



AstroLink 4 Pi

astrojolo.com @2021

WARNING!

Do not connect or disconnect stepper motor when power is on. It may damage stepper motor controller.

Make sure the stepper hold torque is set to 0% before replacing stepper motor with motor of different type.

Do not cover ventilation slits at the enclosure sides and back.



Main features:

- Raspberry Pi* 4 based astroimaging control center
- dedicated *AstroLink 4 Pi* INDI driver
- focuser motor control for *Robofocus*, *Moonlite*, or generic unipolar or bipolar stepper motor
- up to 1/32 micro-stepping control with 2.0A maximum current and 1.4A maximum continuous hold current
- DS1820 temperature sensor input
- permanent focuser position – no need to park focuser after the session
- 2 adjustable PWM power outputs to control dew heaters, telescope fans, or custom Peltier coolers. The maximum load is 40W per output
- 2 switchable power outputs to power mount, cameras, or filter wheels. The maximum load is 5A per output
- 1 additional permanent power output
- 1 additional adjustable 3-10V output
- XT60 high current input voltage socket

Technical data

- dimensions: 137x83x32mm
- weight: 215g
- the maximum current drawn from all outputs: 10A
- AstroLink power consumption: 6W max
- regulated PWM outputs: 40W max
- permanent 12V DC output: 5A max
- switchable 12V DC outputs: 5A max
- focuser stepper motor outputs: RJ12 6 pin, 2.0A max
- adjustable output: 2A maximum peak load, 1.5A continuous load
- sensor inputs: Jack 3.5mm

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Device overview

System and hardware requirements

AstroLink 4 Pi requires a Raspberry Pi* 4 module to be installed. Module with 4GB of RAM is recommended. *AstroLink 4 Pi* has been designed to work under the control of the dedicated *AstroLink 4 Pi* INDI driver, which is available at <https://github.com/astrojolo/astrolink4pi>. Astroberry system is recommended, however any working Linux distribution that supports INDI drivers system will work. Good quality 32GB card is recommended (Class 10 at least). Most of the Raspberry Pi* problems come from a poor quality power supply or SD card.

PWM outputs

AstroLink 4 Pi has two RCA outputs that provide PWM (pulse width modulation) regulated voltage. Regulations cover the full 0-100% range. These outputs are usually used for powering dew cap heaters. Output can be regulated using both controls in the dedicated INDI driver panel and 3rd party software that supports the *INDI* interface. PWM cycle period can be set in the INDI driver options in the range 50-1000ms. Default output value at the connection moment can be defined.

Switchable 12V DC outputs

The device contains two switchable DC outputs, that may provide a supply voltage for imaging setup components (camera, mount, etc). Output can be switched using both controls in the dedicated INDI driver panel and 3rd party software that supports the *INDI* interface. Default output value at the connection moment can be defined.

Focusing motors control

The focusing motor can be controlled with *AstroLink 4 Pi* device. The focusing stepper motor can be connected to the 6 pins RJ12 socket (see Figure 5). It supports 12V unipolar motors with gearboxes and bipolar motors at any microstepping resolution in a range of full step to 1/32. The focusing motor can be controlled with a dedicated INDI driver panel and via *INDI* interfaces. Depending on the *AstroLink 4 Pi* revision, the stepper motor current is adjusted with a potentiometer, or in the INDI control panel. Setting holding power is also possible. For unipolar geared motors it is highly recommended to set holding power to zero, so the motor will not overheat. Setting 1/8 or 1/16 resolution for the unipolar motor is recommended, so the motor movement is smooth.

Permanent 12V DC output

This output is connected directly to the input 12V XT60 socket. Can be used to provide power to a mini PC or any other device powered with 12V.

Adjustable DC output

Internal switching converter provides regulated voltage in a 3-10V range that can be used to power any peripheral devices (DSLR, USB hub, etc.) Voltage can be adjusted with a 2mm flat screwdriver using a small potentiometer.

Sensors

AstroLink 4 Pi can be equipped with a DS1820 temperature sensor to monitor external conditions. The temperature reading is available in the dedicated INDI driver panel and can be used to perform temperature compensation of the focuser position.

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External view



Figure 1 - external views

- | | |
|--------------------------------|-----------------------------------|
| 1. LAN port | 6. Regulated RCA outputs |
| 2. USB3.0 ports | 7. 12V DC output (non-switchable) |
| 3. USB2.0 ports | 8. Switchable 12V outputs |
| 4. XT60 power input (12V DC) | 9. Temperature sensor input |
| 5. Regulated DC output (3-10V) | 10. Focusing motor output |



Hardware setup

Raspberry Pi* installation



Figure 2 - enclosure screws

Installing the Raspberry Pi* module requires opening the *AstroLink 4 Pi* enclosure. You need to unscrew four out of eight screws at the device's sides. Please remove only bottom screws. Then remove enclosure top. After that, you need to unplug the cooling fan.

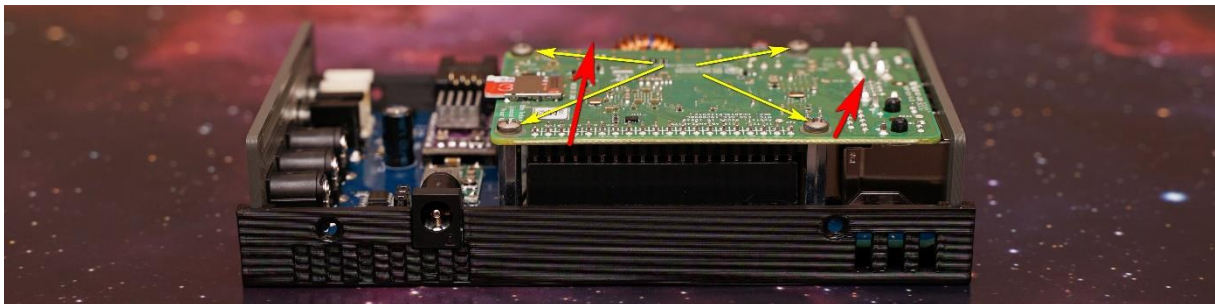


Figure 3 - Raspberry Pi module fixing screws

Then remove four screws that fix the Raspberry Pi* module and place the module in the device. Watch the proper position of the GPIO socket. Put the Raspberry Pi* sockets into the holes in the front device panel and push the pins down to the GPIO socket. Then fix the Raspberry Pi* module with four screws, connect the fan (refer to Figure 4 for the fan polarity), and mount the top part of the enclosure. The last step is to put back four screws at the device's sides.

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Setting focusing motor current

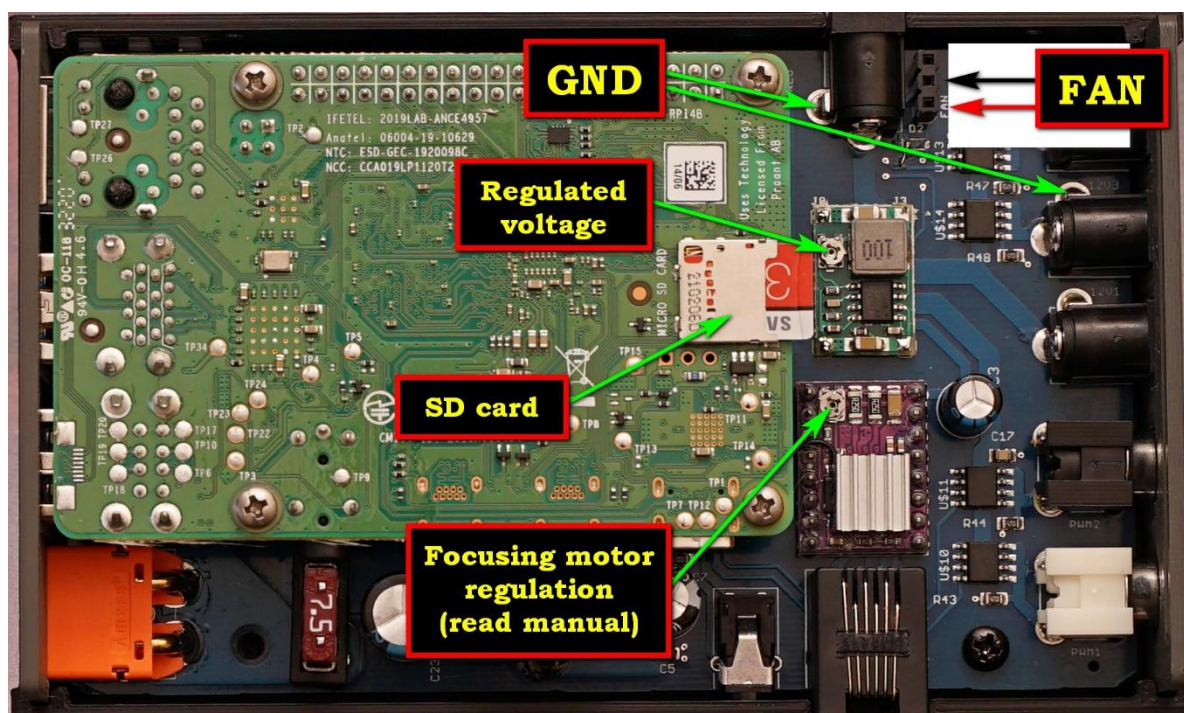


Figure 4 - AstroLink 4 Pi interior

If you can see the current regulation option in the **Options** tab of the **AstroLink 4 Pi** INDI driver, do not adjust the current using the potentiometer. It should be left at the factory default 0.4A, that is 0.2V.

Depending on the *AstroLink 4 Pi* revision you may adjust the focusing motor current at the INDI driver options panel or use the potentiometer. If you cannot see the current adjustment option in the INDI driver panel, then the stepper motor current is regulated with a small potentiometer at the stepper motor controller (see Figure 4). To check the current, you need to measure the voltage between the adjustment potentiometer wiper and the GND point. Required steps:

1. Unscrew and take off the enclosure top. Disconnect fan
2. Power the AstroLink 4 Pi device
3. Do not login to the *astroberry* panel and do not connect the INDI driver
4. Measure the voltage
5. Use a 2mm flat screwdriver to adjust the voltage

The motor current can be calculated from the measured voltage with the following formula:

$$\text{current} = \text{voltage} * 2$$

For example, if the measured voltage is 0.6V, then the output current is set to 1.2A. Please refer to the stepper motor datasheet to set the correct current. The maximum allowed current is 2.0A, but then the holding current should not be set to 100%. The recommended maximum continuous current value is 1.4A.



The default factory value is 0.4A – ready to use by unipolar *Robofocus*, *Moonlite*, or *AstroLink* motors, and safe for most of the bipolar stepper motors.

The stepper motor socket pinout is presented in Figure 5.



Figure 5 - AstroLink 4 Pi focusing motor output

Required connections are listed in the table below.

pin	unipolar	bipolar
1	COMMON	NOT CONNECTED
2	COMMON	NOT CONNECTED
3	COIL A	COIL A
4	COIL A'	COIL A'
5	COIL B	COIL B
6	COIL B'	COIL B'

Setting the regulated output voltage

The voltage at the regulated output can be adjusted using a small potentiometer at the DC converter module (see Figure 4). To access this potentiometer you need to take off the enclosure top (see Figure 2) and then use a 2mm flat screwdriver to adjust the voltage. The regulated output voltage can be set in the range of 3 to 10V. Use a multimeter connected to the regulated voltage output to control the actual voltage value.

Disconnect any device from the regulated voltage output before you start the voltage adjustment operation!



Software installation

System setup

The recommended software is the *Astroberry* system that can be downloaded at the site <https://www.astroberry.io/>. *Astroberry* installation procedure is described there in detail. After the first run, you need to update WiFi settings and connect to the home wireless network and update the system. Do not remove the default astroberry WiFi hotspot, that is used as a failover if it cannot connect to any other configured networks.

After that step, two more actions are required. Open *Raspberry Pi Configuration* and in the *Interfaces* tab enable *1-Wire* – this is required to read data from the temperature sensor. Then in the *Performance* tab enable the *Fan* section, and select GPIO pin to 13. Then adjust the temperature when the internal fan starts to work. The recommended setting is 60-70C – to be on the safe side. When the CPU reaches that temperature the cooling fan will be switched on.

All these actions above are not required when you purchase *AstroLink 4 Pi* device with the preconfigured system.

INDI driver installation

AstroLink 4 Pi INDI driver is available at the <https://github.com/astrojolo/astrolink4pi> page. Required installation steps are listed in the README file.

Driver installation is not required when you purchase *AstroLink 4 Pi* device with the preconfigured system.

INDI driver configuration

The configuration below will be presented for Kstars/EKOS system.

The first step is to create a new hardware profile. Click plus icon next to the profile selector and fill it with all the equipment you have. As one of the *Aux* devices select *AstroLink 4 Pi*. Then click *Save*.

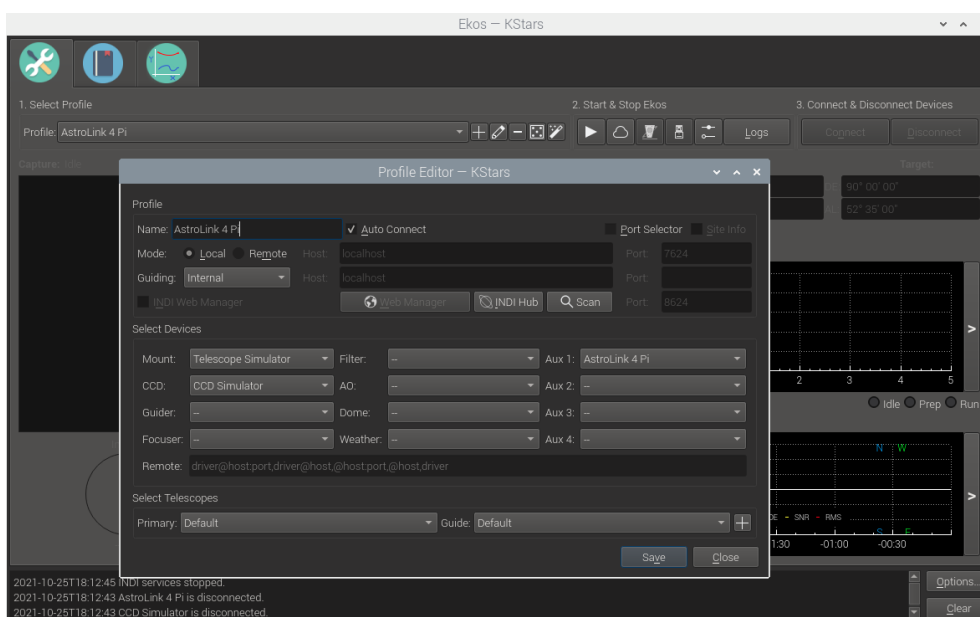


Figure 6- EKOS profile editor



After that, you should be able to start the EKOS with the play button, and *INDI Control Panel* should be opened. If you close *INDI Control Panel* by mistake, it can be always opened with the button with the INDI logo.

AstroLink 4 Pi control panel contains several tabs.

Main Control

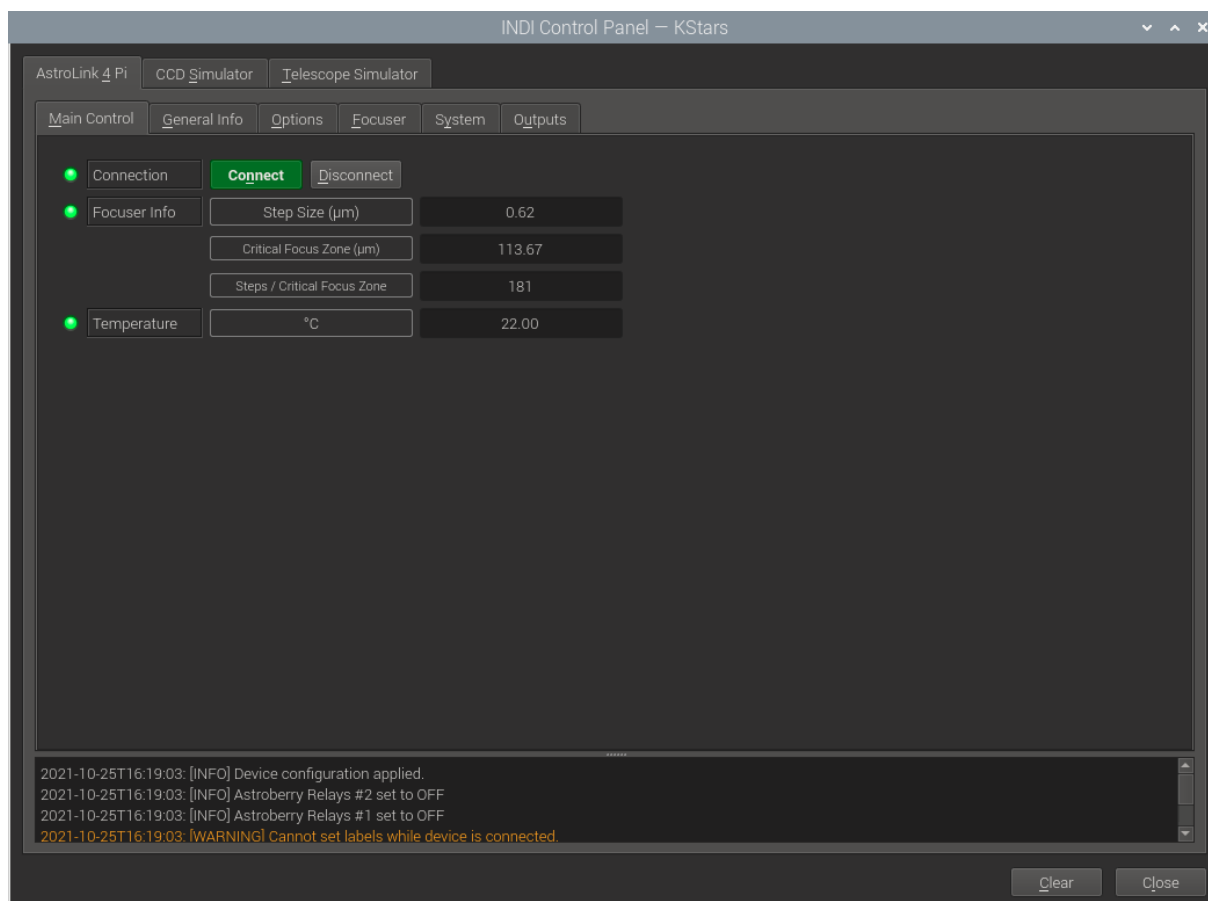


Figure 7 - Main Control

Here you can *Connect* or *Disconnect* from the *AstroLink 4 Pi* device using standard buttons.

Focuser info section contains information about step size and critical focus zone. These values are calculated from focuser configuration data and *Telescope* device data (aperture and focal length).

If the temperature sensor is connected to *AstroLink 4 Pi* device, then the *Temperature* section is present and the current temperature is displayed here. When temperature reading is available, also temperature compensation is possible.

[General Info](#) tab contains some basing information about the driver. None of these fields is editable.



Options

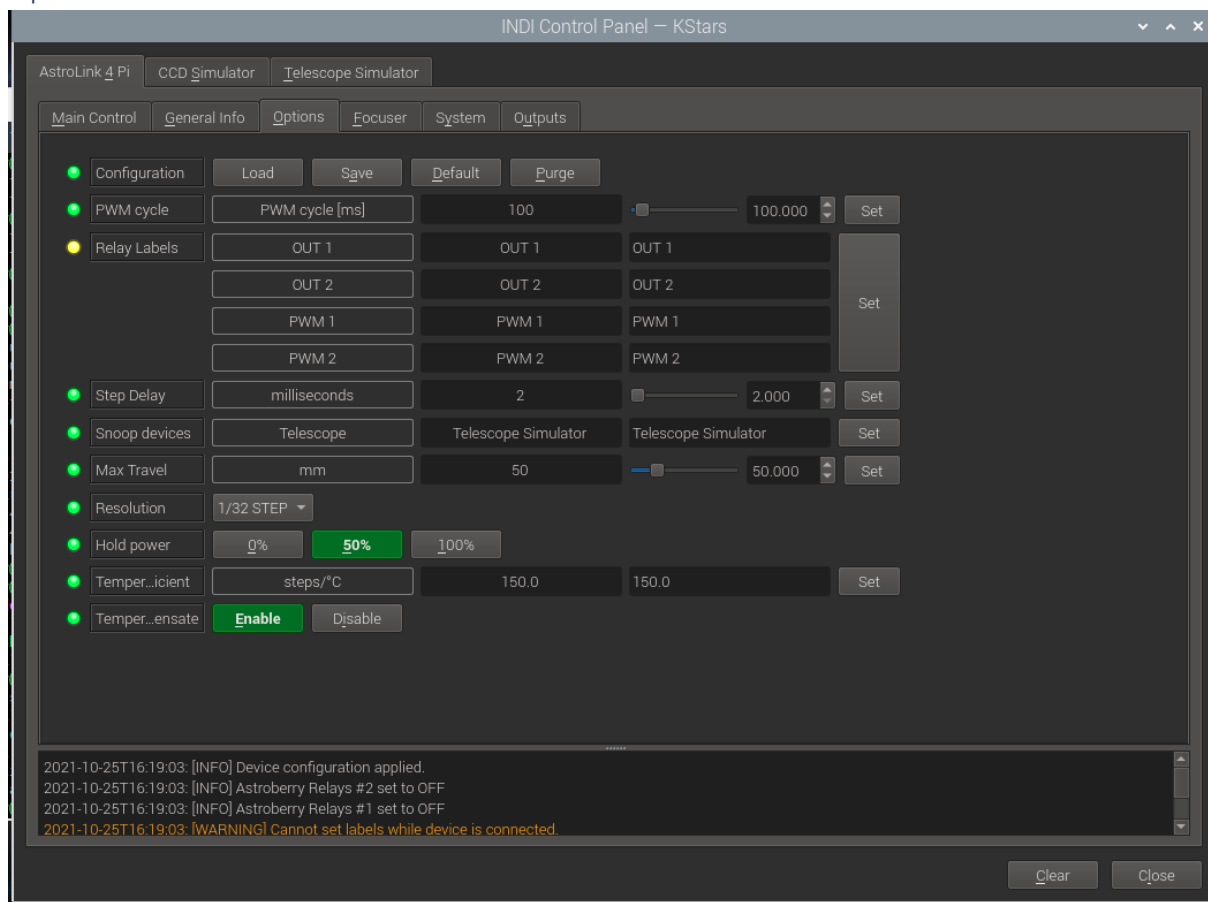


Figure 8- Options tab

Configuration – here you can load, save, reset or purge the INDI driver configuration.

PWM cycle – that is the time in milliseconds that cycles regulated PWM outputs power.

Relay labels – these are names of the outputs, that are shown for convenience in the Output tab.

Step delay – time in milliseconds of each focusing motor step. Should be adjusted to the focusing motor parameters and selected resolution.

Snoop device – that is telescope device name that will be used to retrieve aperture and focal length data.

Max travel – that is the maximum output position of the focuser. This value is used to calculate the step size.

Resolution – here required focusing motor resolution can be selected. For unipolar geared motors 1/1 to 1/4 resolution is recommended. For bipolar motors, without an additional gearbox 1/16 or 1/32 is recommended.

Hold power – here you select the holding power of the focusing motor. For unipolar motors, it should be set to 0 to avoid motor overheating. For bipolar stepper motors should be set to some significant value, so the balance between the motor temperature on idle and holding torque will be preserved. Recommended values are 40-60%.



Temperature coefficient – when the temperature sensor is available, temperature compensation may be performed. The number of steps per one degree of the temperature change should be entered into this field.

Temperature compensate – enable or disable temperature compensation. The temperature compensation cycle is 30 seconds.

Focuser

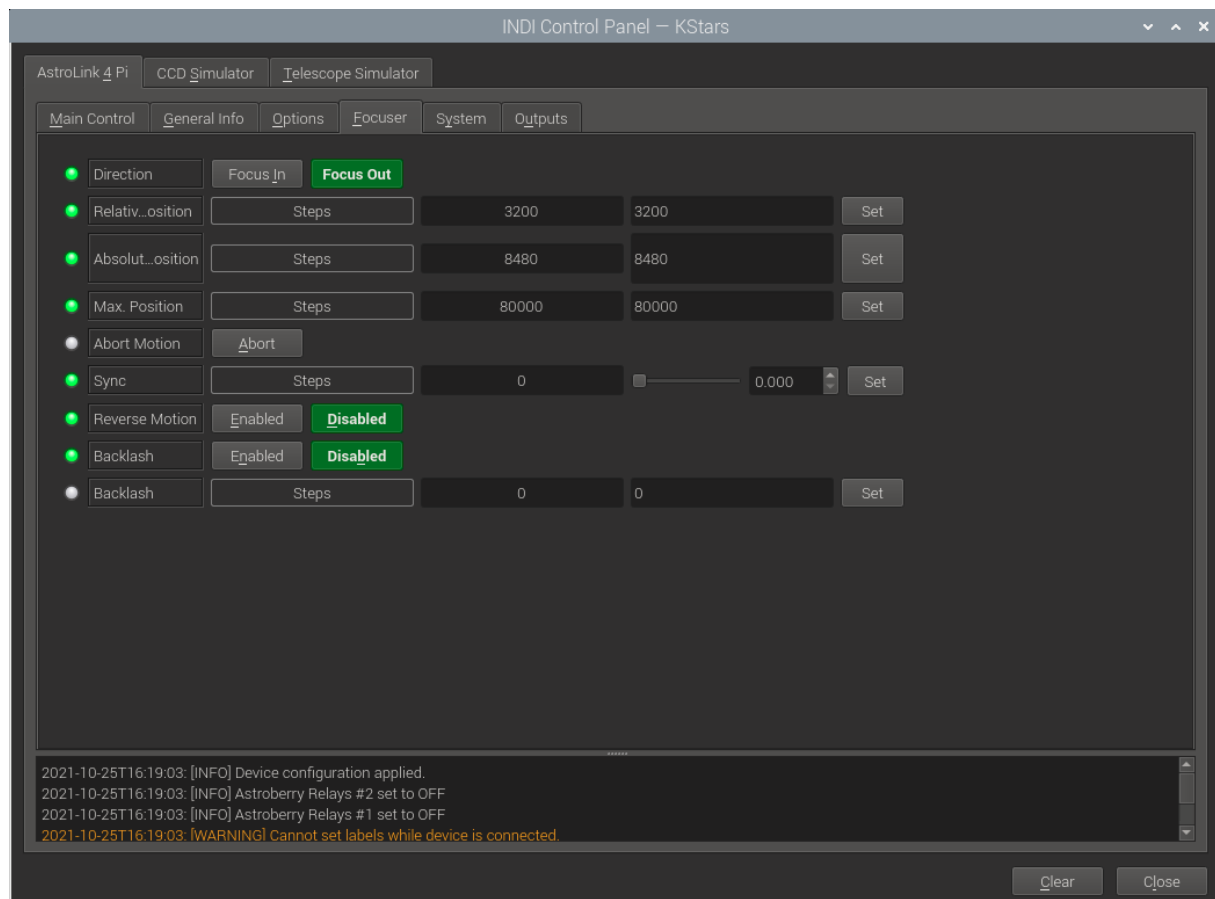


Figure 9- Focuser tab

Direction – controls the direction of the Relative position move

Relative position – allows moving the focuser by the specific amount of steps

Absolute position – allows moving the focuser to the specific position in steps

Max Position – this is the maximum outward position of the focuser in steps

Abort Motion – stop focusing motor movement immediately

Sync - synchronizes current focuser position to the specific amount of steps

Reverse Motion – reverses focuser motion, so In direction becomes Out. This setting depends on your focuser mechanics

Backlash – implements backlash correction



System

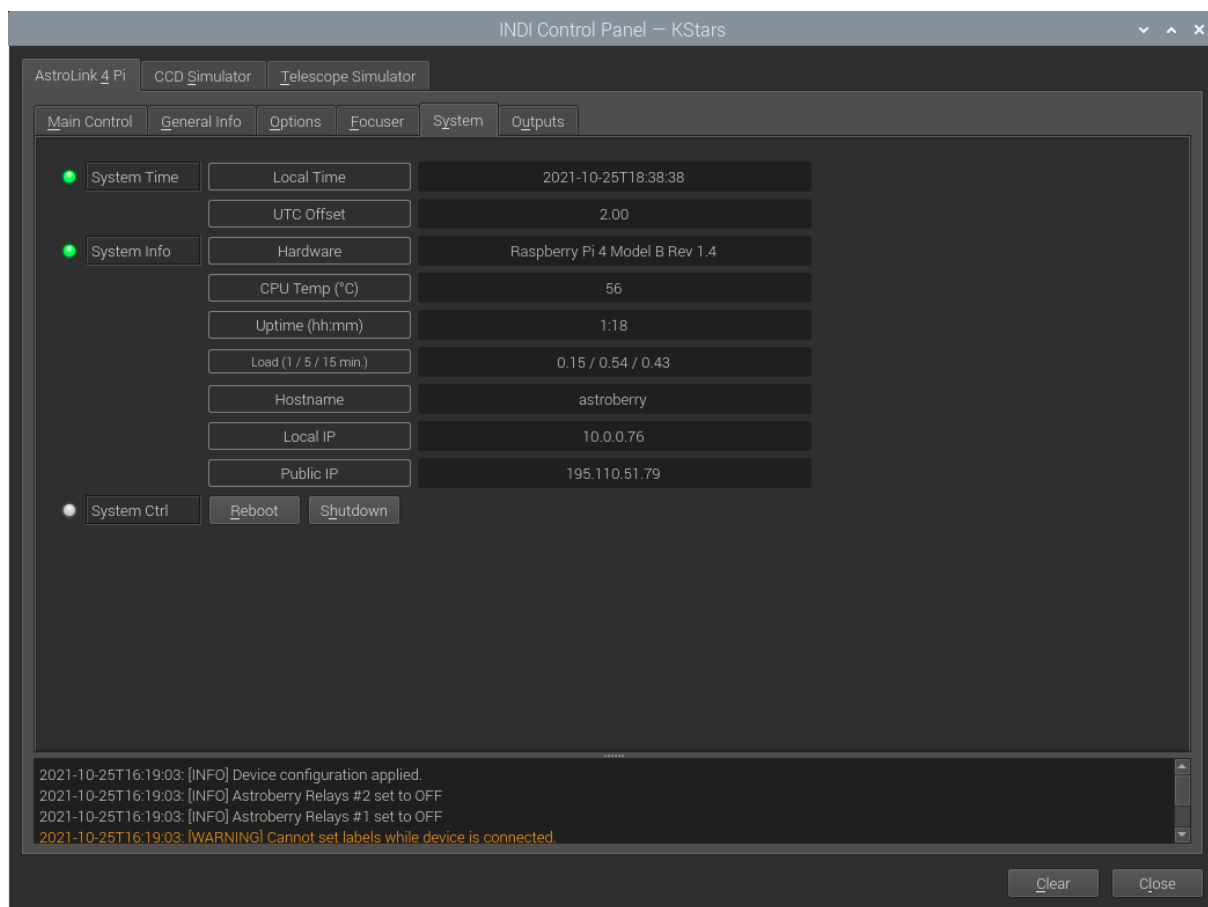


Figure 10- System tab

This tab contains several read-only fields with some information about the system. *System Ctrl* section allows to reboot or turn off the operating system, but to use these buttons some additional configuration of sudo is required, so these operations are allowed without a password.



Outputs

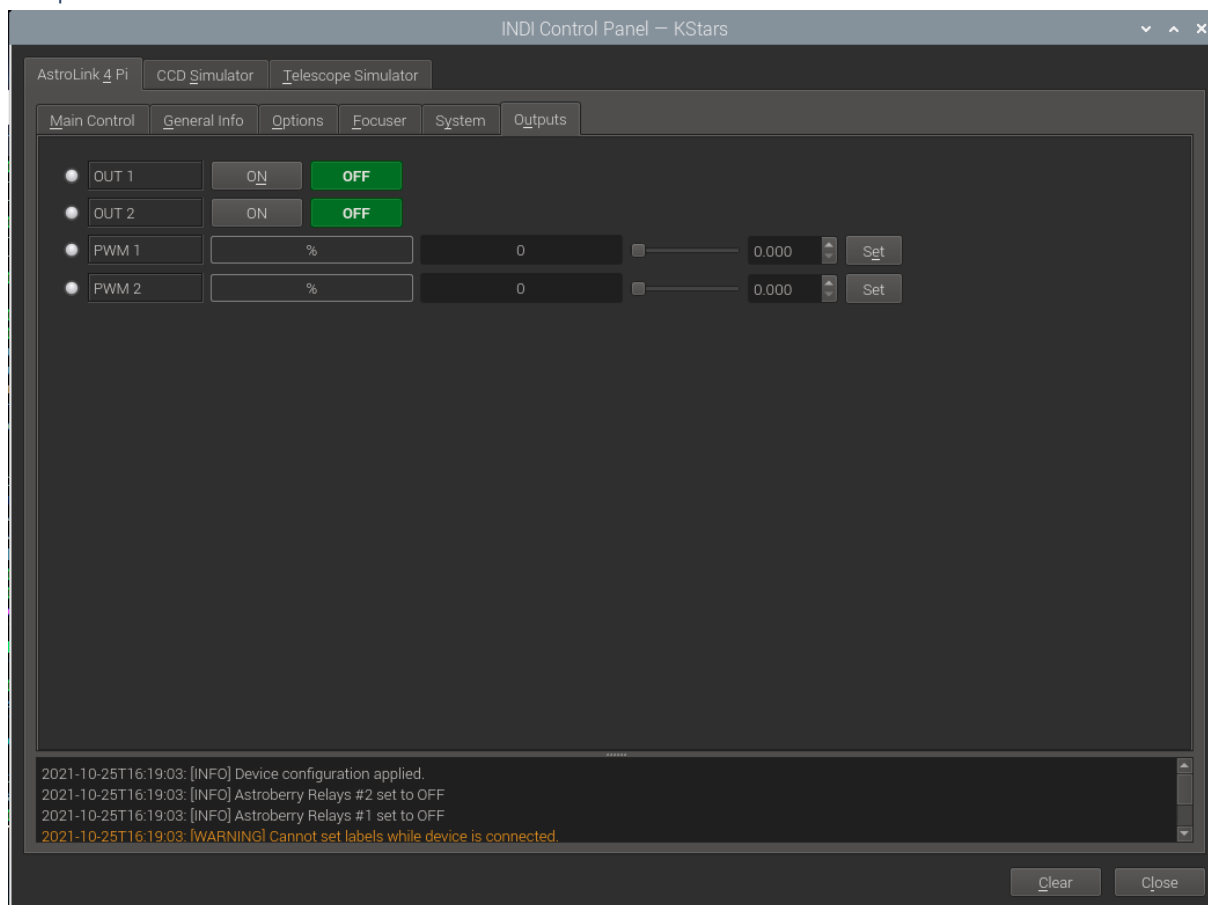


Figure 11- Outputs tab

Outputs tab contains controls for operating with external power sockets of the *AstroLink 4 Pi* device. There are three DC 12V outputs in the device. One is permanent, and two are switchable and can be controlled in this panel. There are also two RCA sockets in the *AstroLink 4 Pi* that can be used for powering dew cap heaters. These sockets provide PWM regulation with a long cycle time (the period can be set in the *Options* tab) in the range of 0 to 100%.

Default values for the outputs can be saved in the *Options* tab. Once saved, these values will be restored on the next connection to the driver.



Temperature compensation

Temperature compensation in *AstroLink 4 Pi* is implemented linearly. So there is only one parameter that describes how temperature affects the focus point. It is not a perfect approach, however, its accuracy is good enough for most amateur setups.

How to determine the temperature compensation coefficient?

The best way is to note the focuser position at different temperatures. When during session temperature changes, the focuser position needs to be adjusted to maintain a sharp focus. When you note these points of temperature and corresponding focuser position, then it is pretty straightforward to calculate the compensation coefficient, i.e. the number of focuser steps required to compensate for one-degree temperature change. And this value needs to be entered into the *Temperature coefficient* field in the *Options* tab. When decreasing temperature requires the focuser position to decrease, then the value will be positive.

How to use compensation?

Once you enter the compensation value into the *Temperature coefficient* field, you need also to enable the compensation. Actual compensation is performed once the calculated focuser position correction is larger than half of the critical focus zone. CFZ value is calculated and presented at the *Main control* tab.



Ground loops

The ground loop in the electrical system occurs when two points that should have the same potential have different voltages. The ground loop in the astroimaging setup may occur when the ground (i.e. minus of power supply voltage) is connected to one receiver with more than one cable path. Here are two example scenarios:

Scenario one

- the newtonian telescope has a mirror cooling fan, and this mirror fan socket is fixed in the metal mirror cell. Its minus is connected to a metal telescope tube
- the imaging camera case is also connected to the power supply minus.

Now, when you power both fan and camera from the same power supply, then the power supply ground will be connected to the camera with power supply cable, but also via the fan power socket, then metal telescope tube, focuser, and camera case.

Scenario two

- an active USB hub is powered from the regulated voltage output from AstroLink
- imaging camera is powered from DC AstroLink output
- the camera is connected to a USB hub with a cable

In this scenario, a negative voltage is supplied to the camera also in two ways. The first one is the main power cable between the camera and AstroLink. The second loop is from 5V output in AstroLink to the USB hub and then with the USB cable to the camera.

The ground loop may cause some problems with connections, that are hard to investigate. The best way is to avoid them. Possible solutions for the second scenario are:

- connect the imaging camera to the computer without an additional USB hub
- power camera from a separate supply
- power USB hub from a separate supply
- do not power the USB hub at all - maybe it is not required
- use a USB cable with galvanic isolation



Tips and troubleshooting

I cannot find the device in my network

Make sure it is powered for at least two minutes, so it booted up properly and connected to the WiFi network.

Use some local area network tool to scan and find the IP address of the Raspberry module (like *Fing* for Android phones).

Make sure you have updated Raspberry Pi* module WiFi settings properly. If it cannot connect to the home WiFi network, then it will start as a failover with its WiFi hotspot: SSID *astroberry*, password *astroberry*, IP 10.42.0.1.

If all above fails, then switch off the home router, so there is no WiFi around, and restart AstroLink 4 Pi. After about two minutes it should be *astroberry* WiFi available, where you can connect.

I have removed the default *astroberry* WiFi hotspot and now cannot connect at all

You need to open the *AstroLink 4 Pi* device and:

- remove SD card and reflash it with the fresh *astroberry* image. Then you will lose all data and configuration
- remove Raspberry Pi* 4 module from the device, connect keyboard, mouse, any screen, power with 5V and 2A power supply, and fix the WiFi configuration

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