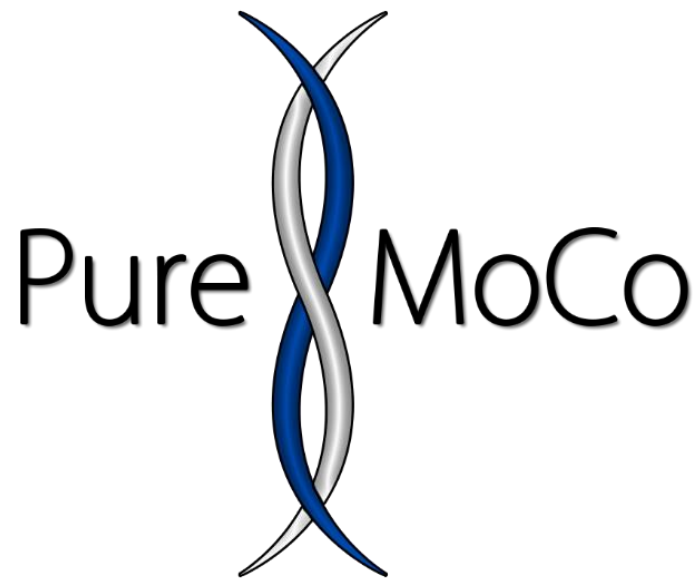


Safety instructions and intended use

To ensure a safe operation, following instructions must to be followed:

- This device is only to be used for operating motion control equipment for camera systems. Any other use is not permitted.
- Operate this device only under supervision. Do not leave it unattended with power supplied.
- This device is designed for a 12V battery supply. Do not use a higher voltage and do not operate this device with the power grid.
- This device is not protected against dust, steam or liquids. Ensure that the device is placed on a surface where these mediums can not get in contact with the device.
- This device generates heat and sparks, so keep it away from flammable vapors, liquids and other easy flammable materials.
- This device may generate electromagnetic waves. Do not use this device in near distance of persons with heart pacemakers or in near of other sensitive electronic equipment.
- Do not place this device in direct sunlight while operating.
- Make sure all used cables are without damages.
- Operate this device only with closed housing.
- Do not put any mechanical stress on the housing.
- Operate this device only in environmental temperature of 0 - 40 °C.
- This device is to be used with a current of max. 0.6A per stepper motor. Setting up higher currents occurs at own risk.
- Never plug off a stepper cable while power is applied. Never turn off the power while the steppers are moving. Both may destroy the stepper drivers and further parts of the device. (Use the emergency stop to stop all steppers and to disable them)
- Do not spin the stepper motors manually, while they are connected. They will work as a generator and produce a voltage which can damage the whole controller. Especially if you are using a slider make sure that the slider won't spin the motor in case of an error or battery issues.

WORK IN PROGRESS



PureControl – Operating manual

v1.21 – 14.09.2017

<http://www.puremoco.com>

<https://www.facebook.com/puremoco>

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Content

1.	Hardware	5
1.1.	Controller.....	5
1.1.1.	Connections.....	6
1.1.2.	Setting stepper motor current	8
1.1.3.	Setting camera-power voltage	8
1.1.4.	Connecting cables.....	9
2.	Install Android app	10
2.1.	Download and activation	10
2.2.	App requirements – First app start	13
3.	App overview.....	16
4.	Settings	20
4.1.	Axis and stepper configuration	21
4.1.1.	General axis config	21
4.1.2.	Stepper speed settings	23
4.1.3.	Stepper current settings.....	24
4.1.4.	Initial Setup.....	25
5.	Manual move.....	27
5.1.	Diagram	27
5.2.	Current position	28
5.2.1.	Precision Mode.....	29
5.2.2.	Precision Mode: Position setting without movement.....	31
5.3.	Current keyframe	32
5.4.	Current axis	33
5.5.	Manual move control slider	34
5.6.	Continue buttons.....	35
5.7.	Motion mode.....	36
5.8.	Motion preset.....	38
5.8.1.	Motion preset: Save new preset	39
5.8.2.	Motion preset: Load existing preset	42
5.8.3.	Motion preset: Delete preset.....	45
6.	Timelapse	47
6.1.	Master-Mode.....	48

6.1.1.	Timelapse Master: Setup.....	48
6.1.2.	Timelapse Master: Status	51
6.1.3.	Timelapse Master: Repeat timelapse shot.....	52
6.2.	Slave-Mode.....	55
7.	Panorama	57
7.1.	Motion settings	57
7.2.	Advanced panorama settings	57
7.2.1.	Mirror lock-up.....	58
7.2.2.	HDR panorama	59
7.3.	Panorama setup	59
8.	Movie-mode	61
9.	Astro-mode.....	62
10.	PlayStation 4 controller support	63
11.	App Update.....	64
12.	Arduino Firmware.....	67
12.1.	Software prerequisites	67
12.2.	Firmware update	76
13.	SilentStepStick stepper drivers.....	82
13.1.	Overview.....	83
13.2.	Microstepping.....	84
13.3.	Power saving.....	85

1. Hardware

1.1. Controller

To ensure a good heat transfer from the stepper drivers, the controller has an aluminum plate on the top site. The stepper drivers are linked to the plate. So please ensure that you don't cover the plate to ensure best possible heat transfer.



The housing is 3D-printed plastic. To get good mechanical properties, PLA/PHA from Colorfabb was chosen as material. This material will deform at around 50-55°C. So please make sure that you don't put the controller into direct sunlight.

The housing will provide basic protection for the internal electronic components. Since a lot of connectors are used, the housing could not be made waterproof. This will mean that you have to make sure that dust or liquids are not able to reach the controller. Operating the controller while rain is only possible if you ensure that no water can reach the controller (e.g. plastic bag).

1.1.1. Connections

The pin-layout of all connectors can be found in the appendix.

- **Stepper motor connections:**



The stepper motors are connected with 4-pin miniXLR plugs to the controller. The miniXLR-connections have a locking-mechanism so it is not possible to accidentally unplug the connection.

Please be aware that you should plug or unplug the connectors only when the power is removed. So the stepper motor should be connected at first and removed at last.

- **Camera and power connections:**



- **TRIG:**

2.5mm stereo audio jack to connect your camera via shutter cable. Focus and shutter can be activated separately. The pinlayout is identical to standard trigger cables, so each trigger cable with 2.5mm audio connection should work.

- **EXT:**

3.5mm stereo audio jack. Enables you to trigger the controller by an external signal. E.g. with a button or hotshoe adapter on your DSLR. Signal output is 3.3V (0,33 mA) and must be shorten for triggering.

- Micro-USB:

This is the USB-connection of the Teensy 3.6. It is used to update the firmware of the controller or to connect the controller to the PureMoCo-Windows-Application.

- Reset (Red button):

This will reset the Teensy. It will also disable the stepper motors and stop all movements. After you have pressed this button, you should restart the Android app if you want to continue.

- PWR1:

This is the main port for connecting your power supply. The whole board is designed and tested for a 12V power supply. The maximum supply voltage is rated with 24V. If you are using voltages above 12V please have a closer look on the heat of the steppers and stepper drivers. If it getting too hot, please lower the stepper current or lower the supply voltage.

- PWR2:

Allows you to connect a second battery exclusively for powering your camera. Depending on the stepper amount and type and your camera type, the peak current can exceed the current amount which your battery is able to deliver. This will result in a shutdown of your battery or a malfunction of your camera.

(Controller stand-by consumption without steppers and camera = 0.18A, controller stand-by consumption without steppers and powering Nikon D750 = 0,4 A). As you can see, a DSLR comparable to the D750 will consume a lot of power. While triggering, there will be a high current peak. **So it is highly recommended to use a second battery if you want to supply your camera with power.)**

- Cam-Power:

3-pin miniXLR jack to supply your camera with power. Current can be set by adjusting the potentiometer of the voltage regulator (see chapter XXX for further details).

- Switch:

As described above, it is possible to use a second battery exclusively to supply your camera with power. If you want to do so, place the switch to "2". This will cut off both circuits, so the port "PWR2" will only supply the voltage regulator which is generating the current for the camera. If placed on "1", both circuits are connected together and the battery on "PWR1" will also supply the voltage regulator.

1.1.2. Setting stepper motor current

This device was tested with a max. current of 0.8 A per stepper motor and a supply voltage of 12V. Higher currents and voltages will generate more heat. The stepper drivers are able to be run at max. 1.2A. Setting up the current over 0.8 A or supply voltage above 12V must be done with much precaution and at own risk since the device is intended to be used $\leq 0.8A$ per stepper at 12V supply.

1.1.3. Setting camera-power voltage

Depending on your camera type, you have to set the right voltage if you want to supply your camera with power over the controller. The right voltage is labeled on the original battery of your camera. For most DSLRs it should be something around 7 - 8 V. Note that fully charged, the original battery will have a higher voltage than it is labeled.

You will need a multimeter and a small flat screwdriver to change the voltage.

If you set the voltage too high, you may damage your camera. Please do this setting only with a disconnected camera!

To change the voltage, open the M4 screw on the top side of the controller. Underneath the screw you will see the potentiometer of the voltage regulator (small set screw). If you turn the screw clockwise, you will increase the voltage. Turning counter-clockwise will reduce the voltage.

The max. voltage which you should set is 10V, do not set the voltage above this limit.



1.1.4. Connecting cables

To ensure a safe operation and protect the components, the cables have to be installed in a specific order.

1. Connect your steppers cables.
2. Connect your battery power supply to “PWR1” (and second supply to “PWR2” if needed). If you have a power switch on your battery or within the power cable, make sure it is switched off.
3. Turn on your power supply.
4. Connect your camera to Master or Slave.
5. (If you want to supply your camera with power from the battery, connect the camera-battery-adapter to “Cam”)

CAUTION:

- Do not plug in or unplug any stepper cables while power is connected to the controller.
- Do not plug off the power cable or shut off power while the steppers are in movement (Press the emergency button at first)
- Do not plug in “Cam-Power” before applying power to the controller and activating the steppers. While boot-up process of the controller, higher current peaks can occur and may damage your camera. So always make sure, that you plug in “Cam-power” after the controller is powered up and you have activated the stepper power. At this point all capacitors are filled and the voltage is stabilized.
- After finishing your operation, remove the 12V power supply cable at first. The remove order of the other cables is not relevant after removing the 12V power supply.

2. Install Android app

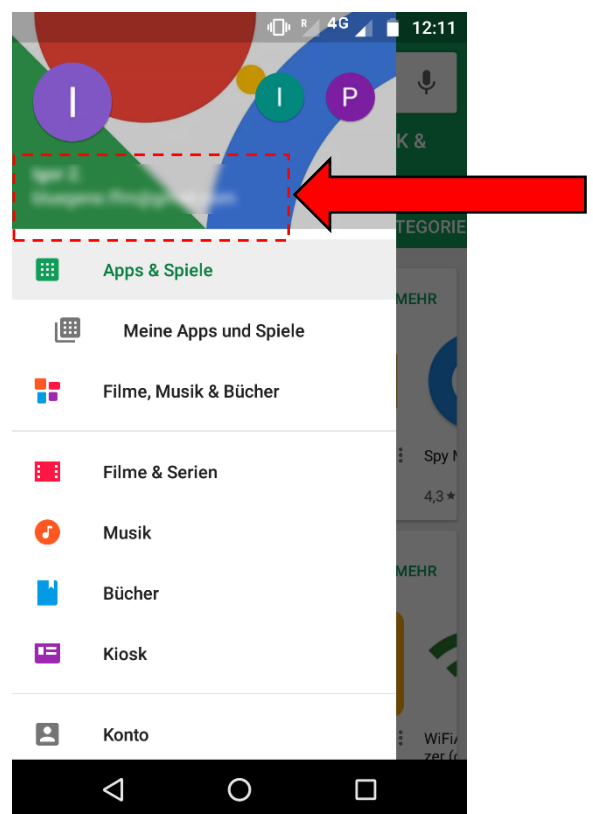
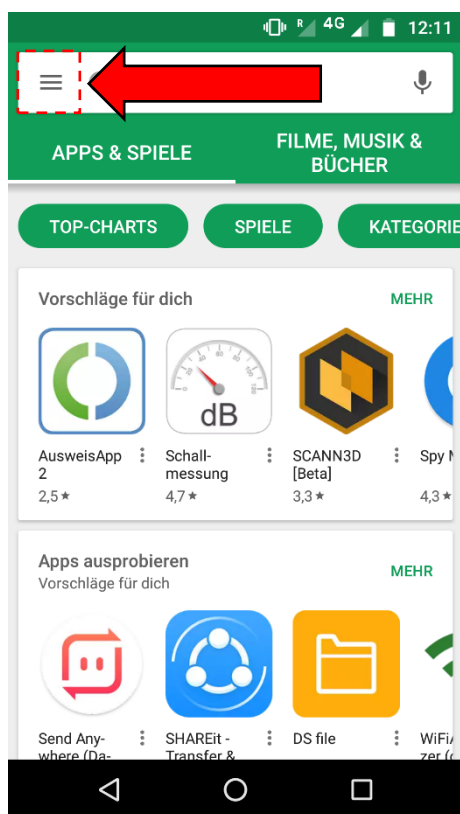
2.1. Download and activation

Download-link to Play Store:

<https://play.google.com/store/apps/details?id=pm.puremoco.free2>

The app version, which you will find in the Play Store, is only a demo version. You will be only able to move one stepper manually. All other functions are included inside the “full version”. If you are a PureMoCo-customer, you will receive the full version for free. If you have a self-made controller and want to use the full-version, please contact me to make the purchase.

To receive the full version, you need to send me your Google Play Store email-address. You can find this mail-address in the Play Store App:



[Hier eingeben]

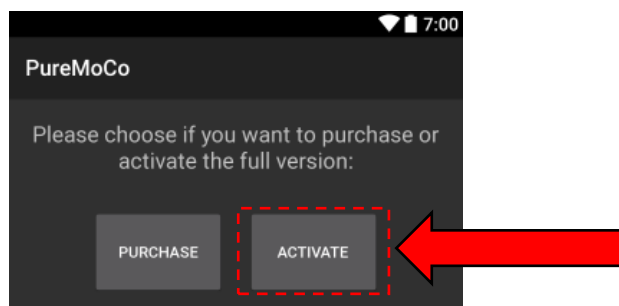
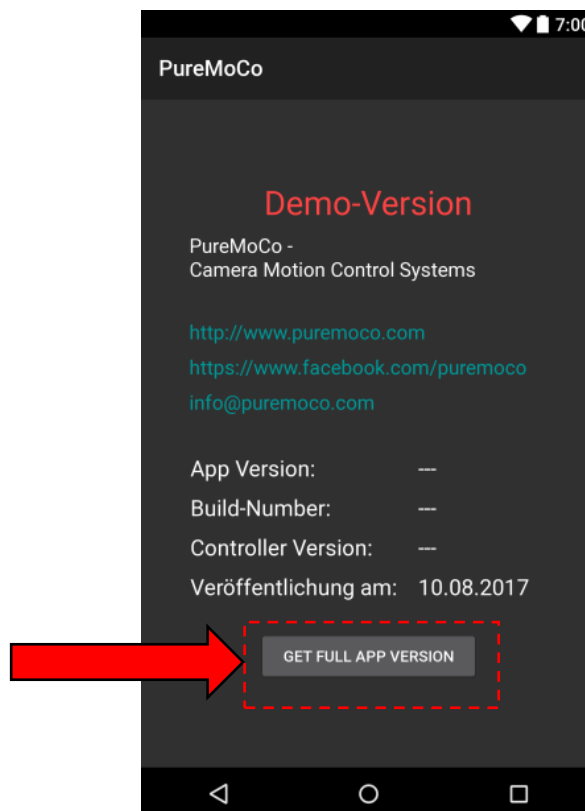
I will add it to the beta test list, so you will receive the beta version, which has the full functionality. After I have added it to the list, you can activate the full version.

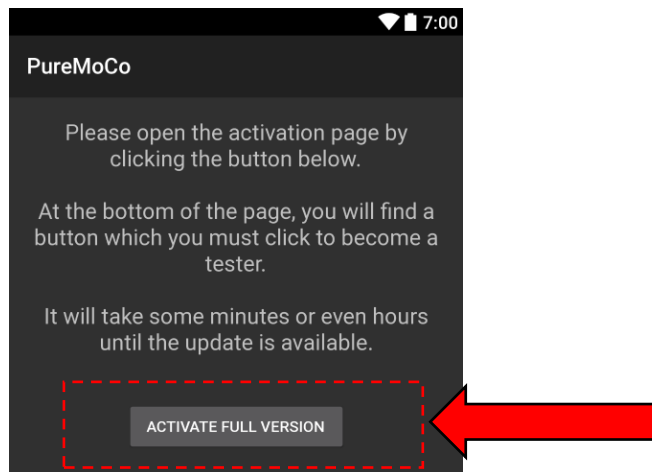
If you have not downloaded the app yet, you can open the activation page here:

<https://play.google.com/apps/testing/pm.puremoco.free2>

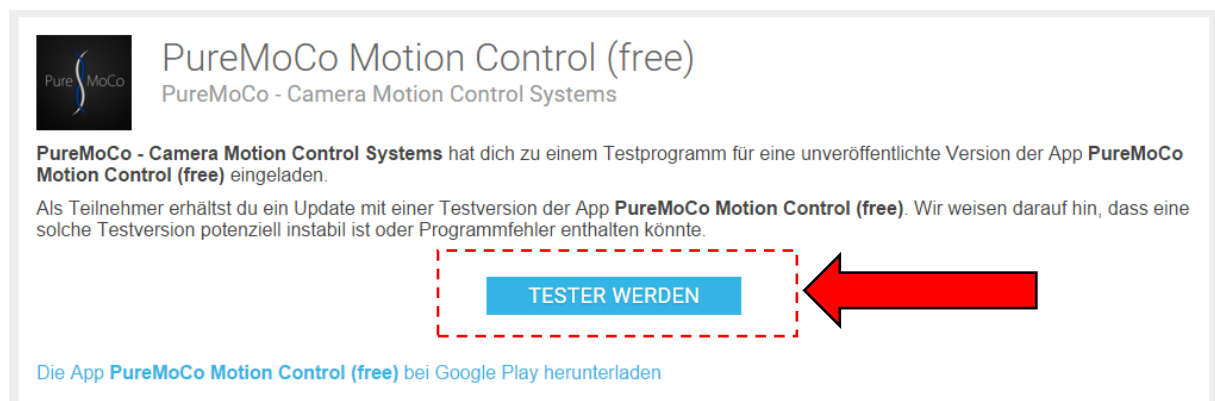
Make sure that you are using the same Google-account as for the Play Store on your Android-device.

If you already have installed the app, you can open the “About”-Page and click on “Get full app version”. This will also open the links above.





After you have clicked the “Activate full version”-button, a page will be opened in your browser. You have to confirm be a tester. Otherwise you will not receive the full version.



After you have accepted the beta test, you will receive the update over the Play Store. Sometimes it may take up some hours. Sometimes it is also required to uninstall the app first and reinstall it again to receive the updated version.

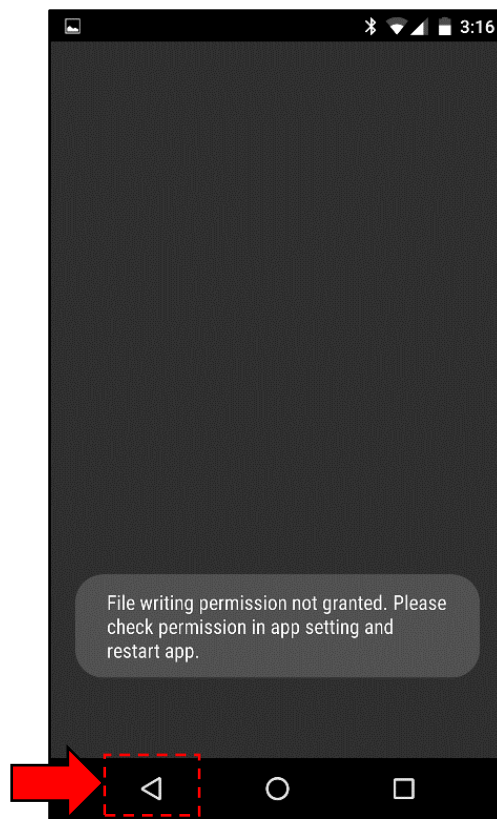
To check if you have received the full-version, open again the “About”-page, there should be no red label with “Demo-version”.

2.2. App requirements – First app start

The app requires some permissions to be able to work. If you are using an Android version <6.0, all permissions should be granted at installation.

If you are using Android 6.0 or higher, you will need to accept the permissions manually during the use of the app. If you start the app without the necessary permissions, you will at first notice an error message regarding the file writing. Since the app is not allowed to create files, the database can't be created.

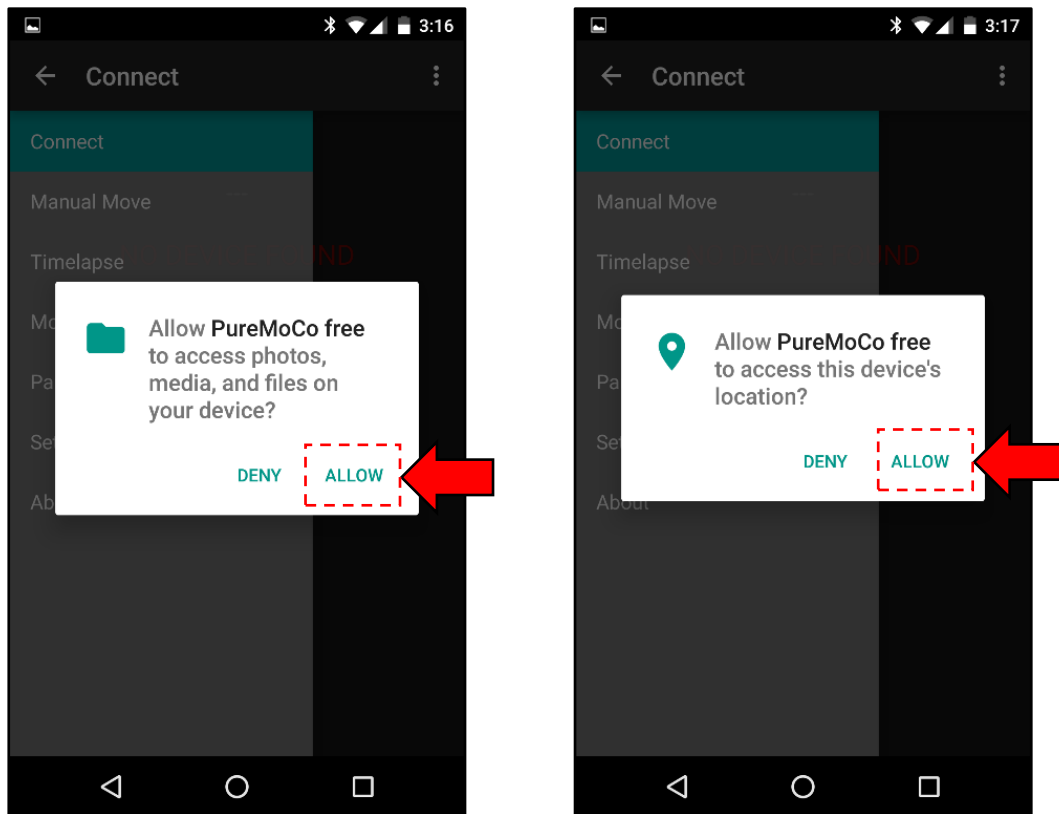
On the first start, you will receive a black screen. If you tap on the “back”-button, you will be asked to allow the permissions for storage access and device location.



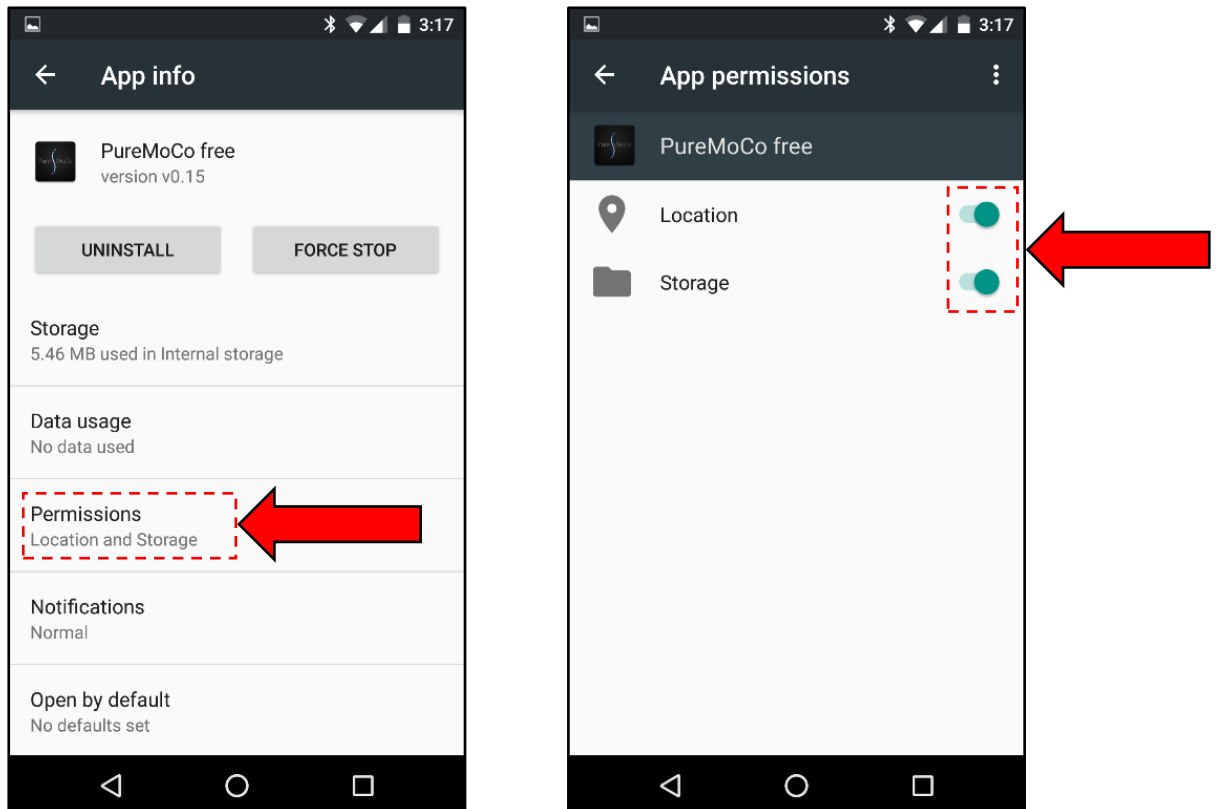
Due to some changes in the Bluetooth API in Android 6.0, you must have your location enabled in order to use Bluetooth communication.

It might be necessary to restart the app several times to get all permission alerts done.

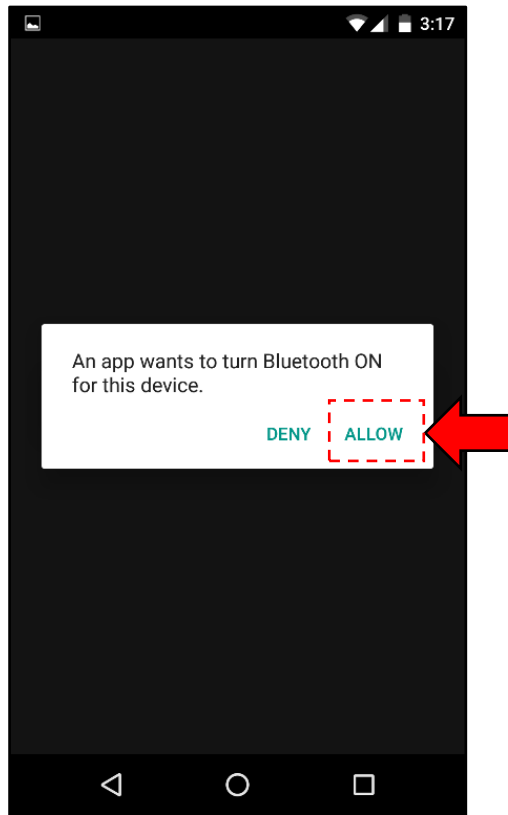
[Hier eingeben]



To check whether you have set all permissions you can look up in the app info under “Permissions”. Storage and Location should be enabled, otherwise the app won’t work properly.



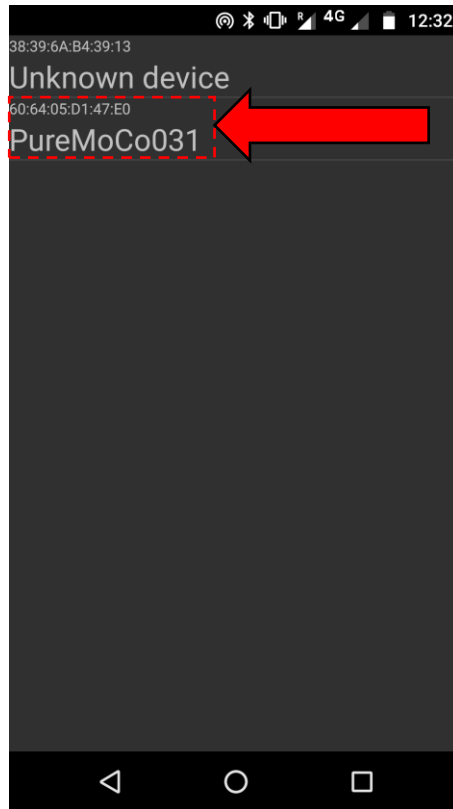
Since the app requires Bluetooth communication, you also have to enable Bluetooth on your device before you start the app. Otherwise you will receive a message to do so. In this case you have to allow enabling Bluetooth and restart the app after you have enabled it.



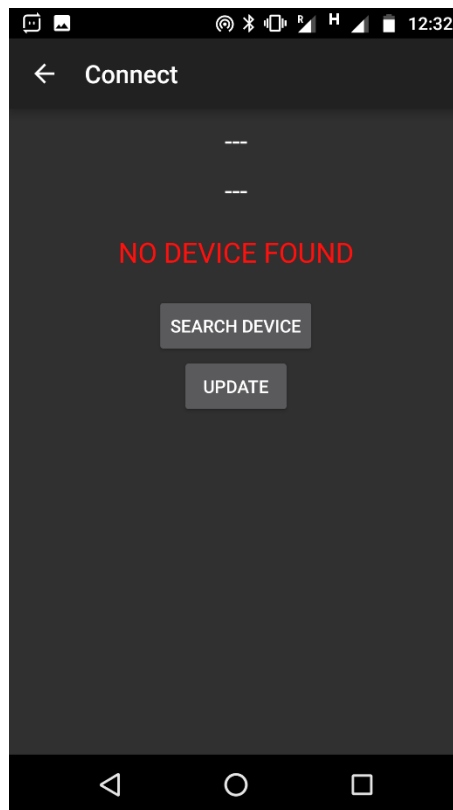
3. App overview

After you have set all permissions and connected the controller to your power supply, you will find this screen each time you start the app. Please make sure, that you always connect the controller first to the power supply before you start the app.

This screen will list all available Bluetooth-device within range. Make sure that you select only the PureMoCo-device.



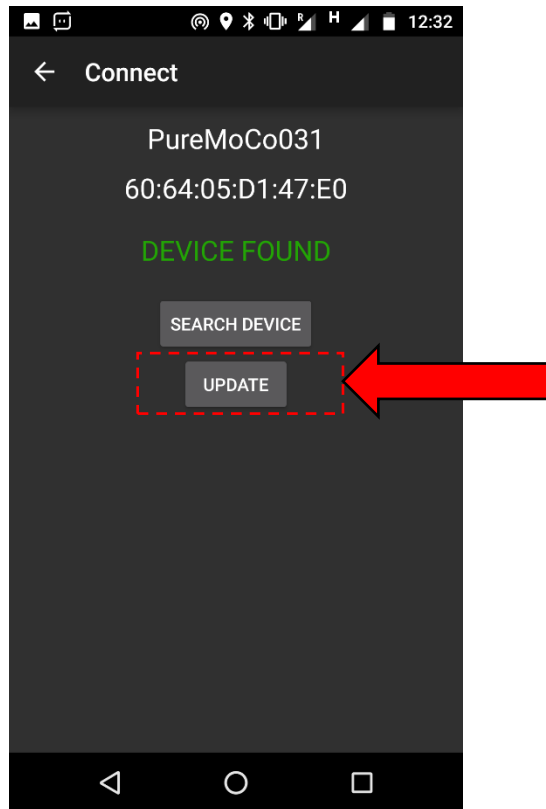
After you have selected the device, you will see this screen:



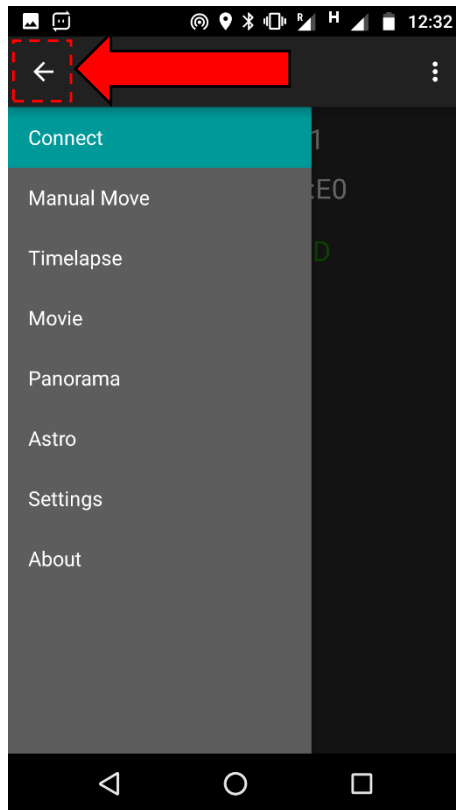
[Hier eingeben]

Please click on “Update” to check if you have selected the correct device. This will also check if the firmware is still up-to-date. If not, you will receive a message and have to update the firmware like describe later in this manual.

The app is now ready to use.



By clicking the arrow in the upper left corner, you will open the navigation menu. This gives you access to all settings and operating modes.

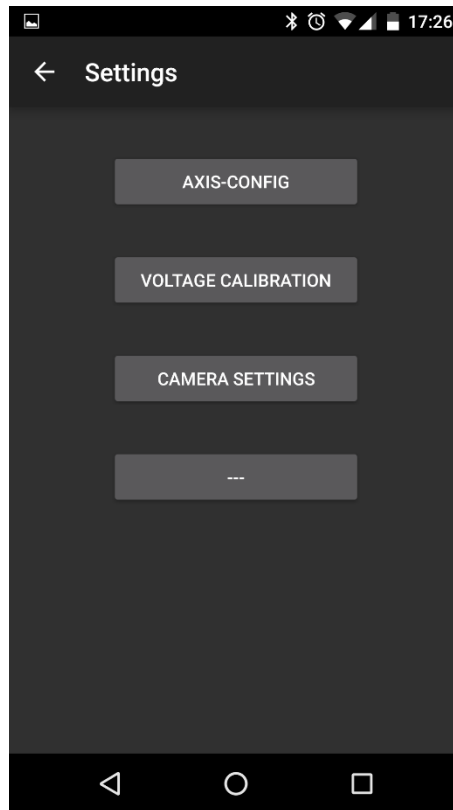


Navigation	Description
Connect	Bluetooth-Connection screen to connect with controller
Manual Move	Calls the manual move screen directly if you just want to manually move the steppers with the software slider or PlayStation 4 controller
Timelapse	Classic shot-move-shot function for timelapse scenes
Movie	Continuous and synchronous movement of all axis for video shots
Panorama	Creath the giga-pixel-panoramas using a pan-tilt-head
Astro	Track stars to enable longer exposure times
Settings	Gives you many possibilities to tune and adjust the controller according your motors
About	Information about software versions of the app and controller

4. Settings

Since the app has a huge range of functions and is compatible with all motor configurations, some settings must be made to adjust the app according your needs.

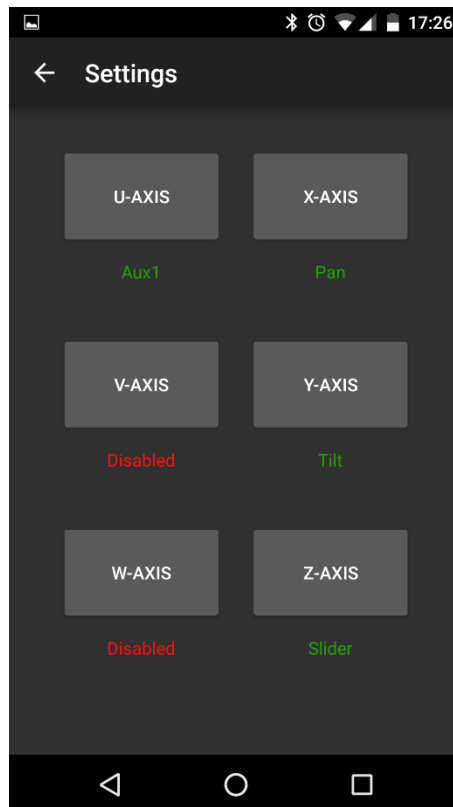
The settings menu is opened via the main navigation.

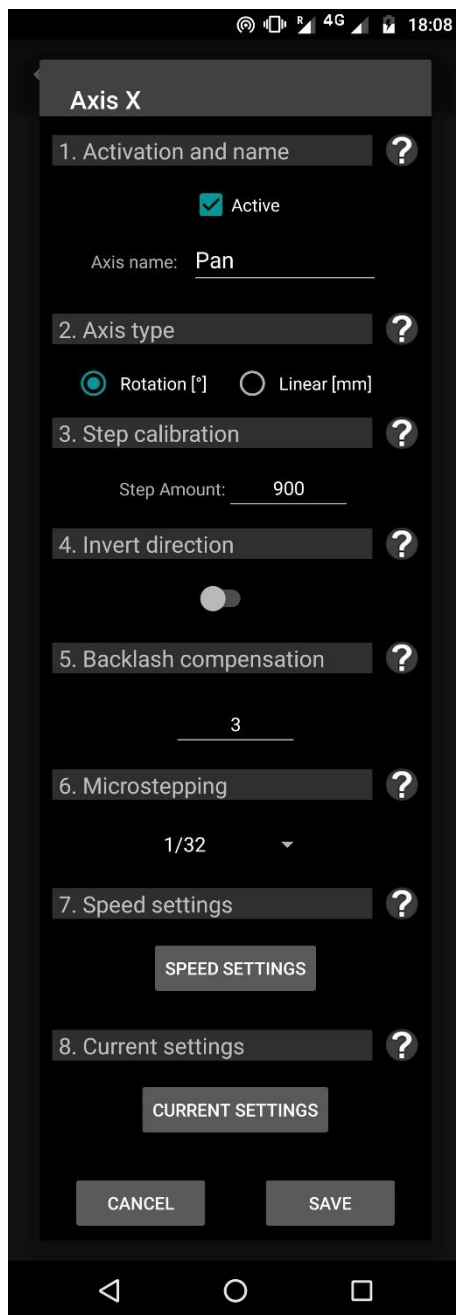


4.1. Axis and stepper configuration

4.1.1. General axis config

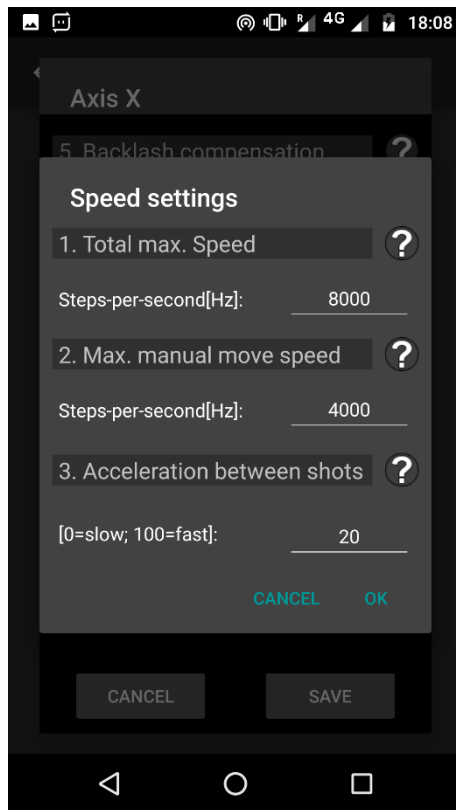
Each of the 6 stepper/axis can be configured individually. The setting menu for all steppers is the same. Before you use the controller for some real shots, please make sure that the settings for all axis are set correctly. Otherwise you may run into some problems.





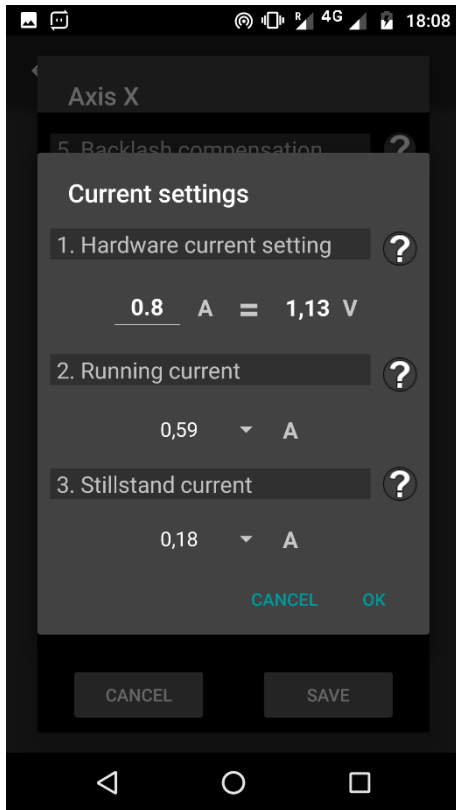
1.Activation and name	Set the name of the axis and enable/disable it. If the axis is disabled, the stepper will not be enabled and won't get any current. You also won't see the axis in the manual movement screen.
2. Axis type	Here you can choose if your axis is rotating or a linear axis. Depending what you choose, the units will change to [°] or [mm].
3. Step Calibration	Do display the correct unit amount, you have to set this value according to your stepper and gear reduction...
4. Invert direction	Here you have the possibility to invert the direction of the axis.
5. Backlash compensation	If your gearing might have some backlash, you can compensate for this with this setting. This works currently only within the Astro-mode. The value which you set here is in [°] or [mm], depending on your axis setup.
6. Microstepping	You can choose between different microstepping-settings. 1/4 or 1/16 should be ok for most applications. If you have a really high gear reduction you maybe want to use 1/2. Full steps(1/1) should only be used in exceptional situations, since this will cause vibrations in most cases.
7. Speed settings	Depending on your stepper, gearing, supply voltage, current settings and load, you will be limited to a certain speed at which your stepper motor can operate. Here you are able to set those max. speeds and other important values to adjust the controller perfectly to your stepper. Further details in the next chapter.
8. Current settings	To save energy and keep the temperature of the drivers and steppers low, you can lower the stepper current while running and in stillstand. Further details in the next chapter.

4.1.2. Stepper speed settings



1. Total Max. Speed	<p>This is the max. speed at which your stepper can move without any issues. This speed will be used for calculation in video mode and when moving to the startposition or to keyframes.</p> <p>Depending on your stepper, supply-voltage, gearing, load, microstepping etc. this value will always depend on the current setup. To determine this value, you have to start at a low value and then just increase and test. When you notice some vibrations, the speed is too high and you have to lower it.</p>
2. Max. manual move speed	<p>Depending on your project and equipment, you might want to limit the speed during manual movement to get better accuracy. This value here limits the max. Speed during manual movement.</p> <p>You can not set this value higher than the total max. speed.</p>
3. Acceleration between shots	<p>Decreasing this value lowers the jerk between two photos in timelapse and panorama-mode. If you set this value high, there will be no acceleration between shots, which will result in a jerky movement and vibrations in your setup. So you should always set this value to get a smooth movement in between pictures. If you set this value too low, the acceleration will be very slow and the movement will take a long time. This might cause timing problems. This value depends a lot on the setup, so the best way to set it right is by testing. You want to set it as high as possible, but without getting a big jerk or vibrations in your setup after the movement is finished.</p>

4.1.3. Stepper current settings



1. Hardware current setting	<p>The current limit is set with a potentiometer on each stepper driver inside the controller. You have to measure the voltage on the Vref-Pin and adjust the potentiometer to your desired limit. This is described at another chapter in this manual.</p> <p>By standard, the drivers in the PureControl are set to 0.6A or 0.8A. Please make sure that you set this value in this field, because the calculation of running and stillstand current it depending on it.</p> <p>By setting the running and stillstand current with the app, you are able to reduce the current limit without adjusting the potentiometer.</p>
2. Running current	<p>Here you are able to set the current limit which is used during the movement. This setting is always depending on the hardware current limit which is set with the potentiometer directly on the stepper driver. This also means that you can not set a higher current compared to the potentiometer setting.</p> <p>A higher current will result in more torque and you will be able to reach higher max. speeds. But you will also need more power and generate more heat on the stepper driver and stepper motor itself.</p> <p>So try to set this value to a minimum which you can work with.</p>
3. Stillstand current	<p>The stillstand current is applied around 2-3 seconds after no movement is detected. This helps to reduce the power consumption and heat generation.</p> <p>Depending on your setup and gear reduction, you can set this value very low or have to set a certain amount if the torque is too low to hold the stepper in position.</p>

4.1.4. Initial Setup

If you install the app for the first time, all values will have default settings, which are adjusted to the PureHead and PureSlider. If you use other motion equipment, it is necessary to adjust all values according to your setup.

At first, you have to choose between “Rotation” and “Linear”. Depending on this setting, your distance will be displayed in degrees (Rotation) or millimeters (Linear). So if you are using a Slider, choose “Linear”. For pan or tilt, choose “Rotation”.

The next step is to decide which microstepping the stepper should run with. Further information on microstepping can be found in chapter XXX. If your axis is having a high gear reduction, it will be necessary to run many steps to move a certain distance. Since the Arduino has a maximum frequency to perform the steps, you will have a certain limit of the max. stepping speed.

If you choose 1/16 or 1/4 microstepping on a high gear reduction axis, your stepping speed might be high, but your axis will move slowly, since it has to perform a huge amount of (micro-) steps. So you might reduce the microstepping to 1/4 or 1/2 and see how this setting performs.

Fullstepping (1/1) should only be chosen, if 1/2 is still too slow. Fullstepping has the big disadvantage, that it will cause vibration to the stepper and your axis.

If you have an axis with a low gear reduction, you might stick with 1/16. This way you will have a higher resolution, which will lead to smoother motion.

Depending on your shooting scenario, you might change the microstepping individually on your needs. For panorama mode a smooth motion is not that important, so you can run with 1/1 or 1/2. On the other hand, for video mode you will need a smooth motion and maybe noiseless operation. So you have to choose 1/16 or even lower. For high speed movement you might even choose 1/2 or 1/1.

Choosing the right microstepping depends on many factors, so there is no general advice which is the best one. Try different settings and over time you will find your favorite settings for your shooting situation.

The next setting is the Power mode, which is described in chapter XXX. Here you can choose between power saving and full power. Power savings comes with two big advantages, obviously your battery will last longer, since less power is consumed. The other advantage is that the steppers, stepper drivers and PCB are not running at full current all the time, which will cause less heat and keep the temperature low. The only situation in which you would choose full power is, when you notice that your axis can not hold the current position while in still stand with reduced motor current (= less torque) due to the power saving.

To display the correct degrees/millimeters during manual mode, you have to set “Amount of full steps..” to the right value. If you have chosen “Rotation”, you must enter the step amount which is necessary to perform a 360° turn. This step amount **always refers to full steps**. The microstepping is calculated in the background.

Most steppers will have 200 steps per 360° turn (=1,8° per step). Then you might have a gear reduction due to planetary gears, worm gears or drive belts. Assuming you have a 1:27 planetary gear and a 1:5 drive belt, you will need to calculate $200 \cdot 27 \cdot 5 = 27.000$ full steps per 360° turn. This is the value which you need to fill in at "Amount of full steps per 360°".

If you have a linear axis, the value will be calculated on a different way. At first, you must know how many steps are necessary to cover to whole slider length. Set "Amount of full steps for linear distance" to 1.000 and "Length in mm" to 1.000. Now go to Manual Move and move the slider to one end. Leave a little gap to the end. Now press "Set home" to mark this position as reference. Your distance should display 0,00mm.

Now move to the other end of the slider and also leave a little gap at the end.

5. Manual move

This is the most important screen you will need during operation. Here you are able to set the positions for each axis. If you are using the PlayStation4 controller, you will only be able to move the axis when this screen is open.

The screen for manual move is identical for timelapse and video-mode. The panorama-mode has a slightly different interface.

5.1. Diagram

The first thing you will notice is the diagram. It shows always 5 points. Those are the positions for one single axis. Depending on the axis setting, those positions are in [mm] or [°].

The X-axis of the graph shows the picture amount when you open it in timelapse-mode. Otherwise it will just show you values from 0 – 5 which are standing for the 5 keyframes.

You can't drag-and-drop the values. When you click on one point, you will receive a closer information about this point.



5.2. Current position

This value shows the current position of the selected axis.

When you click on this value, you will open the “precision mode”, where you are able to make exact movements. Further information on the this function can be found in the next chapter.

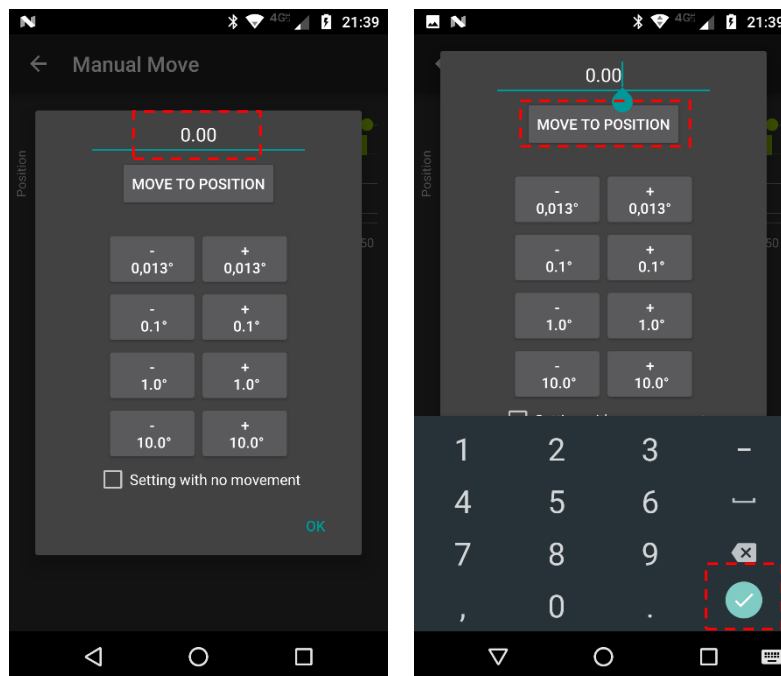


5.2.1. Precision Mode

The main control to move the steppers manually is the slider like described in chapter ... With this you are able to move each stepper slow or fast. This is good for a quick setup, but not great if you need exact positioning. If you need the exact position or want to make very little movements, the precision Mode is a good choice.

Like described on the page before, you just click on the position text to open precision mode. The precision mode is only active on the axis and keyframe, which you have selected earlier.

The current position is displayed at the top of the screen. If you click in this field, the number pad will open and you are able to put in a new position directly. When you click on “Move to position” or at the confirm icon in the number pad, the movement will start. Please note that there is no info screen about the movement. So please check if the movement is finished before you continue to click anything else.

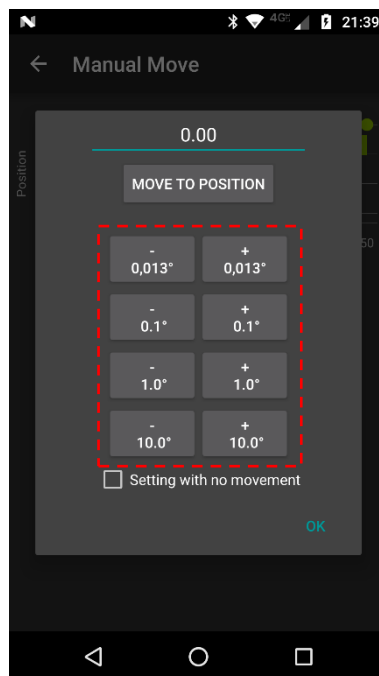


Another possibility to use the precision mode are the buttons with fixed steps. The smallest step is 0,01 mm / °. If your gear reduction or microstepping is too low and not able to reach this resolution per step, the minimum resolution will be calculated automatically.

Example:

- Stepper with 200 steps per 360° (standard 1,8° stepper)
- Gear reduction 1:4,5
- $4,5 * 200 = 900$ steps per 360° → resolution of 0,4° per step
- With 1/32 microstepping → $32 * 900 = 28.800$ steps per 360° → $0,0125° \sim 0,013°$ per microstep

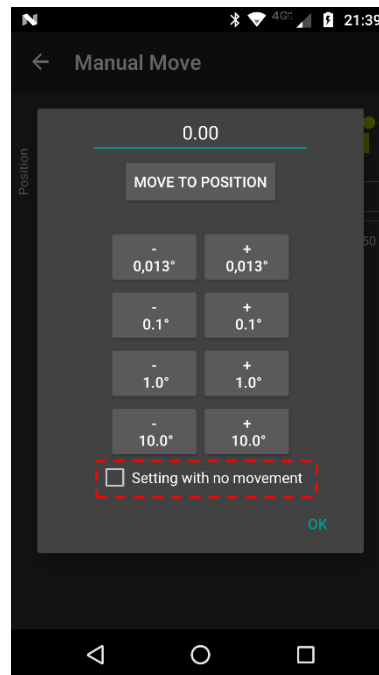
Please also be here aware that there is on information about the current movement. So please wait until the movement is finished and do not click the buttons in a short interval.



5.2.2. Precision Mode: Position setting without movement

This feature enables you to set the positions manually without any stepper movement. This is very helpful if you have larger distances and so not want to drive all the way just for setup.

When this checkbox is enabled, you can type in a new position and confirm it. It will be saved, but there is no stepper movement. Please note that this feature will only disable the movement in precision mode. If you the control slider or switch between keyframes, the movement will take place like usually.



Example of usage:

You have a pan-tilt-head and a 10m slider. It would take a lot of time if you would drive the 10m slider just to set up the position. Instead, you use the “Setting with no movement” function.

For this kind of shot, the “linear with fade”-motion is recommended. The first thing you would do is to move all axis to their start position like usually. Then you click on the “End”-position. Now you open the precision mode and activate “Setting with no movement”. Since you know the length of you slider, you just type in 10.000mm (=10m) and click on “Move to position”. This will save the value and the graph will be updated. But there will not by any movement currently.

The pan-tilt-head can be setup the same way or you just use the conventional method by using the control slider. Now you have setup all 3 axis without driving the whole way. No you click on “Move to start”. The pan-tilt-head will move back, but the slider will stay in position (since it is already at the start).

Now click on “Continue” to proceed with the shot. It is very important that you don’t click again on the “End” keyframe, otherwise to movement will start and can not be aborted...

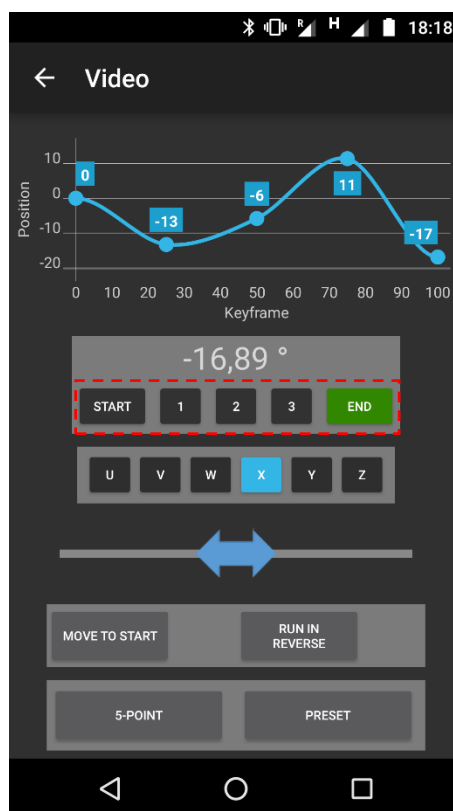
5.3. Current keyframe

Here you can choose between the 5 keyframes while in “5-point”-mode. Otherwise only “Start” and “End” will be displayed.

When the screen is opened, only “Start” and “1” are enabled. So you have to set keyframe after keyframe to enable all.

When you click on a keyframe, which you have already set, all axis will move to this with the max. speed, which is declared in the axis config.

You always have to set all 5 keyframes, otherwise the value will be 0 and you might get a movement which you don’t want to have.



5.4. Current axis

You are only able to move one axis at the time in manual move mode. (If you want simultaneous movement of multiply axis you have to use the PlayStation 4 controller).

Each axis has its own color which matches with the graph and the PS4 controller LED-light. So the currently selected axis will have a color while the other ones are black.



5.5. Manual move control slider

This is the control interface for the stepper movement. If you move this slider to the left or right, your stepper will move in one or the other direction.

Always make sure that you drag-and-drop the slider. Do not click it, otherwise it might be possible, that your stepper will start moving and not stop. In this case just simple drag-and-drop it again.

This control interface has an acceleration and deceleration for the stepper movement. So when you let go of the slider, your stepper will start the deceleration and still move a little bit. This is important to avoid any position error due to the inertia of the movement.



5.6. Continue buttons

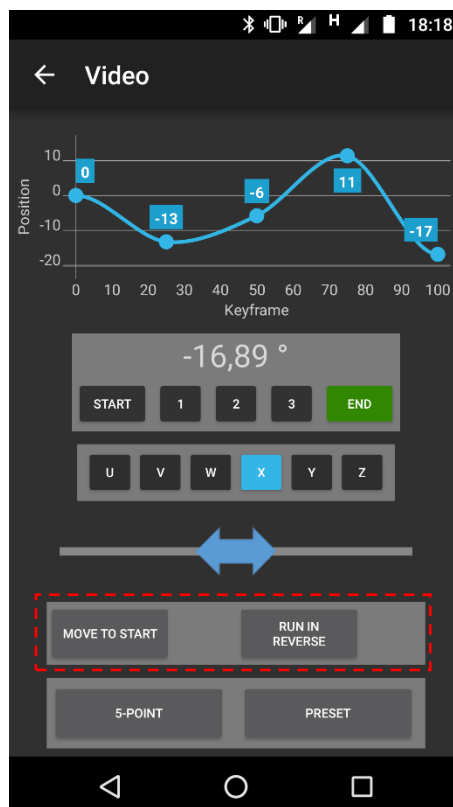
With those two buttons you are able to continue after you have set the positions in timelapse or movie-mode.

As mentioned earlier, you have to set the position of each keyframe one after another. So you have to set all positions first, before you can continue. Until then, both buttons will be disabled.

After you have clicked on “End” and set the position, you have to choose if you want to start backwards from the end-position and move towards the start position, or if you want to drive back to the start position and start from there.

If you want to start from the end-position, just click “Run in reverse” and it will continue. Please note that this button is only enabled when you have selected the “End”-position.

If you want to drive back to the start-position simply click on “move to start” or just click the “start”-keyframe. All axis will start moving with their max. speed to the startposition. You will get a message and have to wait until all axis have reached their start. After this is done, the “move to start”-button will change into a “continue”-button and you can click on it.



5.7. Motion mode

This button will switch between the 3 motion modes which are described on the next page.

When you change the motion mode in timelapse or video-mode, it will be saved. So next time you open the manual move screen, the previous motion mode will be activated.

You should choose the motion-mode before you make any settings on the positions. Otherwise you might get a movement, which you don't want to have.

The motion-mode is always valid for all axis. It is not possible to run different motion-modes on different axis.



Motion name	Description	Graph
Linear	Motion with a constant speed	<p>The graph shows a straight line representing constant speed. The x-axis is labeled 'Keyframe' and ranges from 0 to 3.9 with increments of 0.3. The y-axis is labeled 'Position' and ranges from 0 to 320 with increments of 40. Five keyframes are marked with yellow dots and labeled with their position values: (0, 0), (0.9, 69), (1.8, 138), (3.0, 207), and (3.9, 276).</p>
Linear with fade	Motion with a constant speed, but with an acceleration at the start and deceleration at the end.	<p>The graph shows a curve representing motion with acceleration at the start and deceleration at the end. The x-axis is labeled 'Keyframe' and ranges from 0 to 3.9 with increments of 0.3. The y-axis is labeled 'Position' and ranges from 0 to 280 with increments of 40. Five keyframes are marked with yellow dots and labeled with their position values: (0, 0), (0.9, 24), (1.8, 119), (3.0, 214), and (3.9, 238).</p>
5-point-move	Set up 5 individual keyframes, which will be connected via a smooth spline	<p>The graph shows a smooth spline connecting five keyframes. The x-axis is labeled 'Keyframe' and ranges from 0 to 3.9 with increments of 0.3. The y-axis is labeled 'Position' and ranges from -30 to 20 with increments of 10. The five keyframes are marked with yellow dots and labeled with their position values: (0, 0), (0.9, 19), (1.8, -33), (3.0, 24), and (3.9, -16).</p>

5.8. Motion preset

If you want to repeat a specific movement, you can do this by using presets. You can save a preset with a specific name and load it later. The number of presets is not limited. All preset-data is saved inside the database-file. So you will be able to transfer the presets to other devices or make a backup.

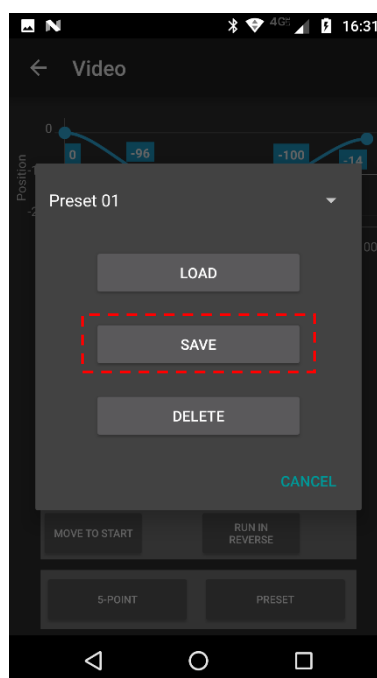


5.8.1. Motion preset: Save new preset

Before you are able to use presets, you have to create at least one preset first. To do this, open the manual move screen in Movie or Timelapse mode. Then set the positions for each axis like you would do normally. After you have set all positions, click in the “Preset” button.

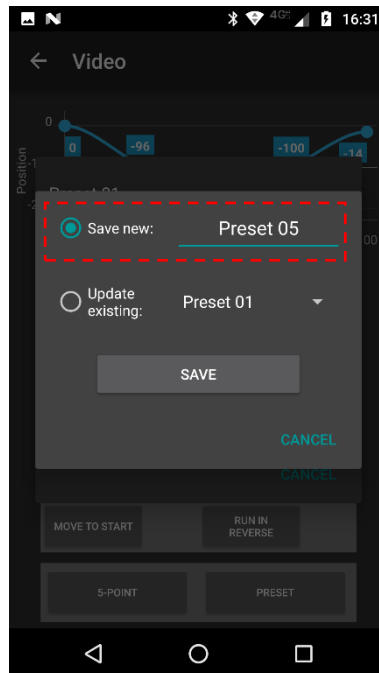


A window will pop up, where you can choose between different options. Since you want to create a new preset, just choose “Save”.

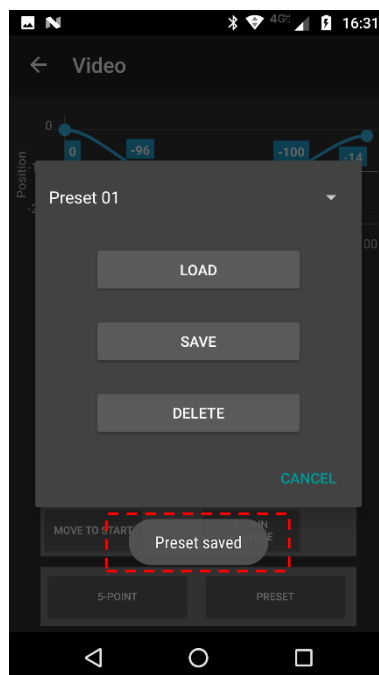


[Hier eingeben]

This will open another screen where you can choose if you want to create a new preset or update/overwrite an already existing preset. To save a new preset just type in the custom name of your preset and click on save

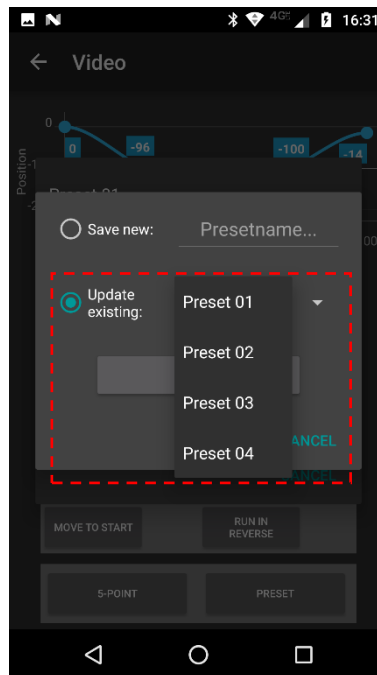


You will get a confirmation that the preset was created. After that, you can close the preset window.



[Hier eingeben]

Instead of creating a new preset, you can also update or overwrite an existing preset. In this case choose “Update existing” and select the preset from the dropdown list.



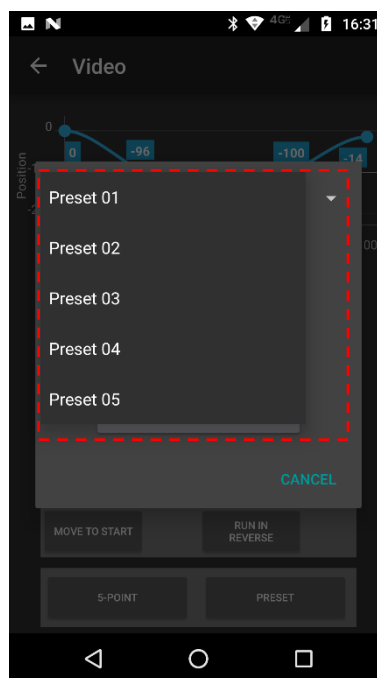
After you have clicked on “Save” you will also get a confirmation that the preset has been updated.



5.8.2. Motion preset: Load existing preset

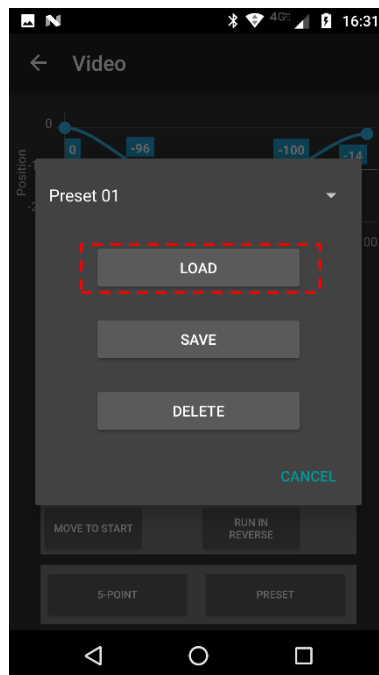
Before you open an existing preset, you have to set all axis to their startpositions. This is very important; otherwise you will get a different movement or might even crash into something. All positions are relative to the startposition and depending on it. **If you set a different startposition you might risk damage to your camera or other equipment. So be very careful when operating with presets.**

To open an existing preset, just choose the right preset from the dropdown-list.

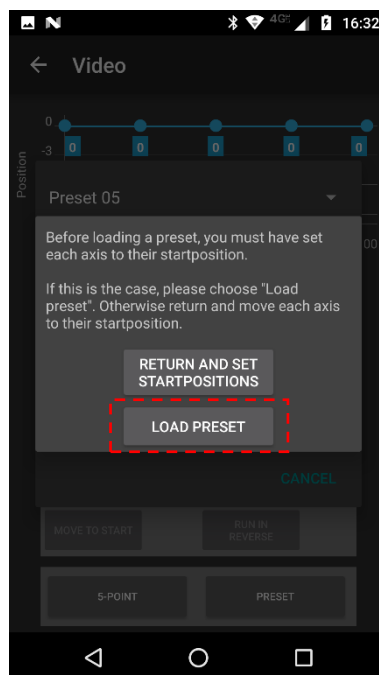


[Hier eingeben]

Click on “Load” to read the data.

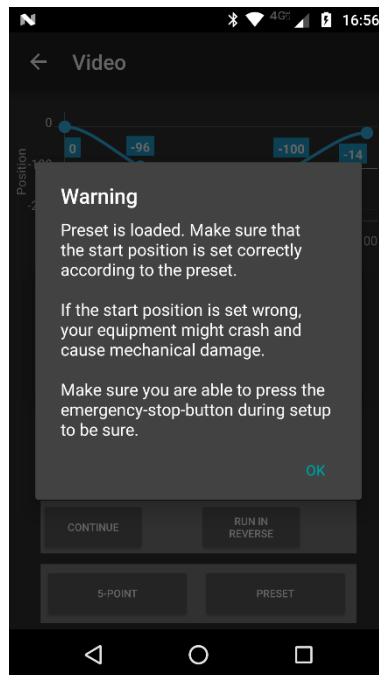


This will open a screen, which will remind you to set the correct start positions first. Click on “Load Preset” to continue.



[Hier eingeben]

You will then get another advice/warning about the correct use of the startposition.

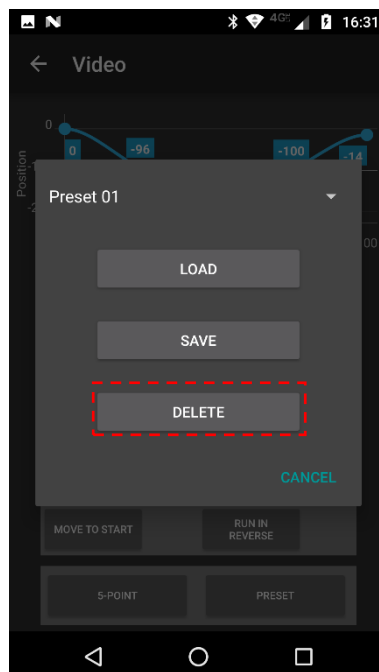
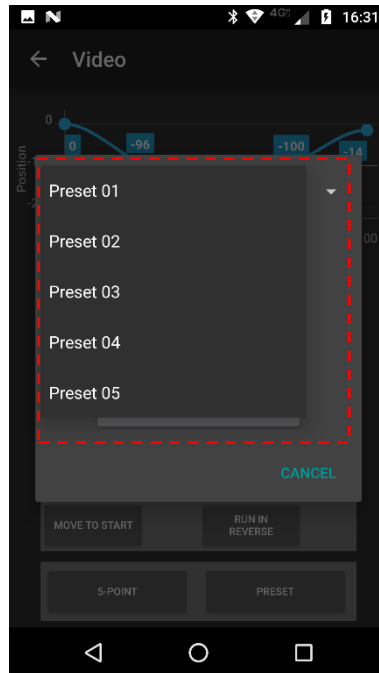


After you have confirmed this, you are ready to start. The “Continue” button will now be enabled and you can continue the Movie or Timelapse mode. To check all positions I would recommend to open each position and check whether the saved position match with your desired shot. To do this just click on each position. This can take some time if you are driving a long distance.



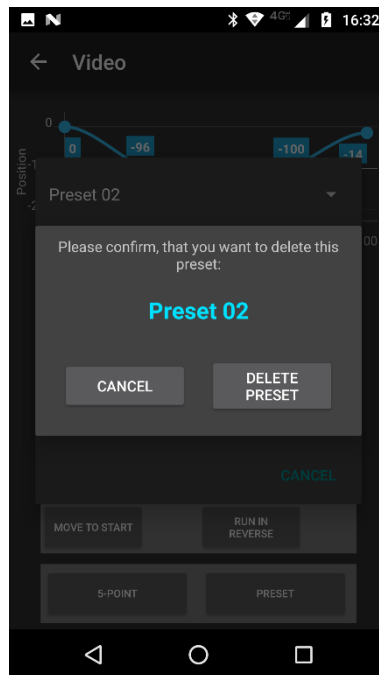
5.8.3. Motion preset: Delete preset

To have quick setup, it is recommended to keep the list of existing presets clean. If you have presets which are no longer used, you should delete them. To do this, just select the desired preset from the list and click on “Delete”.



[Hier eingeben]

This will open a screen with the preset name, which you have to confirm. After this, the preset will be deleted.



6. Timelapse

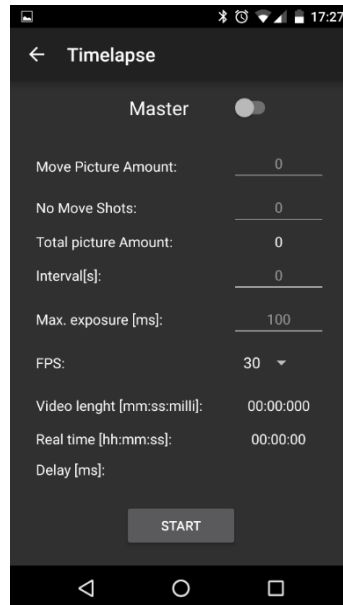
In Timelapse-mode, also known as shot-move-shot, you can choose between “Master” and “Slave”. In Master-mode, the trigger interval will be set in the app and the controller will trigger your camera over a remote shutter cable.

In Slave-mode, the controller will react to an extern trigger signal. This can be e.g. a hardware button or your camera over a hotshoe-adapter.

After you have selected the timelapse-mode within the navigation menu, the preset-menu will open. Here you have the possibility to load a previously saved preset, to create a new preset or just setup a new shot without saving.

6.1. Master-Mode

6.1.1. Timelapse Master: Setup



Master / Slave	Select between “Master” and “Slave” mode
Move Picture Amount	Amount of pictures, which will be done with a motion between shots
No Move Shots	Amount of pictures which will be done without any motion at start and end of a sequence
Total picture Amount	= “No Move Shots” + “Move Picture Amount” + “No Move Shots”
Interval	Interval in seconds between picture triggering
Max. exposure	Fill in with your desired maximum exposure time in milliseconds
FPS	Select between 24,25 and 30 fps. This setting is only important to calculate the video length below
Video length	Depending on the selected FPS and Total Picture Amount, the video length for the finished timelapse sequence is calculated
Real Time	Depending on the selected interval and Total Picture Amount, the necessary real time for the whole timelapse sequence is calculated
Delay	Delay between movement and triggering

Master-Mode is selected as default, so you don’t need to change anything to select Master-mode.

The best way to go, is to make all settings from top to bottom.

The first setting is “Move Picture Amount”. Here you must enter the amount of pictures which will be performed with a motion.

Next is “No Move Shots”. This option will add pictures in stillstand at the start and end of the motion. This is handy, if you are planning to fade your sequences during postproduction, so the pictures with motion will not be lost due to the fading.

“Move Picture Amount” + “No Move Shots” (start) + “No Move Shots” (end) will be your total picture amount which will be display below. You can also leave “No Move Shots” empty, if you want each picture with a movement.

The next setting is “Interval[s]”. Here you must set the interval between shots in seconds. Minimum is 1 s, maximum is 9999 s.

The last settings is “Max. exposure[ms]”. Here you have to enter the maximum exposure time, which you will have during your shot. **Pay attention, that this value is in milliseconds.** So if your max. exposure time is 5 seconds, you must enter 5000 ms.

Make sure that your max. exposure time is shorter than your interval. If you enter a time which is too long, you will receive an error message. In this case you have to lower your max. exposure time or increase your interval.

After you have set all values, the “Real time” and “Delay” will be updated and displayed at the end. The delay time is the time which will be between the end of motion and the camera triggering at each shot. Due to the motion, vibrations in your system will occur. The longer the delay time is, the longer your setup will have time to stabilize. So if you set your max. exposure close to the interval time, you will end up having a short delay, which might lead to blurred images.

Depending on your stepper motors, moving distance and speed, the fix move time of 200ms might not be enough. You will notice this problem, when your camera is triggering, although your steppers are still in movement.

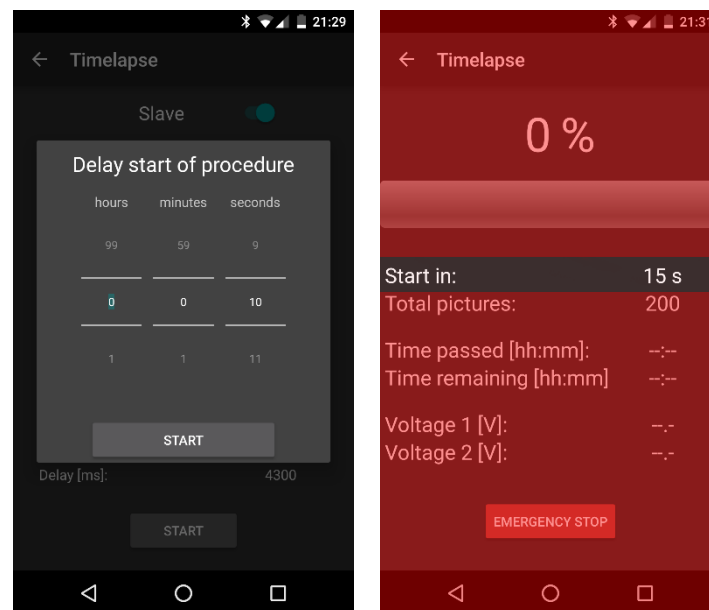
If this is the case, you have to abort your shot and fix this behavior by trying at least one of following solutions:

Solution	Effect
Increase the stepper speed/acceleration between shots or lower the microstepping	Your steppers will move faster, which will result in a shorter moving time (this might cause more vibrations in your setup)
Increase the picture amount	If you have more pictures on the same distance, the move distance between each shot will be shorter
Lower your max. exposure or increase the interval	This will increase your delay time. The stepper motion will take then place during a part of the delay time.

After you have set all values, you can click on “Start”. Before starting the procedure, all values are checked automatically. If some values are missing or not inside the correct range, you will receive an error message which will tell you what is wrong.

If the settings are correct, there will pop-up a screen, in which you have the possibility to delay the start of the procedure. If you leave the values to “0”, the procedure will start as soon as you hit “Start”.

Otherwise there will be a countdown on the status screen with the remaining time in seconds until the first picture is taken. This delay is handy if you want to start maybe “dDSLRdashboard” on your Android-device and make all settings.

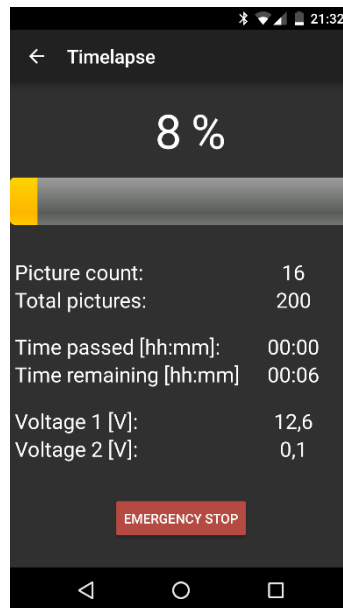


After you have clicked “Start”, all relevant values will be transmitted to the controller and from this moment on, the Android app will only listen to the current status. If you don’t need the current status, you can close the app, since the procedure is running only on the controller.

Make sure your camera is switched on, not in stand-by mode and the trigger cable (Master) is connected before your click “Start”. Otherwise you might miss the first few shots.

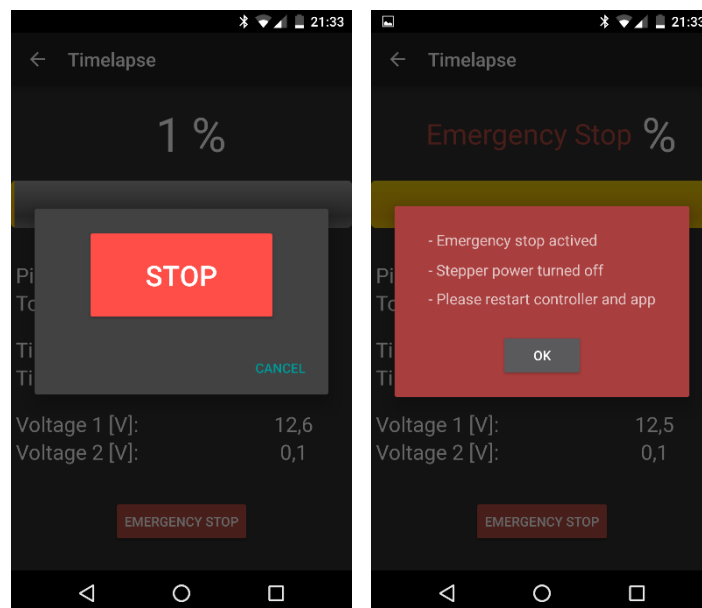
6.1.2. Timelapse Master: Status

Once the procedure has started, the current status will be updated with each picture taken.



You only have the possibility to stop the procedure and perform an emergency stop which will end the program and disable all steppers. To avoid any unintended emergency stop, an alert will be opened, in which you need to confirm the emergency stop by pressing "STOP".

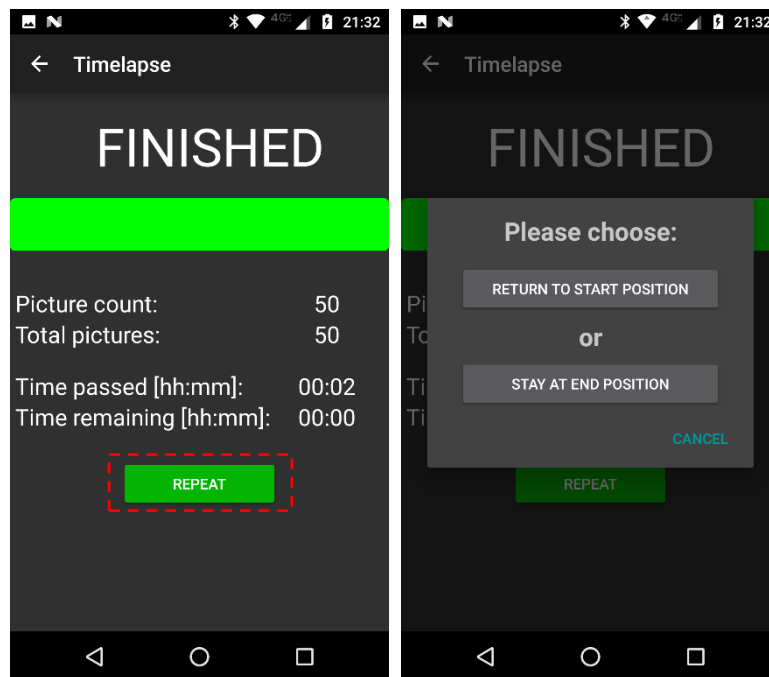
During the emergency stop, all stepper drivers will be disabled, so that your steppers will have no current. A red alert will appear, which will confirm the emergency stop and you will need to restart the controller and Android app to setup another shot.



6.1.3. Timelapse Master: Repeat timelapse shot

After your timelapse shot is finished, you can repeat the exact same shot again, do some setting changes or run the shot in opposite (reverse) direction.

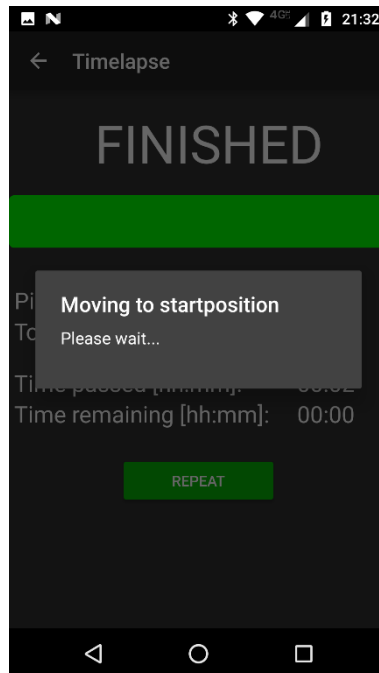
When the shot is finished, a green “Repeat”-button will appear. When you click this, another window will be opened and as you if you want to return to the startposition (to repeat the exact same movement) or if you want to stay at the current end position. This will give you the possibility to run the shot in reverse direction which is quite usefull since you don’t lose any time by driving back to the start.



If you choose “Return to start position” all axis will run with their max. speed back to the start. A window will inform you, that you have to wait until the movement is finished. Once all axis have reached the start, the screen will close and the timelapse setting screen will be displayed.

If you choose “Stay at end position” the timelapse settings screen will be displayed immediately.

All setting will be stored. You can change them or just confirm everything and continue.



When you choose “Stay at end position”, the manual move screen will automatically choose the “End”-position. Now you are able click on the “Run in reverse”-button. The process will start and your shot will be repeated again, but in opposite direction.

Of course you are also able to drive back to the Start-position and repeat the shot in the same direction as before.



6.2. Slave-Mode

In contrast to the Master-mode, the trigger signal in the Slave-mode is an external signal. This mode is useful for stop-motion-animation, where you might not have a regular camera triggering interval, but it can also be used for classic timelapse shot-move-shot if necessary.

There are three possibilities to trigger the Slave-mode:

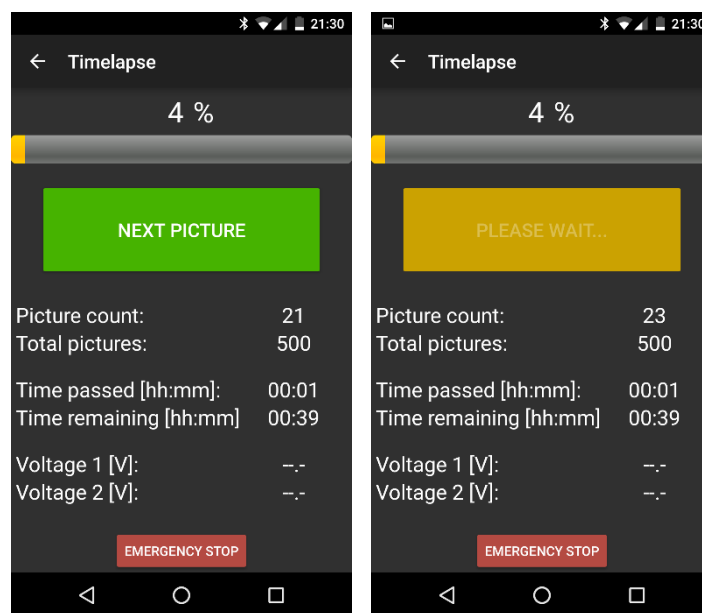
1. Camera hotshoe adapter	<p>If you use a hotshoe adapter and connect the output cable to the 2.5mm Slave input jack, the controller will notice each camera triggering.</p> <p>So you can trigger your camera over the normal camera shutter button, a remote trigger, a build-in intervalometer, qDSLRdashboard and so on.</p>
2. Hardware button / Sensor	<p>You can also connect a hardware pushbutton, photoelectric sensor or any other sensor as your trigger signal. Since the camera must be triggered, you also have to connect the shutter cable to “Master” in addition to the Slave-cable.</p> <p>To achieve a trigger signal, the Slave-connection must be shorten. If you use a pushbutton, just connect XXXXX and the controller will notice the pushbutton actuation. If you use other sensors, please have a look at XXXX.</p>
3. Software button	<p>Due to a build-in software button in the status screen of the Slave-mode, you also have to possibility to trigger the camera manually over the Android app. To do so, it is necessary to connect the camera shutter cable to “Master”.</p>

All three modes are interchangeable, without changing any other option inside the app. E.g. it is possible to trigger your camera over a hardware pushbutton for one photo, and use the software button for another photo.

The status screen for Slave-mode is similar to the status-screen of the Master-mode, except that you have the software button for manual triggering.

If an external trigger impulse (software button or over the Slave-jack) is detected, the software trigger button will switch its color to yellow and will be disabled. So you have to wait until the exposure is finished to be able to make another shot. This time is the “max. Exposure time” which you have entered during setup.

If your shooting interval is not regular and not the same as entered during setup, the values of “Time passed” and “Time remaining” will not be wrong and must be ignored.

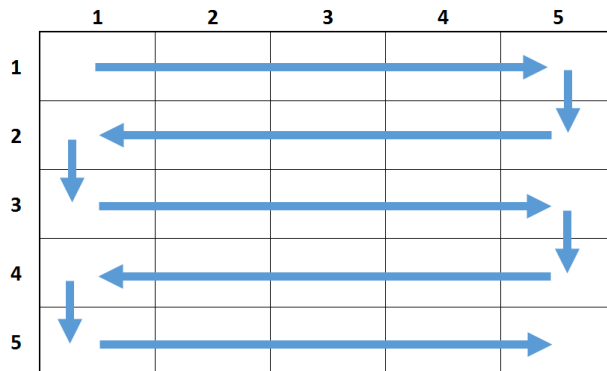


7. Panorama

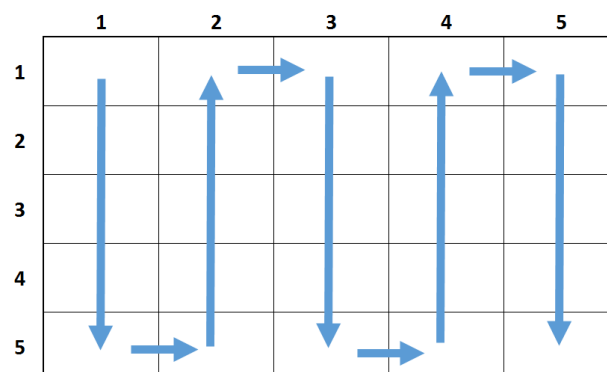
7.1. Motion settings

You can choose between two different motions for panorama pictures:

Row-by-row:



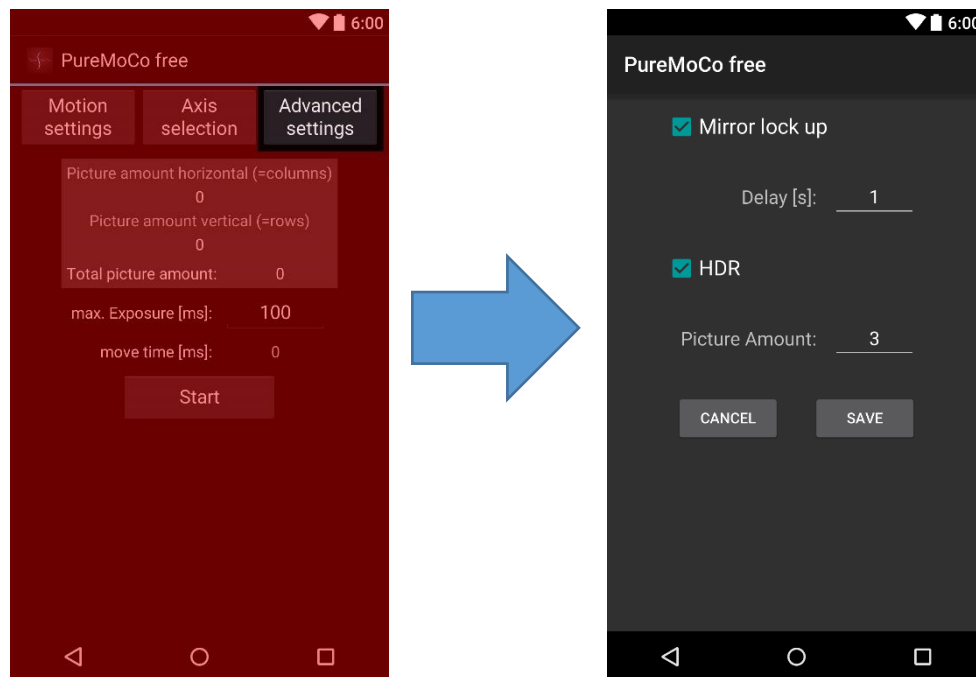
Column-by-column:



Which one you choose, is depending on your personal preferences. Column-by-column is recommended to be used, when shooting 360° panoramas. Compared to row-by-row, you don't have to change your position frequently to avoid being in the picture.

7.2. Advanced panorama settings

Within the advanced panorama settings, you have the possibility to setup mirror lock-up and HDR pictures.



7.2.1. Mirror lock-up

To avoid vibrations due to the mirror actuation of your DSLR, nearly all DSLR have the option of a mirror lock-up. In this mode, you will need to trigger your DSLR twice. The first triggering is to move the mirror, the second triggering is to start the exposure.

In the advanced setting you have the possibility to setup this second triggering and set the delay between the mirror lock-up and exposure.

Note:

If you are using a Nikon DSLR (or other DSLR which has the same feature), you have two options to setup the mirror lock-up:

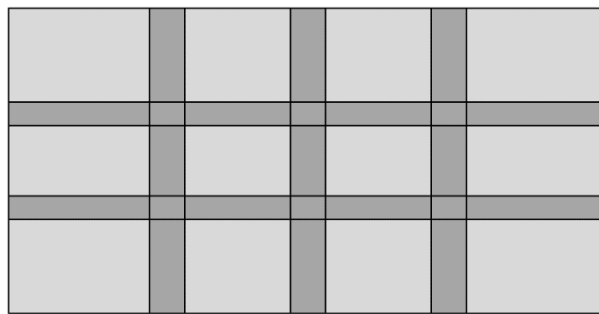
1. Select "Mup" on the shooting mode selection wheel. This will require a second trigger and you must setup the mirror lock-up in the advanced settings.
2. Select "Single-shot" on the selection wheel and activate the mirror lock-up in the custom options. There you will have the possibility to set the delay time between both shots. Since the camera will trigger automatically twice, **do not active mirror lock-up in the advanced settings.**

7.2.2. HDR panorama

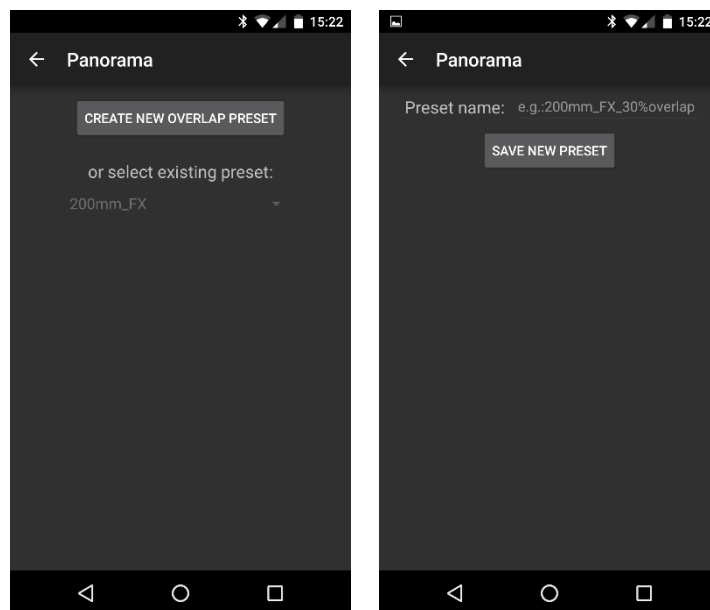
If you are planning to shot HDR panorama pictures, you have to set up the picture amount

7.3. Panorama setup

Each panorama consists of several pictures, which will be joined into one single picture. To do so, a certain overlapping amount is necessary. An overlapping of 30-40% (vertical and horizontal) is an optimum for each picture.



The overlapping amount will be set-up manually before each shot. If you shot panoramas with constant settings (same camera, same lens and same focal length), you have to possibility to save the overlapping as a preset once and call those settings for the followings panoramas.



8. Movie-mode

9. Astro-mode

← Astro

1. Rotation direction ?

☒ North ☐ South

2. Rotation speed ?

☒ Sidereal (stars)
☐ Solar (sun)
☐ Lunar (moon)
☐ Test (fast)

3. Exposure Time (HDR) ?

	Exposuretime [s]	Delay time [s]
1.	---	---
2. <input type="checkbox"/>	---	---
3. <input type="checkbox"/>	---	---

4. Picture amount ?

- 1 +

5. Mirror lock-up ?

☐ Enable mirror lock-up

6. Continue ?

Total time: ---

CONTINUE

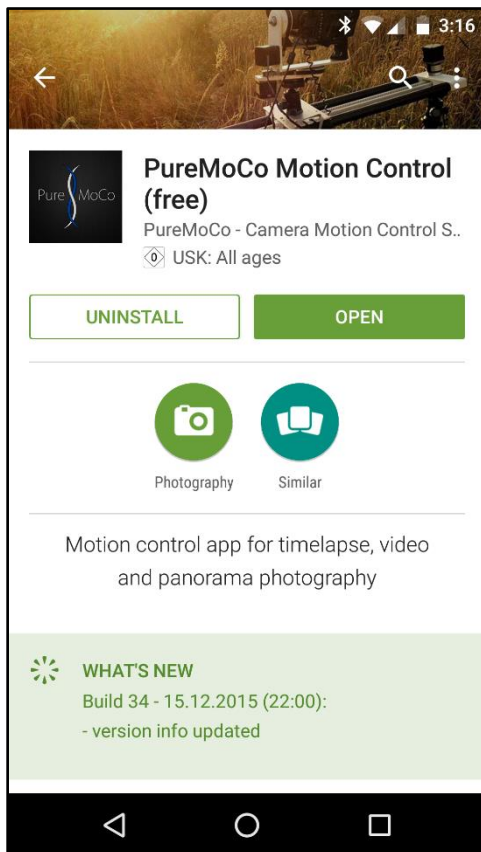
10. PlayStation 4 controller support

11. App Update

Like with every other app you install from the Google Play Store, you will receive updates over the Play Store automatically.

Some updates will only affect the app itself, so there will be no changes in the Arduino firmware. In this case, it is sufficient to only update the Android app.

Other updates however, will require an Arduino firmware update. In this case, you will find a notice in the Play Store changelog to update your firmware. The changelog will be displayed in the Play Store as a box with a green background labeled “WHAT’S NEW”:

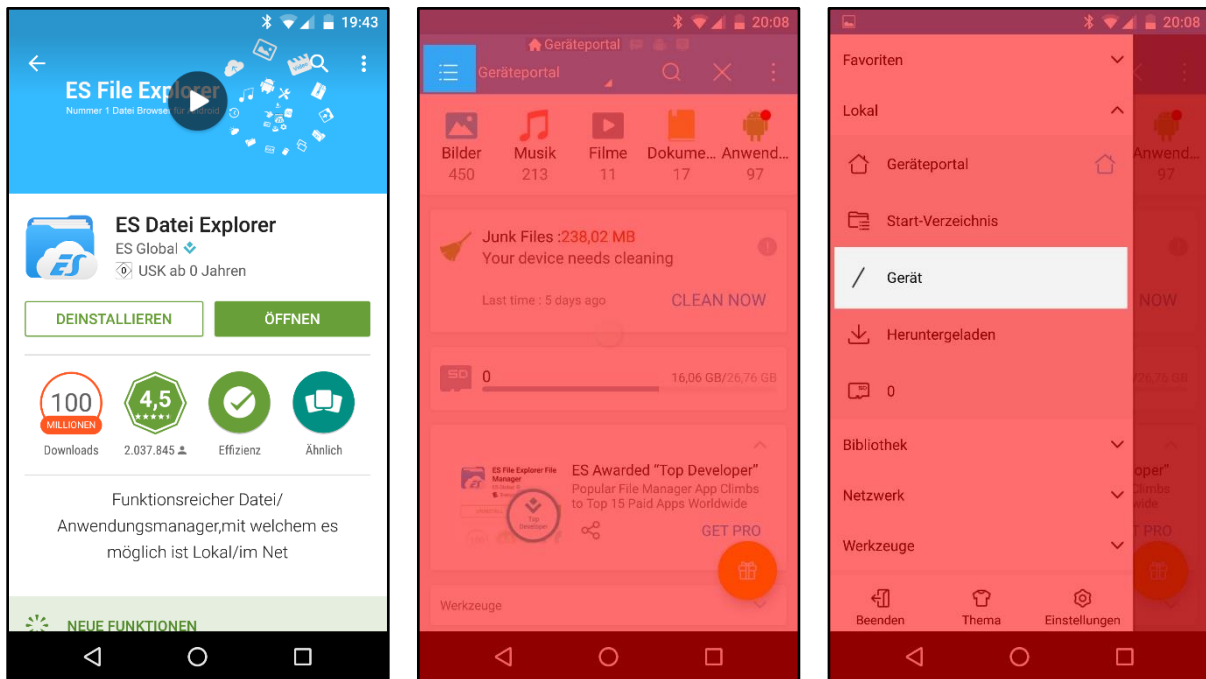


There will be also some app updates, which will have changes in the settings database. In this case, you will also find a notice in the Play Store changelog. **If this kind of update is performed, it is necessary to delete your current database stored on your phone.** This way, the app is capable of creating a new database with the updated data.

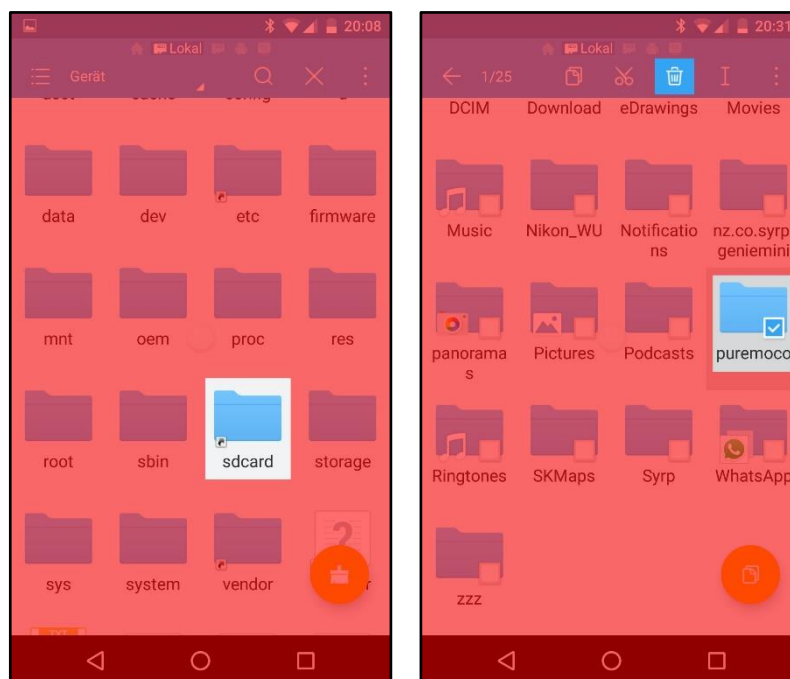
If you do not delete your database after an update which indicates in the changelog to do so, the app will crash right after starting, since it cannot read the values from your old database since they do not exist yet.

[Hier eingeben]

The database-folder will be stored at your “sdcard”-partition of your device. If you don’t have a file explorer to browse your files, I recommend using “ES Datei Explorer”:



Navigate to the puremoco-folder and select the folder by holding 2-3 seconds. Then, the options in the upper navigation will appear. Tap on the waste basket to delete the entire puremoco-folder



12. Arduino Firmware

12.1. Software prerequisites

NOTE:

When connecting your controller via a USB-cable to your PC, make sure to disconnect all your steppers from the controller. Due to the board layout, the steppers will receive the 5V voltage over the USB-Port of your PC. To avoid this, disconnect your steppers before connecting the USB-cable.

To be able to update the firmware on your controller (Arduino), you will need the Arduino IDE. The latest version can be found on the official website:

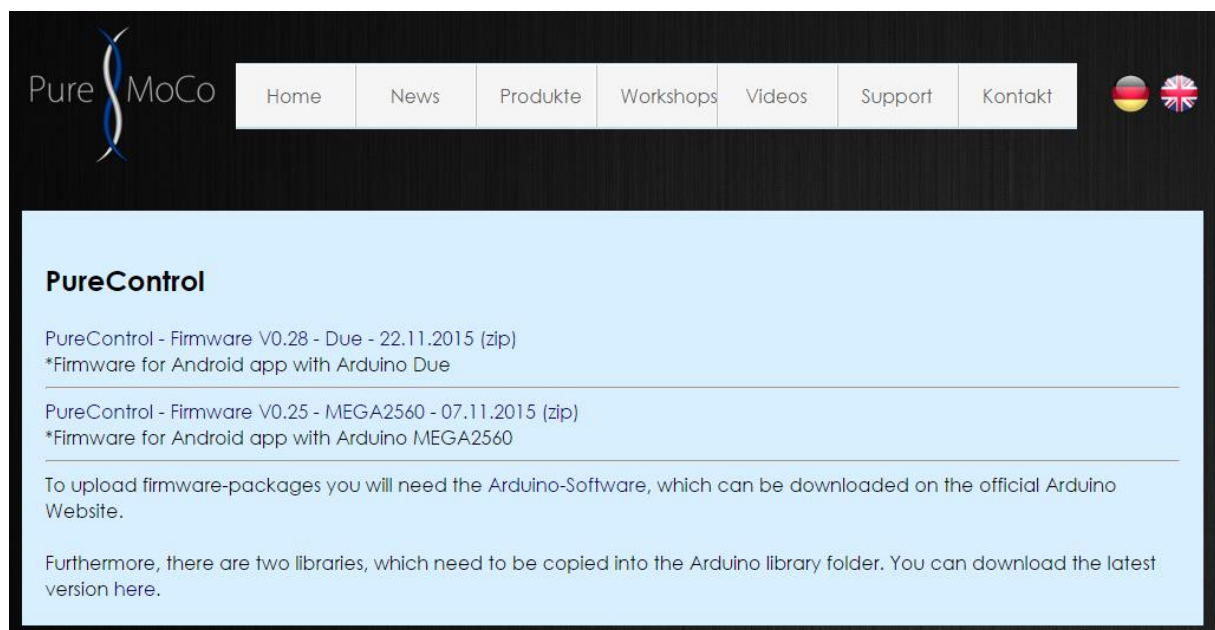
<http://www.arduino.cc/en/Main/Software>

Furthermore, you will need two additional libraries for the firmware able to be run. The current version of both libraries can be downloaded as a package here:

<http://puremoco.com/downloads/firmware/libraries.zip>

The latest version of the firmware itself, will be linked on the website:

<http://puremoco.com/pages/firmware.php>

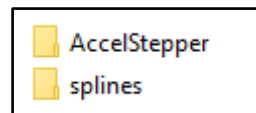


[Hier eingeben]

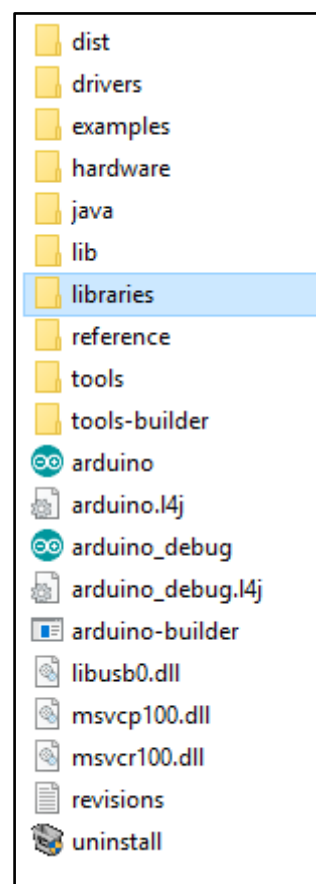
The firmware and the additional libraries will be packed into a zip-archive. Extract both archives, so that you will get the folders:



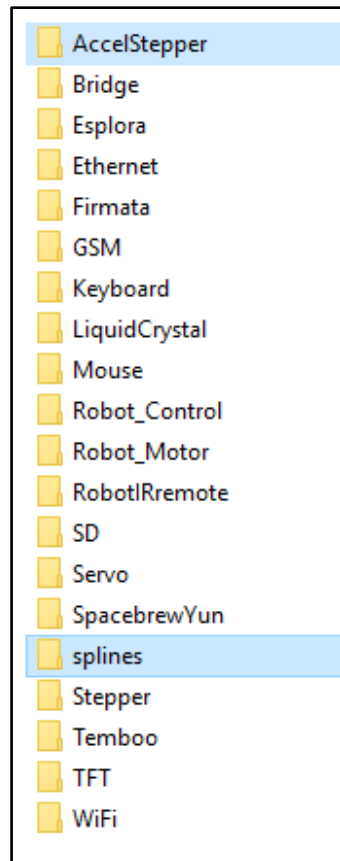
The libraries folder will contain the folders “AccelStepper” and “splines”:



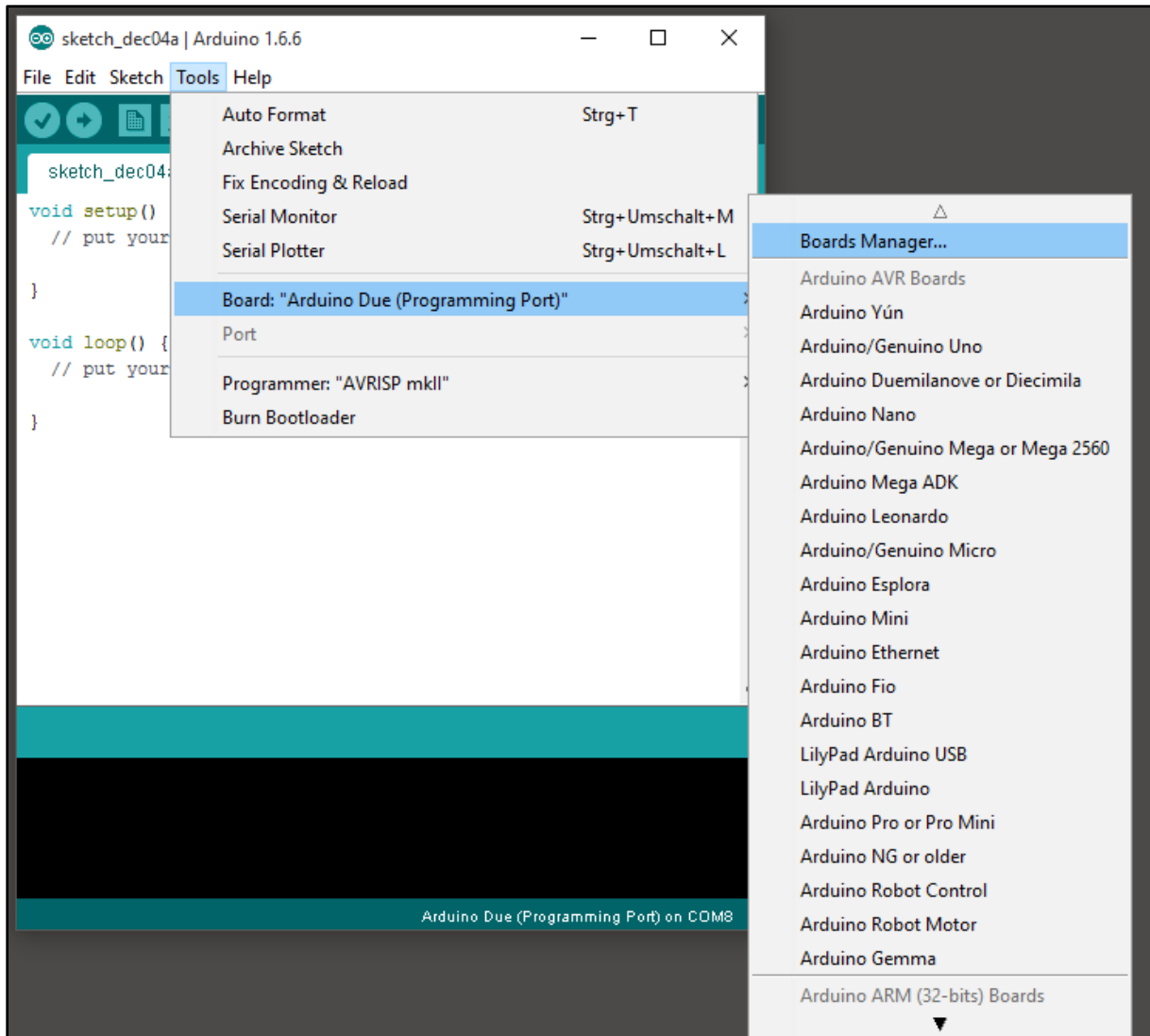
After you have installed the Arduino IDE, copy those two folders into the Arduino installation folder into the folder “libraries”:



After you have copied the folders, the libraries-folder should look like this:

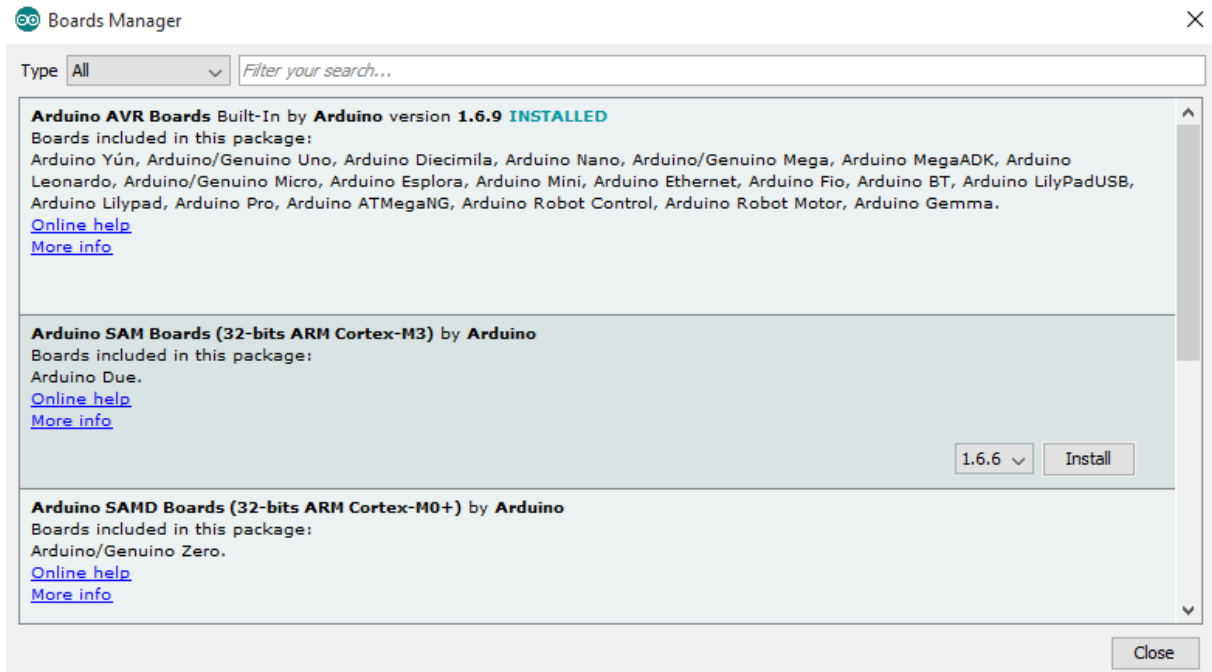


Open the Arduino IDE and open the “Board manager”:



[Hier eingeben]

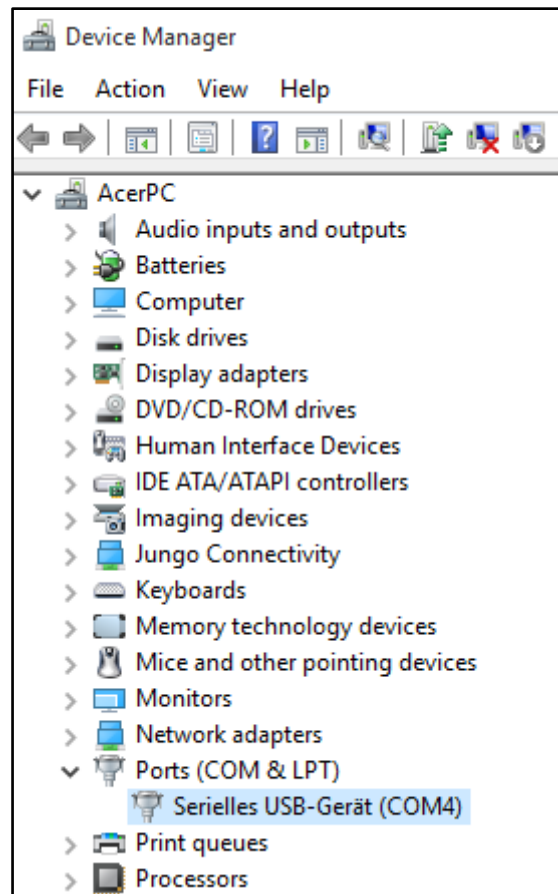
Search for “Arduino SAM Boards (32-bits ARM Cortex-M3) by Arduino”, select the latest version and click on “Install”:



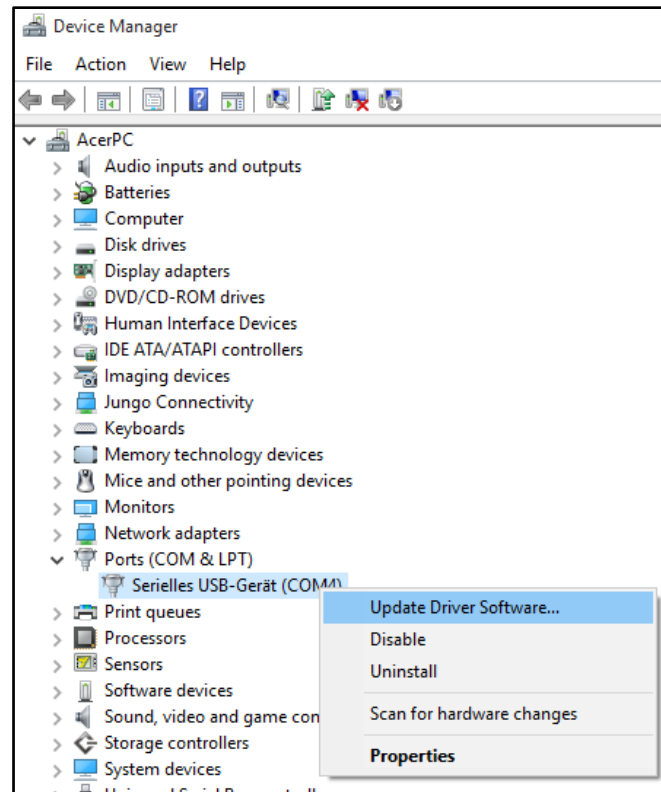
Close the Arduino IDE and connect your controller (=Arduino) via a micro-USB to your PC. Make sure to use the Programming Port (the micro-USB port on the right side) of your Arduino Due.

Windows should now start searching hardware drivers for the Arduino. Depending on your Windows version, it may find some drivers or will return an error message that no drivers could be found.

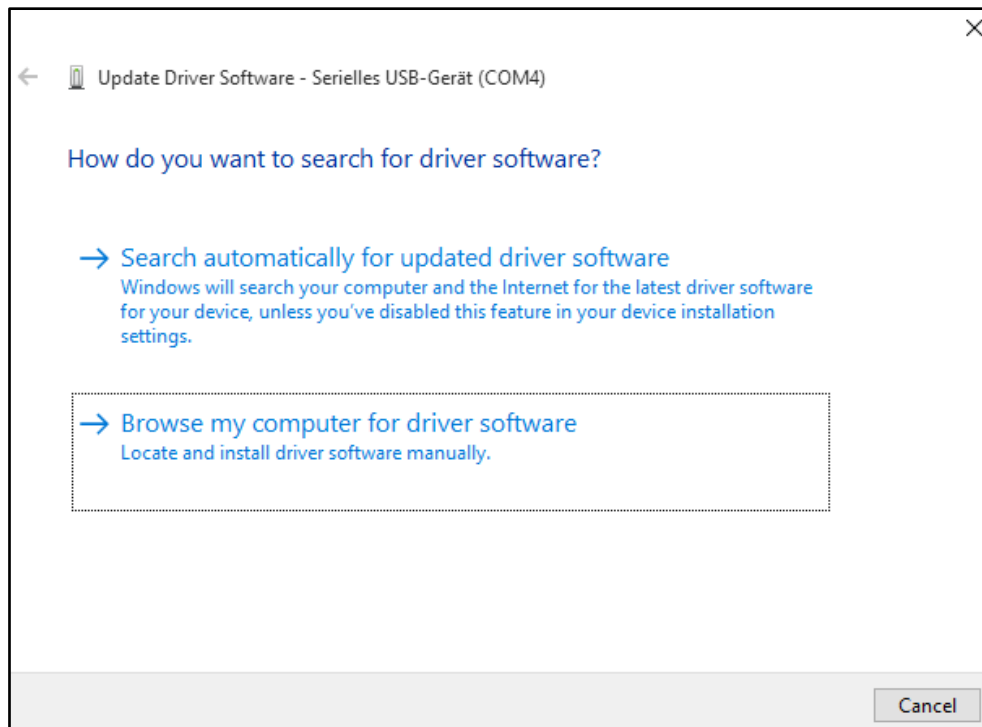
In both cases, open your Windows device manager. The Arduino should be shown in the “Ports (COM & LPT)” category:



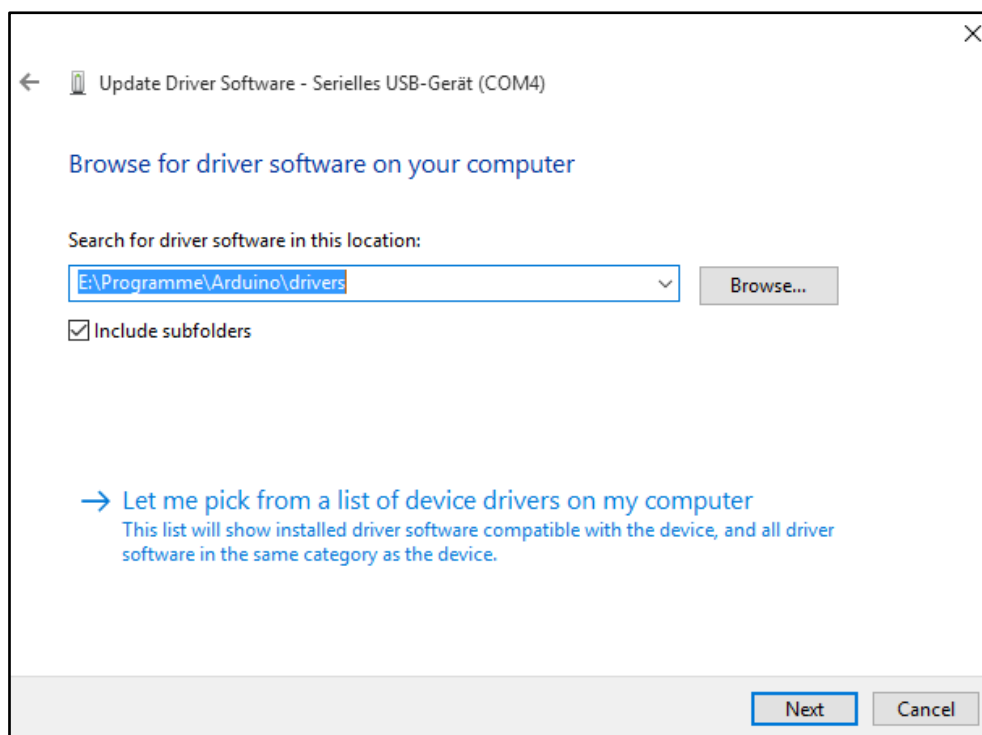
Make a right click on the Arduino and choose “Update Driver Software...”:



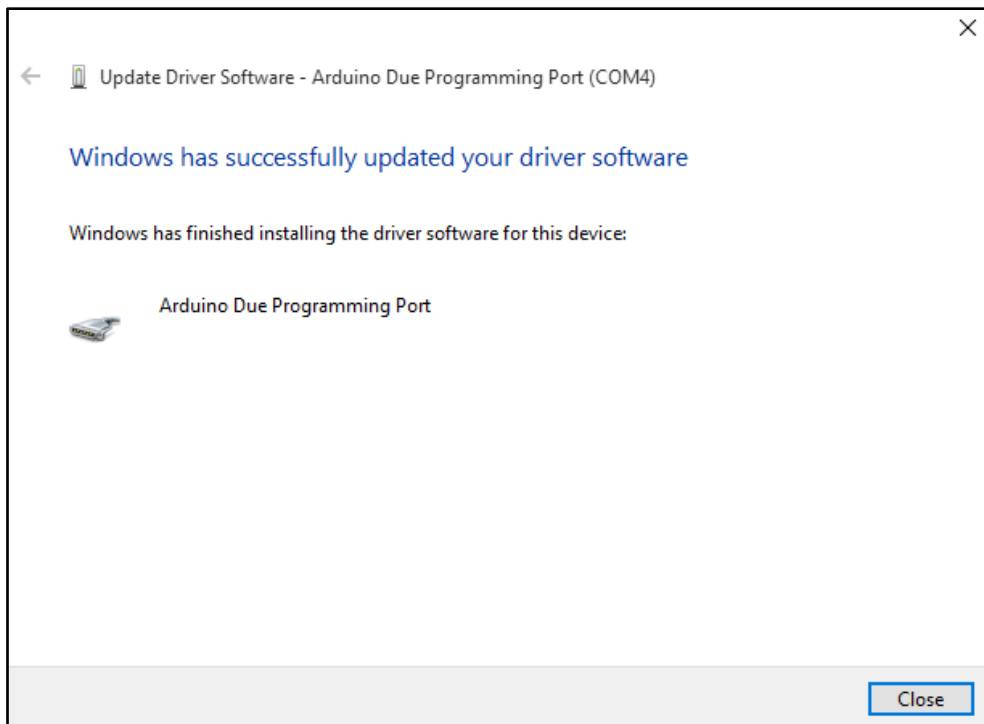
Choose “Browse my computer for driver software”:



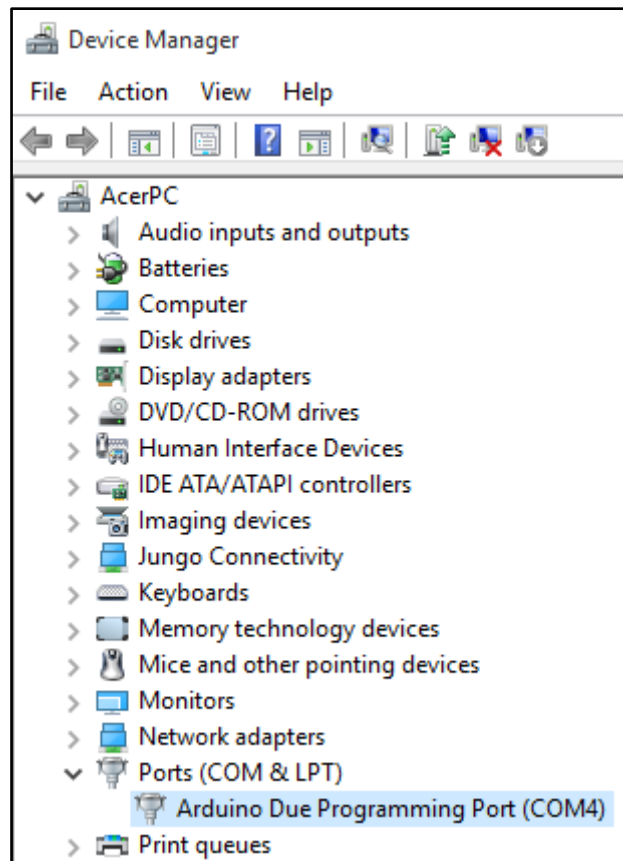
Make sure that "Include subfolders" is checked. Browse into your Arduino install directory and choose the "drivers" subfolder.



The drivers should be installing now and if everything went alright, the Arduino should finally be labeled as "Arduino Due Programming Port":



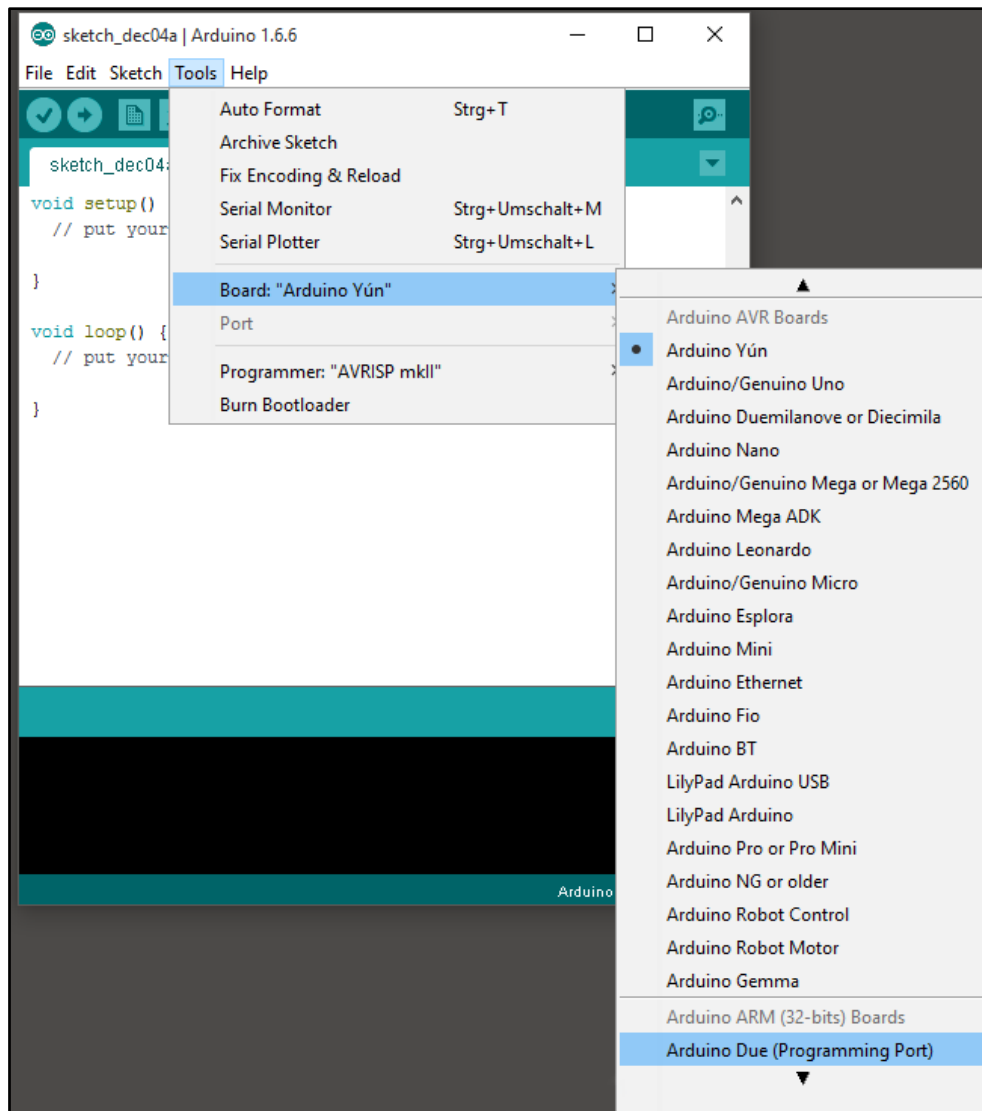
After the drivers are successfully installed, your Arduino should be named “Arduino Due Programming Port” at “Ports” and will have a COM-Port-number:



12.2. Firmware update

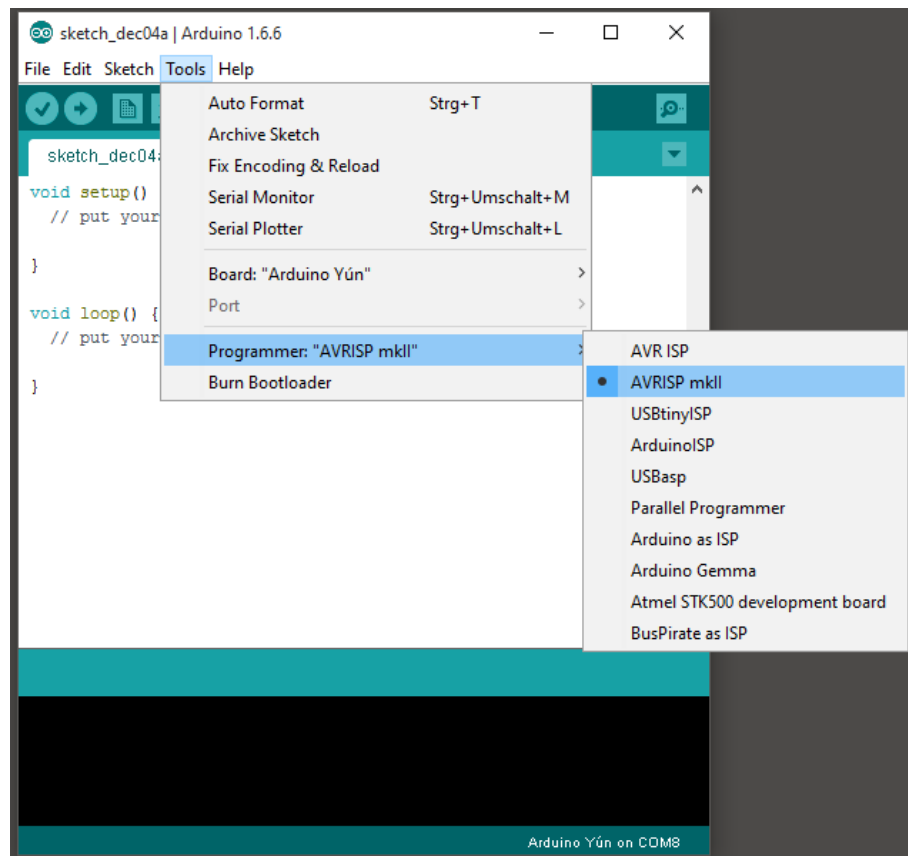
Keep your Arduino connected to your PC and open the Arduino IDE. Go to Tools→"Board:" and select "Arduino Due (Programming Port)", which should be on the bottom of the list:

[Hier eingeben]

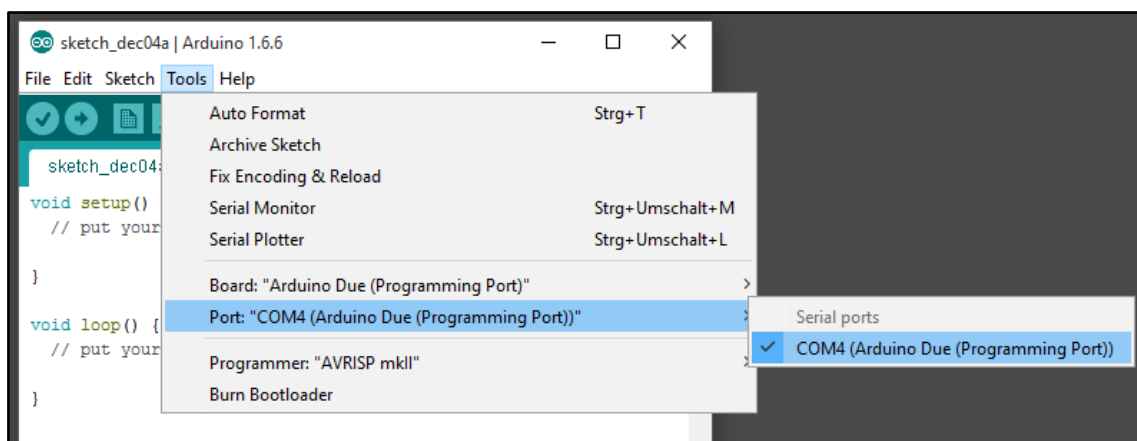


Under “Tools→ Programmer” select “AVRISP mkII”:

[Hier eingeben]

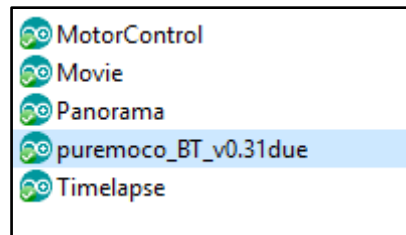


Under “Tools→Port”, make sure, that the right COM-Port (your Arduino is selected). Especially, when you have several COM-Ports or Arduinos. Otherwise you will encounter an error during upload:

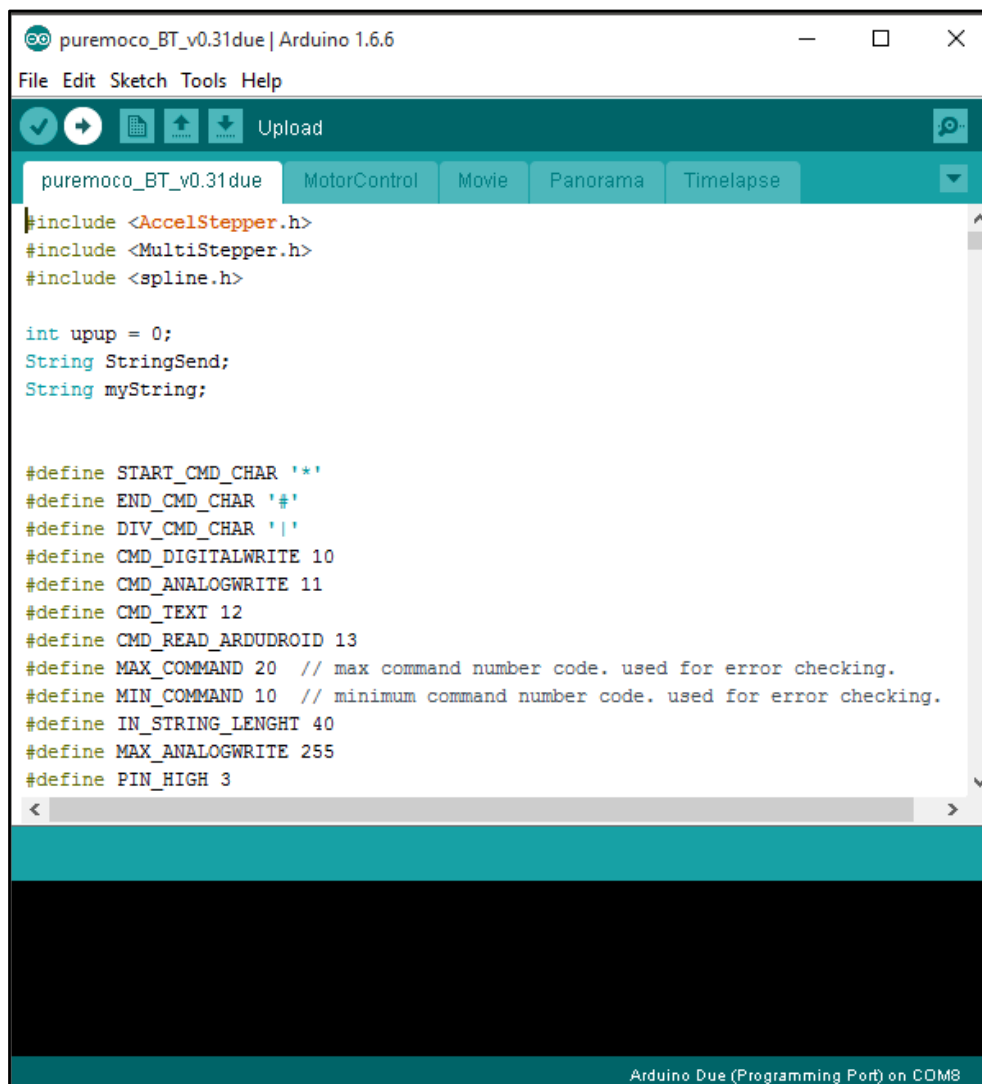


Now it is time to open the downloaded firmware. Go to “File→Open” and open the “puremoco_BT_vXXX” within the downloaded and extracted folder.

[Hier eingeben]

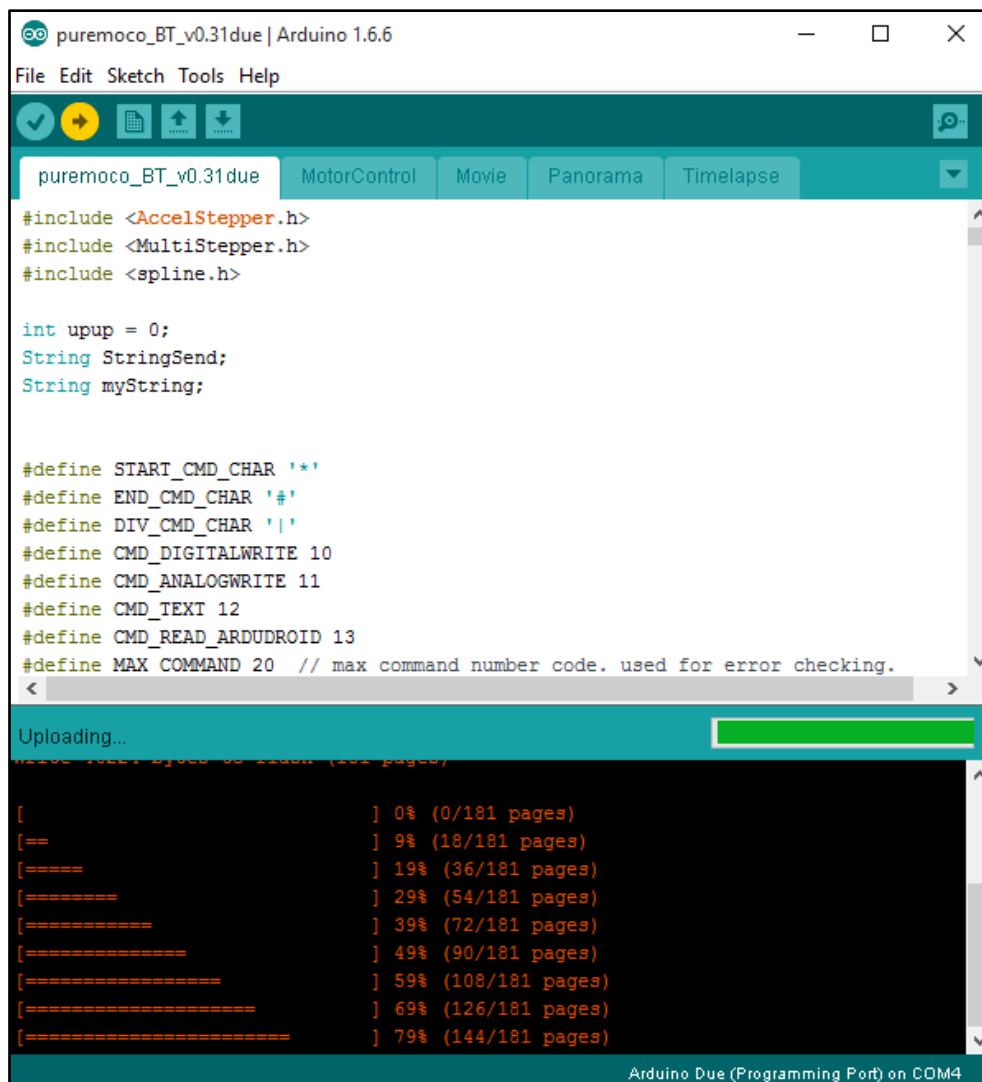


Now you should see the code and can click on the “Upload”-button:



The upload will start and will take some seconds to finish. The current progress can be monitored in the lower black textfield:

[Hier eingeben]



```
puremoco_BT_v0.31due | Arduino 1.6.6
File Edit Sketch Tools Help

puremoco_BT_v0.31due MotorControl Movie Panorama Timelapse

#include <AccelStepper.h>
#include <MultiStepper.h>
#include <spline.h>

int upup = 0;
String StringSend;
String myString;

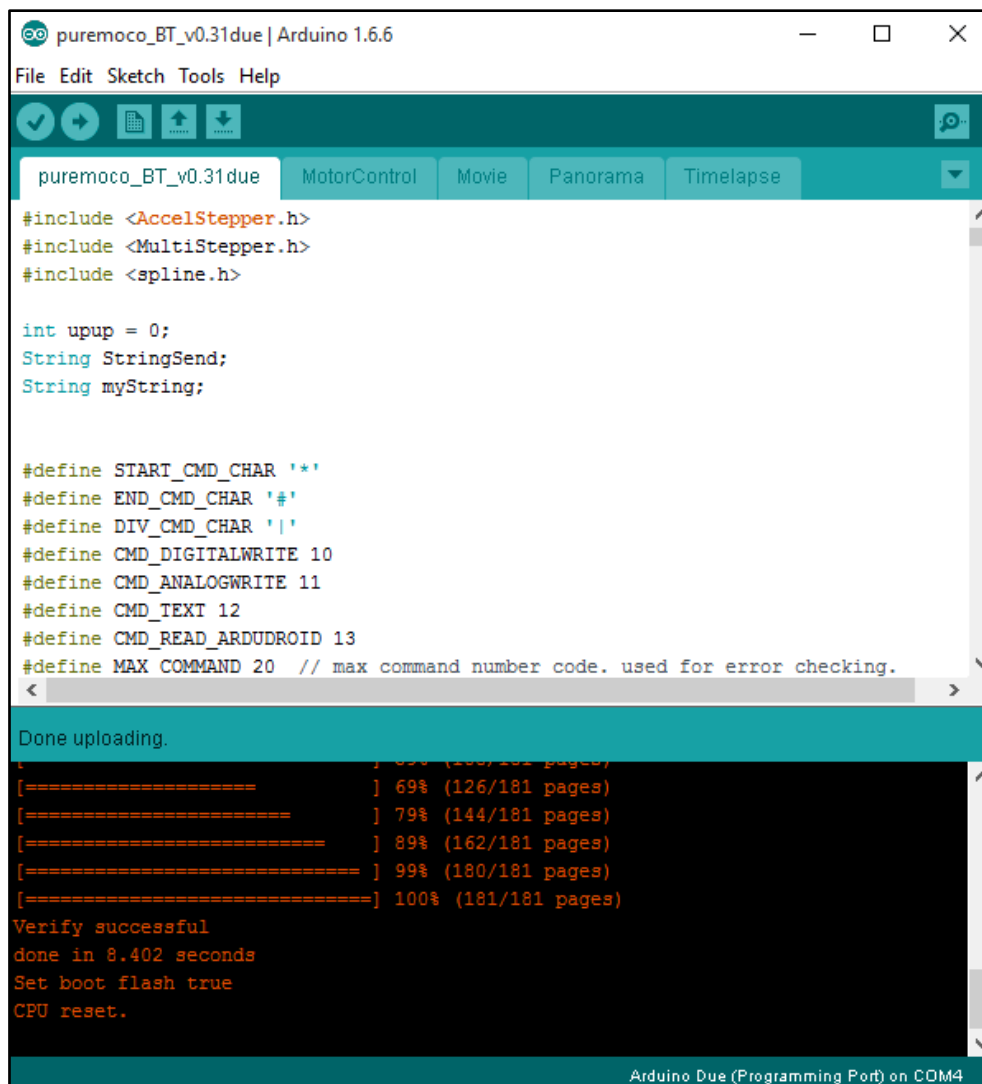
#define START_CMD_CHAR '*'
#define END_CMD_CHAR '#'
#define DIV_CMD_CHAR '|'
#define CMD_DIGITALWRITE 10
#define CMD_ANALOGWRITE 11
#define CMD_TEXT 12
#define CMD_READ_ARDUDROID 13
#define MAX_COMMAND 20 // max command number code. used for error checking.

Uploading...

[ ] 0% (0/181 pages)
[==] 9% (18/181 pages)
[====] 19% (36/181 pages)
[=====] 29% (54/181 pages)
[=====] 39% (72/181 pages)
[=====] 49% (90/181 pages)
[=====] 59% (108/181 pages)
[=====] 69% (126/181 pages)
[=====] 79% (144/181 pages)

Arduino Due (Programming Port) on COM4
```

If the upload was successful, you will be able to see following text:



The screenshot shows the Arduino IDE interface. The top menu bar includes 'File', 'Edit', 'Sketch', 'Tools', and 'Help'. Below the menu is a toolbar with icons for checking, uploading, and downloading. The sketch name 'puremoco_BT_v0.31due' is displayed in the top left, and tabs for 'MotorControl', 'Movie', 'Panorama', and 'Timelapse' are visible. The main text area contains C++ code for a stepper motor controller, including headers for `<AccelStepper.h>`, `<MultiStepper.h>`, and `<spline.h>`. It defines several command codes and includes a loop function. The bottom status bar indicates 'Arduino Due (Programming Port) on COM4'. The bottom console window shows the upload progress and a successful verification message.

```
puremoco_BT_v0.31due | Arduino 1.6.6
File Edit Sketch Tools Help

puremoco_BT_v0.31due MotorControl Movie Panorama Timelapse

#include <AccelStepper.h>
#include <MultiStepper.h>
#include <spline.h>

int upup = 0;
String StringSend;
String myString;

#define START_CMD_CHAR '*'
#define END_CMD_CHAR '#'
#define DIV_CMD_CHAR '|'
#define CMD_DIGITALWRITE 10
#define CMD_ANALOGWRITE 11
#define CMD_TEXT 12
#define CMD_READ_ARDUDROID 13
#define MAX_COMMAND 20 // max command number code. used for error checking.

Done uploading.
[=====] 69% (126/181 pages)
[=====] 79% (144/181 pages)
[=====] 89% (162/181 pages)
[=====] 99% (180/181 pages)
[=====] 100% (181/181 pages)
Verify successful
done in 8.402 seconds
Set boot flash true
CPU reset.

Arduino Due (Programming Port) on COM4
```

If the upload was not successful, the corresponding errors will be displayed. Always make sure to have the correct board and COM-Port selected within the “Tools”.

13. SilentStepStick stepper drivers

To be able to connect and control stepper motors with the Arduino, stepper motor drivers are necessary. On the PureControl, 6 SilentStepStick drivers can be installed. Those drivers are produced and distributed by watterott.com.

The drivers contain the Trinamic TMC-2100 chip which is the main component on of the SilenStepStick. For further information on the driver and chip, please have a look on these websites:

Official Watterott SilentStepStick Github page:

<https://github.com/watterott/SilentStepStick>

Trinamic TMC2100 product page:

<http://www.trinamic.com/products/integrated-circuits/stepper-power-driver/tmc2100>

Trinamic TMC2100 product sheet / manual:

http://www.trinamic.com/scripts/download.php?file=articles%2Fproducts%2Fintegrated-circuits%2Ftmc2100%2Fdatasheet%2FTMC2100_datasheet.pdf

13.1. Overview

Since the PureControl-PCB is designed to take up the SilentStepStick drivers, you don't have to worry about connecting the necessary pin connections. If you want to have a further understanding of the driver functions, please have a look at the links written in the chapter above.

SilentStepStick

Pinout

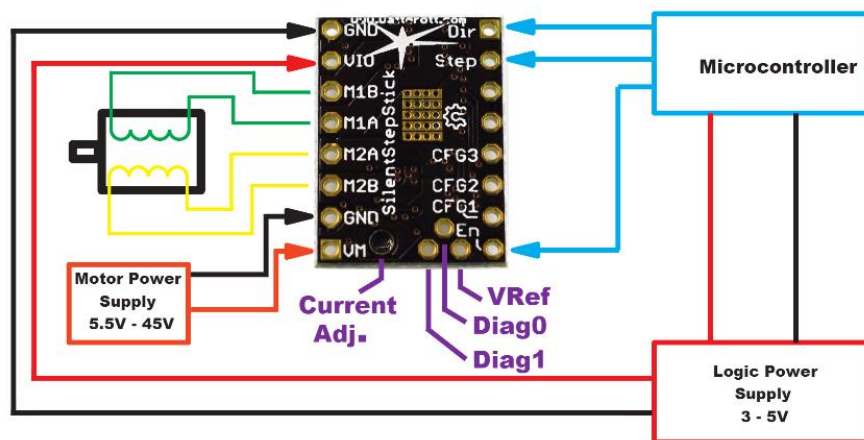


Abbildung 1 SilentStepStick - Pinout (Watterott, https://github.com/watterott/SilentStepStick/blob/master/hardware/SilentStepStick_v12.pdf)

13.2. Microstepping

The SilentStepStick offers two main modes how the stepper is supplied with current: spreadCycle and stealthChop. Further information on both modes and microstepping can be found in the Trinamic TMC2100 data sheet. So the following information will be only as an overview.

spreadCycle:

allows higher loads, torque and acceleration but steppers will create annoying high pitch sounds

stealthChop:

allows noiseless operation of steppers. Torque will be less then with spreadCycle, but is not really relevant for camera motion systems

Microstepping can be set using the CFG1 and CFG2 pin on the SilentStepStick. Since those pins have three input states (GND, VCC and open) it is not simply possible to connect those pins directly to the Arduino digital output pin.

Because of this layout of the drivers, CFG1 and CFG2 are connected over optocouplers to the Arduino. This way it is possible to switch between the three states.

All the possible microstepping configurations of the SilentStepStick are listed in the table below. Including all possible settings would require a lot of optocouplers and Arduino output pins. Because of this, the PureControl includes the green highlighted modes only.

As mentioned above, spreadCycle will allow more torque, but your steppers will generate an annoying noise. This will be the case if you set your steppers to “1/1 full”, “1/2 half” and “1/16 spreadCycle”. “1/4 quarter” and “1/16 stealthChop” should be however silent during operation.

Which microstepping you choose for your steppers depends on your steppers, gearing and axis setup. If you have a low gear reduction, you might choose 1/16 or 1/4. If you have a high gear reduction, you might choose 1/2 or 1/1.

1/1 and 1/2 might cause vibration on the motors, depending on your use, this might be disturbing.

CFG1	CFG2		Interpolation	Chopper Mode
GND	GND	1(full)	None	spreadCycle
VCC	GND	2(half)	None	
Open	GND	2(half)	Yes - 256 Steps	
GND	VCC	4(quarter)	None	
VCC	VCC	16(sixteenth)	None	
Open	VCC	4(quarter)	Yes - 256 Steps	
GND	Open	16(sixteenth)	Yes - 256 Steps	stealthChop
VCC	Open	4(quarter)	Yes - 256 Steps	
Open	Open	16(sixteenth)	Yes - 256 Steps	

13.3. Power saving

The SilentStepStick drivers (TMC2100) have an inbuilt power saving function, which will reduce the stepper current if the motor is in standby. This feature is described in the Trinamic TMC2100 data sheet:

1.3 Standstill Current Reduction

The automatic standstill current reduction allows to automatically reduce the motor current by nearly two-thirds to save energy in standstill. This is possible in many applications, as normally less holding torque is required. In case the standstill current option has been enabled, the motor current becomes softly ramped down from 100% to 34% in 44M clock cycles (3 to 4 seconds) if no step pulse has been issued for more than 3M clock cycles (standby delay time). The soft current ramp avoids a jerk on the motor.

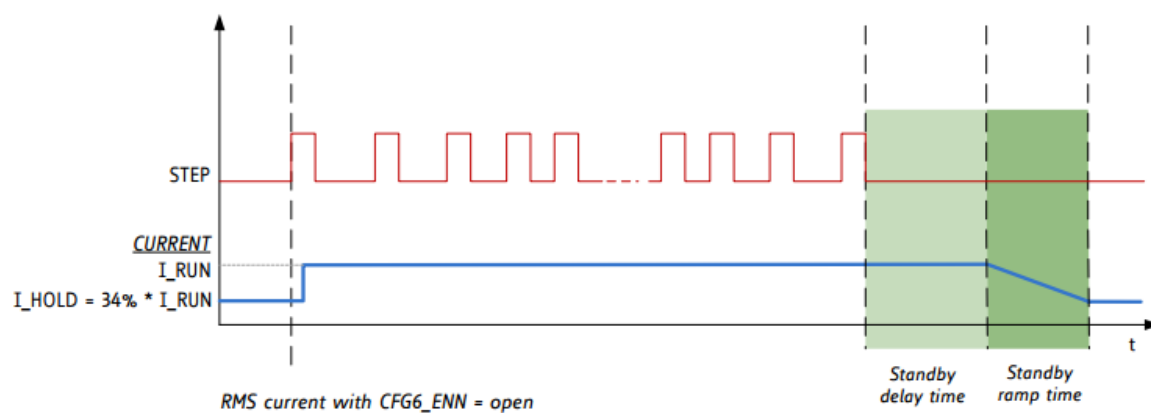


Figure 1.2 Standstill current reduction

Abbildung 2 - Standstill current reduction (Trinamic, <http://www.trinamic.com/products/integrated-circuits/stepper-power-driver/tmc2100>)

In the PureMoCo control app, you have the possibility to setup between this power saving mode or full power mode individually for each axis. Power saving mode is enabled as default.

The only case to enable full power mode would be, if your axis could not hold the current position with the reduced current. This would be the case if your load is very high and you have a low gear reduction build in.

In this case the stepper will be running at its torque maximum. If you now would reduce the current, the torque would decrease and the stepper will move uncontrolled. So only switch to full power mode, if you encounter a problem during stillstand.

Besides saving power of your battery and increasing the runtime of it, current reduction has also another benefit. Due to the reduced current, the drivers will produce less heat inside the housing, which will extend the lifetime of the components.

