IN/OUT:** When "Overshot" is selected, in "Backlash IN/OUT" only one direction needs to be filled. A value that is slightly larger than the backlash value measured by the method described in the <u>Backlash measurement</u> can be filled. The other one should be 0.

3、Enter "Imaging" Tab, click "AF" button at the right corner, then we can see "Autofocus" Tab, as shown in Figure 9-2。If the camera and the Oasis Focuser are already connected, click "Start autofocus".



Figure 9-2

The curve after focusing completed is shown as in Figure 9-3.





If the backlash compensation value is set too small, the backlash will be prominent on the right side from the starting position and will show as a horizontal line in the curve, which causes auto-focus to fail. If this happens, increase the backlash compensation value and re-run the autofocus until the horizontal line disappears and the focus curve looks like a hyperbolic.

This method can be used to measure the actual backlash of the device. Set the backlash compensation value to 0 and perform autofocus. The length corresponding to the horizontal line is the actual backlash value of the device. Figure 9-4 shows the focus curve with the backlash compensation value set to 0. We can see that the actual backlash is about 400 steps.



Figure 9-4

#### 9.2. Notes about auto-focusing

The key factors that affect the success of autofocus are: autofocus exposure time, autofocus step size, autofocus initial offset steps, the initial position, and the backlash compensation setting.

**Autofocus exposure time:** The exposure time affects the signal-to-noise ratio of the star, as well as the shape of the star. When shooting with a color camera or with a monochrome camera with the LRGB wide band, the typical exposure time can be set to a few seconds. If you shoot with SHO in a narrow band, you can increase the exposure time. If the exposure time is too long and the star shape is not good, it may affect the star HFR value calculation and cause focusing failure. The choice of specific exposure time can be tested according to your own equipment.

**Autofocus step size:** If the value is too large, there will be no enough good HFR data to fit the curve. If the value is too small, the HFR changes little and the curve will look like "W", affecting the curve fitting or not be able to move near to the actual focus position.

**Autofocus initial offset steps:** A too little value can result in not being able to fitting the curve well. A too big value will result in waste of time, or it may be too far away from the focus position and fail to calculate the star HFR value.

Initial position: The initial position needs to be close to the actual focus position.

**Backlash compensation:** As mentioned above, setting the backlash compensation too small can cause the focus curve to appear horizontal line and fail to find focus position.