



# Documentation

Software version 2.0 alpha 3  
Hardware revision D

Airic Lenz

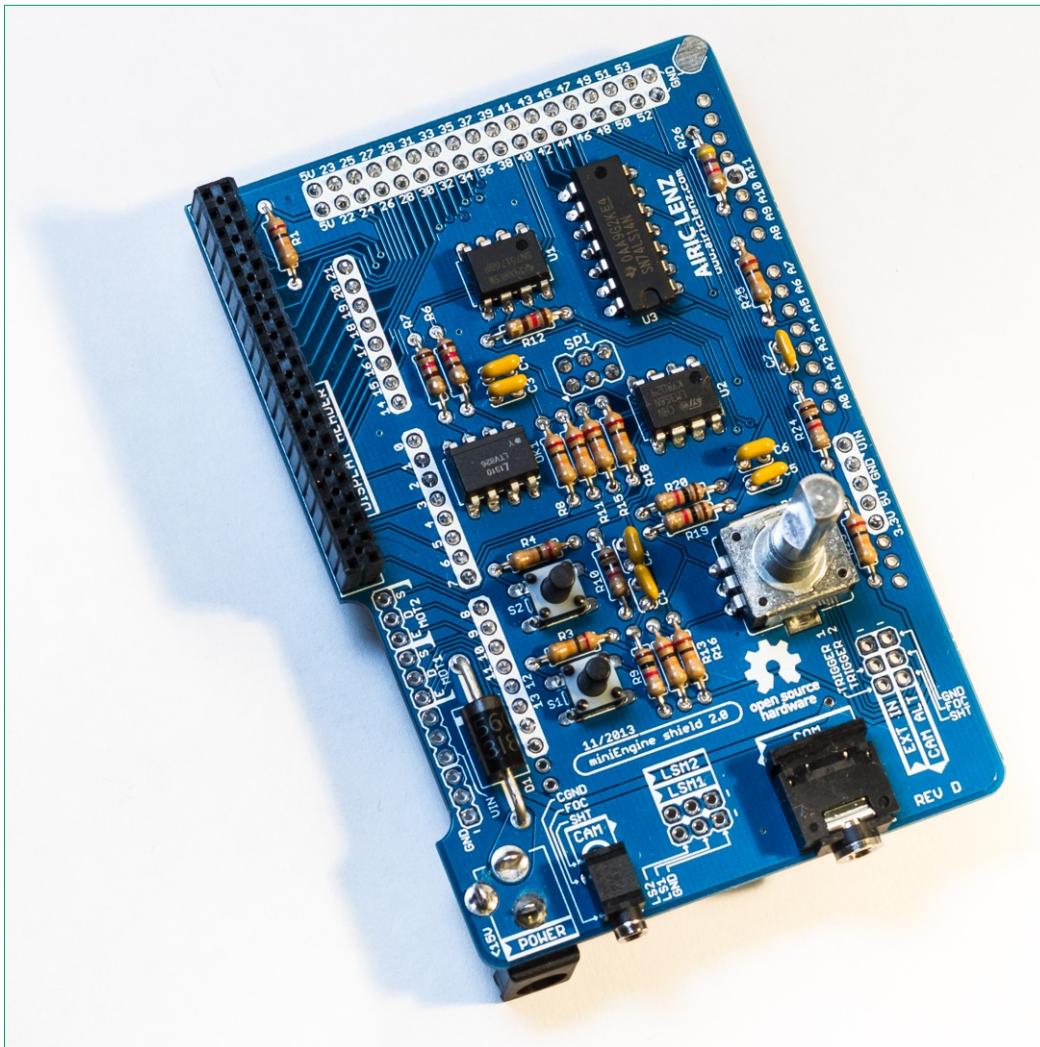
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## 1 | Introduction

The miniEngine is open-source motion-control-system for time-lapse as well as video photography. The current version provides all functions needed to smoothly and precisely control 2 stepper-motors and one camera. It is Arduino DUE based and comes with a shield, designed to hold all required hardware components. These components allow user input as well as connecting 2 stepper-motor-drivers for then connecting the motors.

This is how a fully assembled miniE (short for miniEngine) shield for the Arduino DUE looks like (the display is not plugged into the shield for a better view):



▲ The miniEngine 2 Arduino shield

These functions are currently supported by the system:

- Simultaneous control of two stepper motors
- Control of one photo-camera (needs to be remote triggerable)
- Time-lapse recording in shoot-move-shoot mode
- Time-lapse recording in continuous mode (also usable for video shoots)
- System is fully adjustable to the hardware used, e.g. stepper motor calibration to be able to set up precise moves in cm / °
- User input via one rotary encoder and two buttons
- 320 x 240 pixel colour TFT display
- All settings / program data stored on an SD card for easy and fast reconfiguration using multiple cards holding different set-ups
- Fully open-source

These are the major components that are required for the system:

1 Arduino DUE with the miniEngine 2 software installed

1 ITDB02-2.4E Display (320x240 Pixel, SD-Card, Touch) from ITEAD Studio

1 miniEngine 2 Arduino shield (can be bought on [www.airiclenz.com](http://www.airiclenz.com))

1 or 2 Stepper Motor Drivers (BigEasyDriver is recommended and supported)

1 or 2 Stepper Motors

1 7-15V Power supply capable of supplying up to 4A

## | 2 | Hardware (miniEngine 2 Arduino Shield)

The following chapter explains how to assemble the miniEngine shield and which components are needed in detail.



There is an additional power input on the miniEngine shield. This input is secured up to 5A by a beefy diode and can easily handle the amount of energy the stepper motors might need. **USE THIS POWER-JACK and NOT the original power-jack of the Arduino!!!** Otherwise you might destroy the Arduino!

### | 2.1 | Bill of Material

Amount and Part	Board designator(s)	Description / package
11x 20kΩ Resistor	R1, R3, R4, R8, R11, R13, R15, R16, R18, R23, R25	1/4W, 5%, THT Resistor
5x 1kΩ Resistor	R9, R10, R19, R20, R24	1/4W, 5%, THT Resistor
3x 120Ω Resistor	R6, R7, R12	1/4W, 5%, THT Resistor
1x 4.7kΩ Resistor	R26	1/4W, 5%, THT Resistor
7x 100nF Capacitor	C1, C2, C3, C4, C6, C6, C7	2.54 mm pitch Capacitor
1x 5A Diode	D1	DO201AD
1x 2.5MM Stereo Jack	CAM	2.5mm Headphone jack
1x 3.5MM Stereo Jack	COM	3.5mm Headphone jack
1x 2-Channel Optocoupler	OK1	LTV826, DIP-8
1x Differential Bus Transceiver	U1	SN75176B, DIP-8
1x 2-Channel Op-Amp	U2	LM358, DIP-8
1x Hex Inverting Schmitt Trigger	U3	SN74HC14N, DIP-14
2x Tactile Switch	S1, S2	Tactile Button, THT

2x 1x18 Male Pin Header	Arduino Pins (marked white)	Male Pin Header with 2.54mm pitch, THT
4x 1x8 Male Pin Header	Arduino Pins (marked white)	Male Pin Header with 2.54mm pitch, THT
1x 2x20 Female Pin Header	DISPLAY HEADER	Female Pin Header with 2.54mm pitch, THT
1x 2x3 Female Pin Header	SPI	Female Pin Header with 2.54mm pitch, THT
1x Rotary encoder	ROT1	PEC11, 25mm shaft, 24 steps, 24 indent, switch
2x Limit switch	LSM1, LSM2	Generic 2x3, THT, 2.54mm pitch header
1x Trigger inputs & alternative Camera output	EXT IN, CAM ALT	Generic 2x3, THT, 2.54mm pitch header

## | 2.2 | Assembly Steps

**Step 1**

Solder all Resistors and all Capacitors to the board:

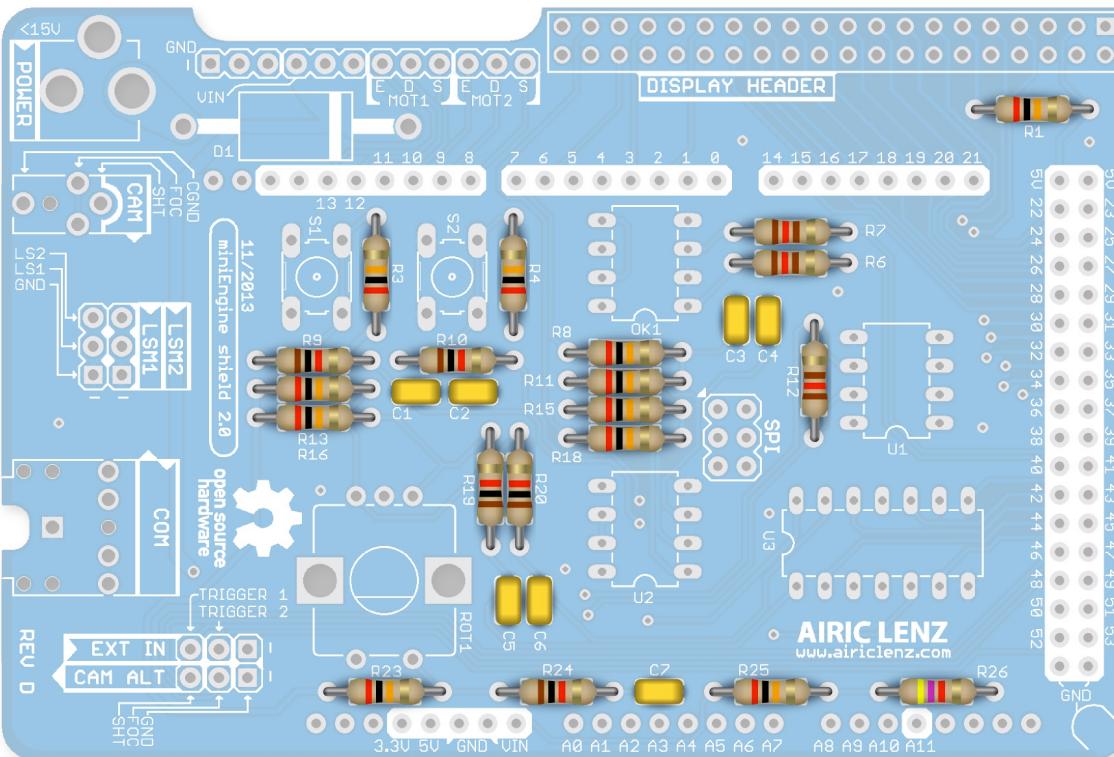
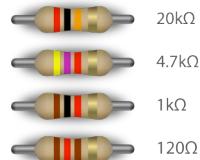
**20kΩ:** R1, R3, R4, R8, R11,R13,  
R15, R16, R18, R23, R25

**1kΩ:** R9, R10, R19, R20, R24

**120Ω:** R6, R7, R12

**4.7kΩ:** R26

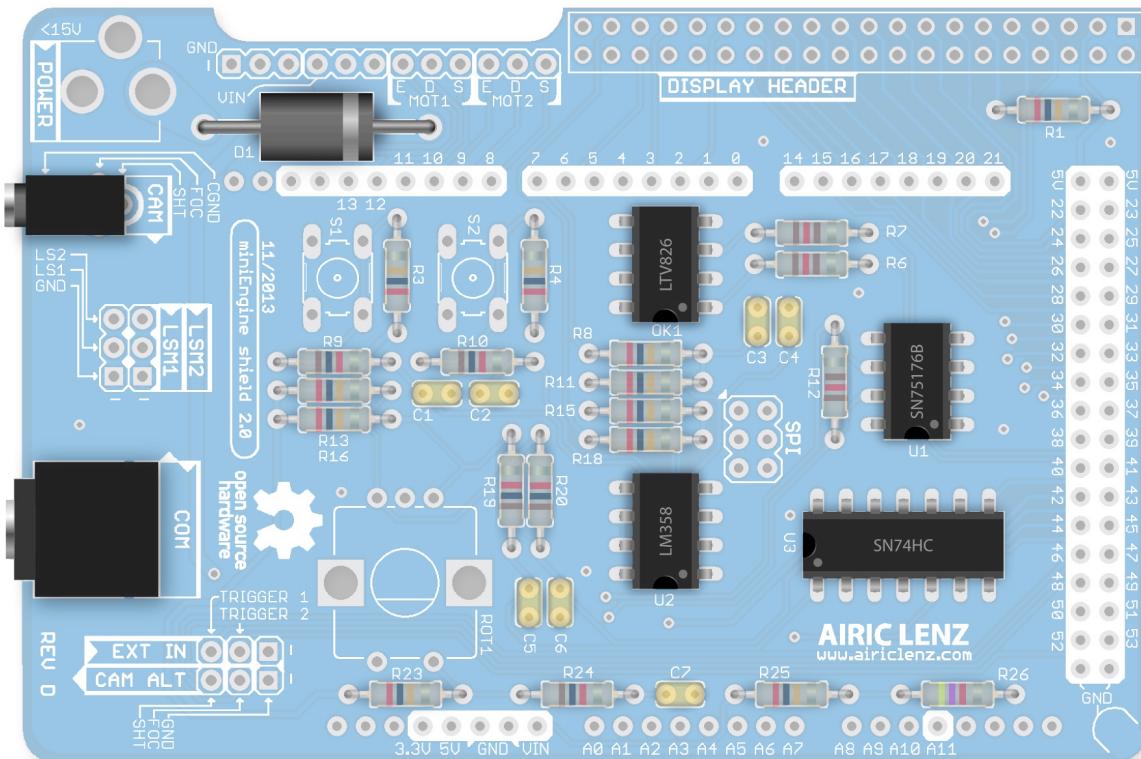
**100nF:** C1, C2, C3, C4, C5, C6 ,C7



## Step 2

Solder all medium sized top side components:

- U1: SN75176B (Communication)
- U2: LM358 (Backlight amplifier)
- U3: SN74HC (Invert. Schmitt Trigger)
- OK1: LTV826 (Optoisolator)
- D1: 5A Rectifier Diode
- CAM: 2.5 mm Stereo Jack
- COM: 3.5 mm Stereo Jack



## Step 3

Solder all BOTTOM side components:  
**MUST BE SOLDERED TO THE BOTTOM SIDE!**

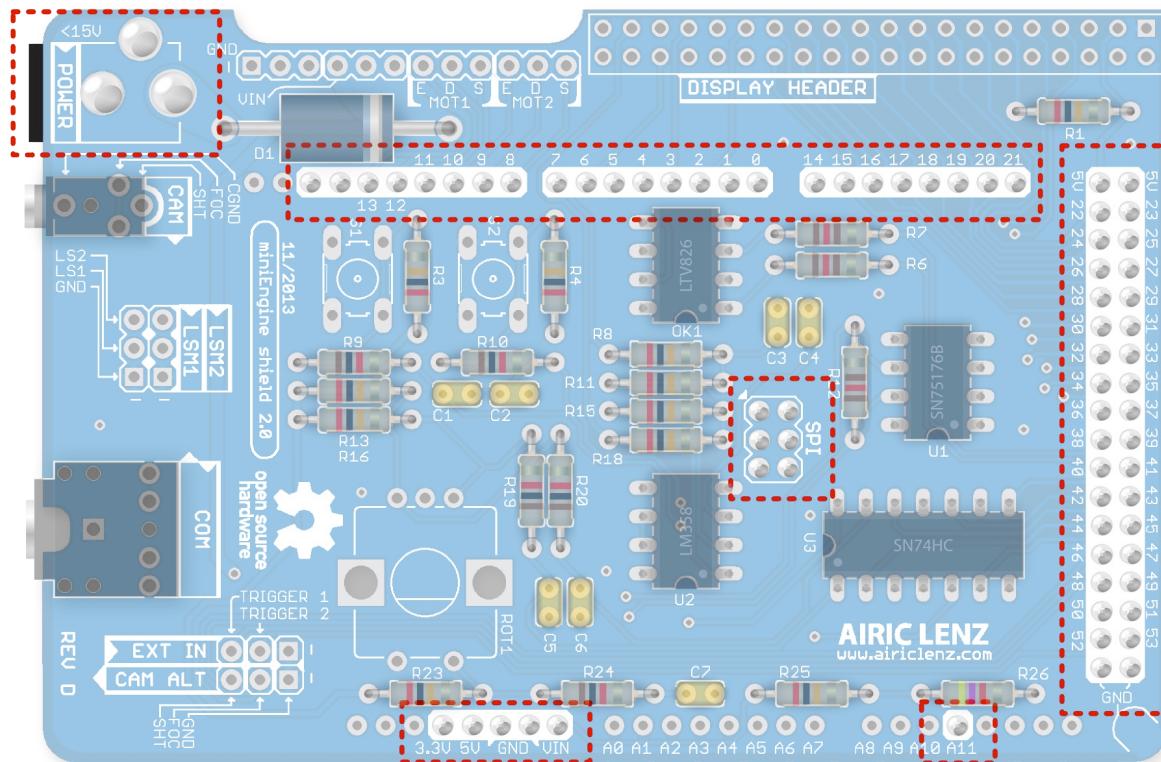
**POWER:** 2.1mm Power Jack (inner pin positive)

**Arduino Pins:** Male Pin Headers need to be soldered to the white marked holes! You can solder unmarked pins too but white marked ones must be soldered.

4 headers with 8pins  
(one needs to be broken for Power Pins and Analog input pin 11)

2 headers with 18pins

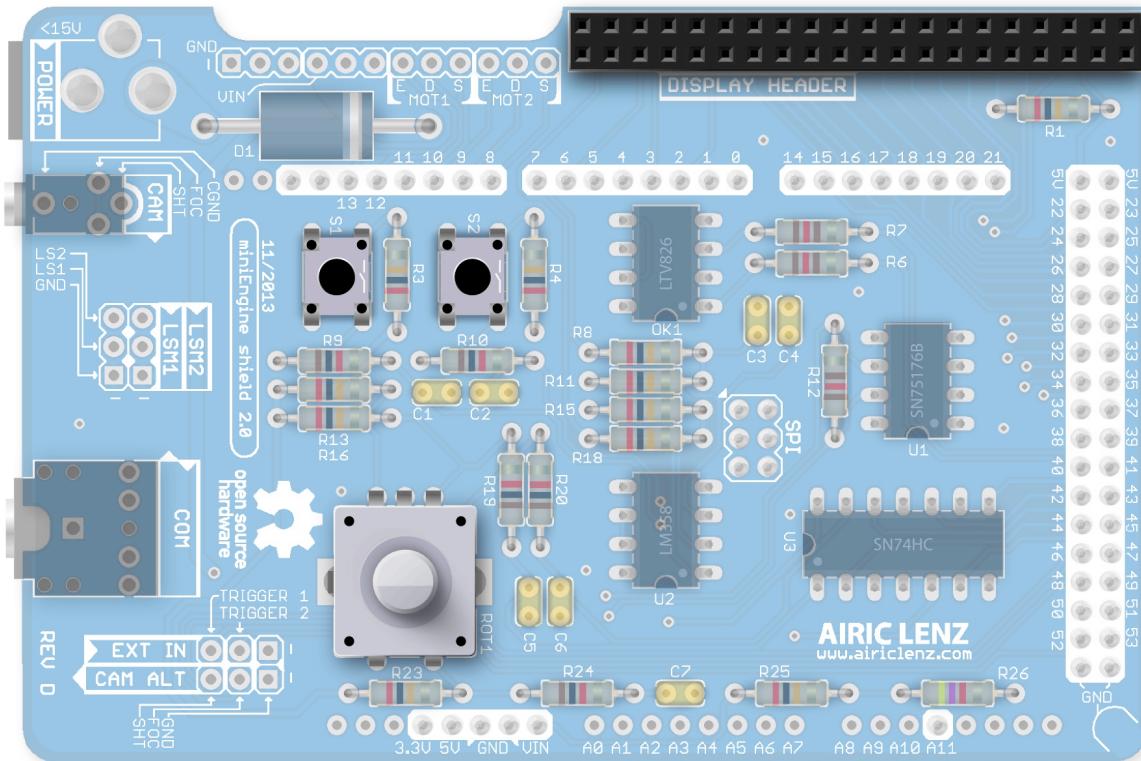
**SPI Port:** 3x2 Female Header



## Step 4

Solder the big top side components:

- S1, S2: Tactile Switches  
DISPLAY HEADER: 20x2 Female Header  
ROT1: Rotary Encoder

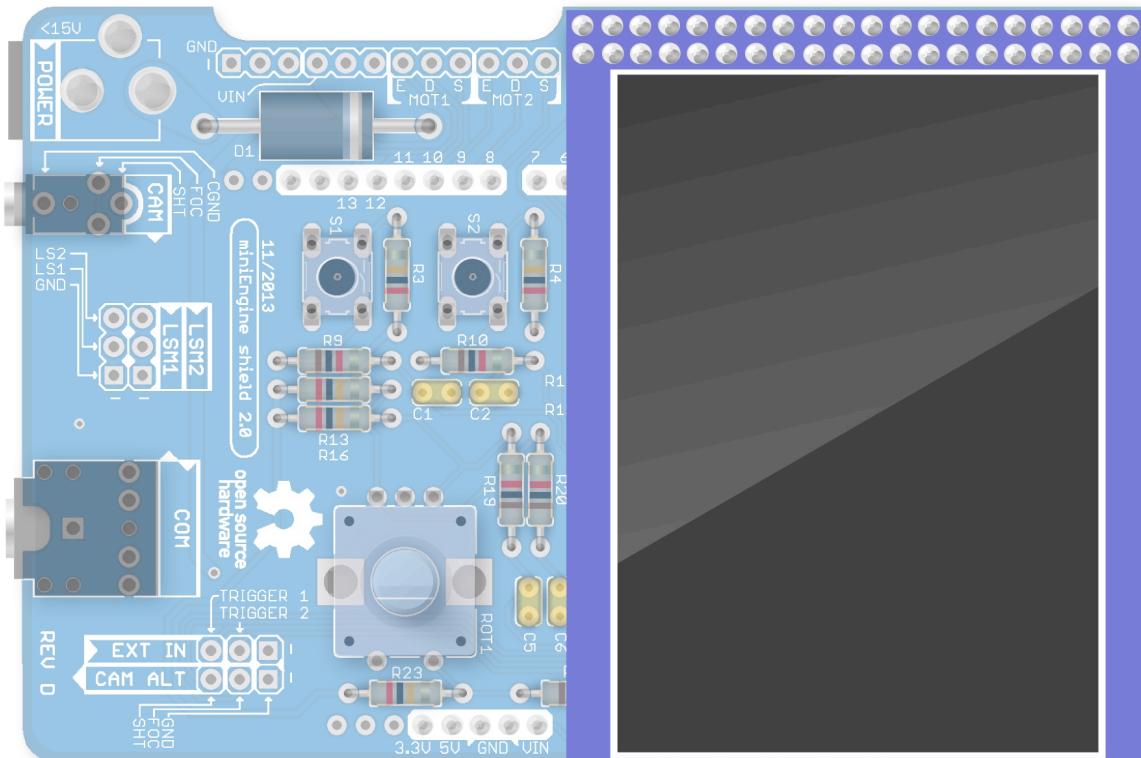


## Step 5

Plug the components together:

**Shield:** When you have checked that everything was soldered correctly, plug the shield carefully into your Arduino DUE. Be aware that unplugging it again is not easy as many pins are willing to stay connected to the Arduino.

**Display:** Switch the ITDB02-2.4E display to 16 bit and then plug it carefully to the DISPLAY HEADER of your shield. Be aware that unplugging it again is not easy as it was designed for secure placement in this header.



## | 2.3 | Shield functions



www.airiclenz.com

## miniEngine v2.0

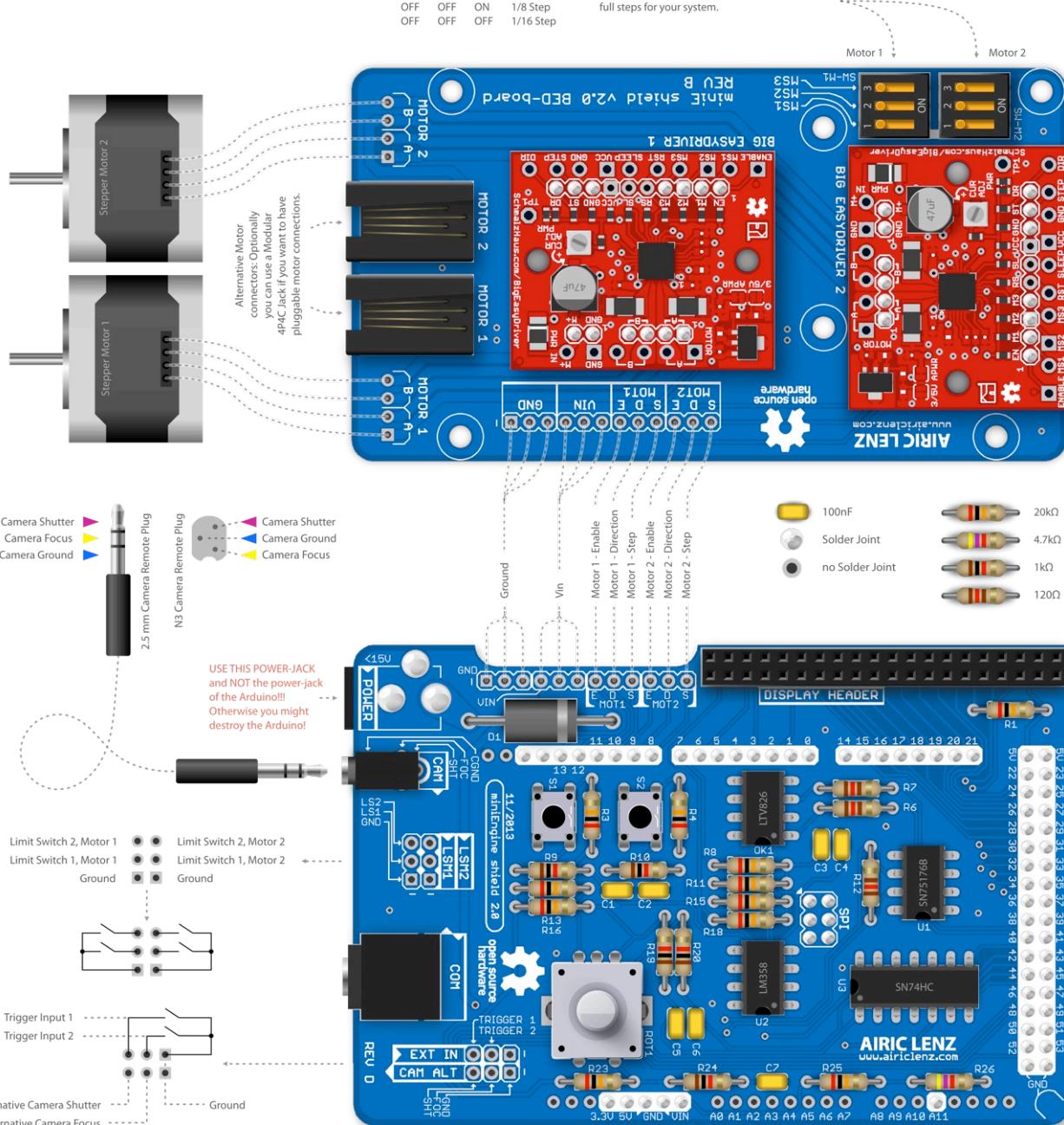
AIRIC LENZ photography

December 2013

we ❤️ open source hardware

MS1	MS2	MS3	Resolution
ON	ON	ON	Full Step
OFF	ON	ON	1/2 Step
ON	OFF	ON	1/4 Step
OFF	OFF	ON	1/8 Step
OFF	OFF	OFF	1/16 Step

**Motor microstep switches:** These DIP-Switches are optional and you are free to not use them. By default the BigEasyDrivers runs with 1/16 step. They are only required if you want 1/8, 1/4, 1/2 or full steps for your system.



## | 3 | Software

| 3.1 | *Installation & Update*

The installation process as well as the Update process are identical. For installing and updating the software on your Arduino DUE please follow this guide.



Updating the software to a newer version will overwrite the settings file on the SD card. Please write down important settings like the motor-calibration-values before updating!

If you don't already have installed the Arduino Development Suite (for the Arduino DUE the beta version 1.5.x is needed), please download it from:



<http://arduino.cc>

and install it. The latest miniEngine 2 software can be downloaded from here:



<http://github.com/airiclenz/miniEngine2>

Now, after you downloaded the project, please unzip (if you downloaded a .ZIP-archive) or copy it to any location you want. Please open the new folder and then open

*Software \ libraries \*

You should then see the following folder content:

- ▶ bitOps
- ▶ DueTimer
- ▶ MoCoM
- ▶ RotaryEncoder
- ▶ StepperMotor
- ▶ UTFT

2 of the 6 required libraries were developed by me. Two of them were not.

The library **UTFT** (here in version 2.0) was developed by Henning Karlsen (<http://henningkarlsen.com/electronics/library.php?id=52>).

The **DueTimer** library was developed by Ivan Seidel (<https://github.com/ivanseidel/DueTimer>).

A big „Thank you“ to both of you for making these libraries available!

To successfully compile the miniEngine 2 code, you need to install these 6 libraries within your Arduino development environment. To do so, open the Arduino folder. This folder should be placed in your user accounts documents folder (You can check the path in the Arduino settings). On a Mac this folder usually can be found here:

/Users/USERNAME/Documents/Arduino

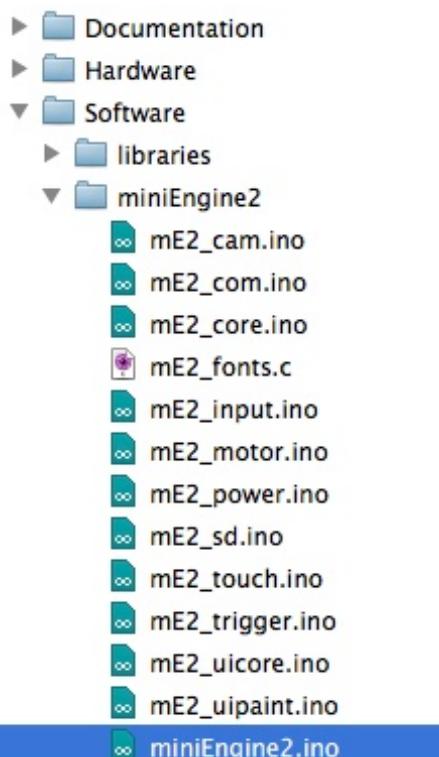
On a Windows system this folder should be placed here:

Drive:\Users\USERNAME\My Documents\Arduino

In this folder you should find a sub folder called *libraries* (if not, create a folder called *libraries* in the Arduino folder). Now copy all 6 library folders from your download folder into this Arduino-library folder. If you are doing an update, simply replace the old folders.

Now re- start the Arduino programming environment. You just installed the needed libraries and should now be able to compile and install the miniEngine software on your Arduino Due. In the project folder you downloaded, go back to the sub-folder Software\miniEngine2\:

Open the project in your Arduino 1.5.x by double clicking the main project file *miniEngine2.ino* (all needed files will then be loaded automatically).



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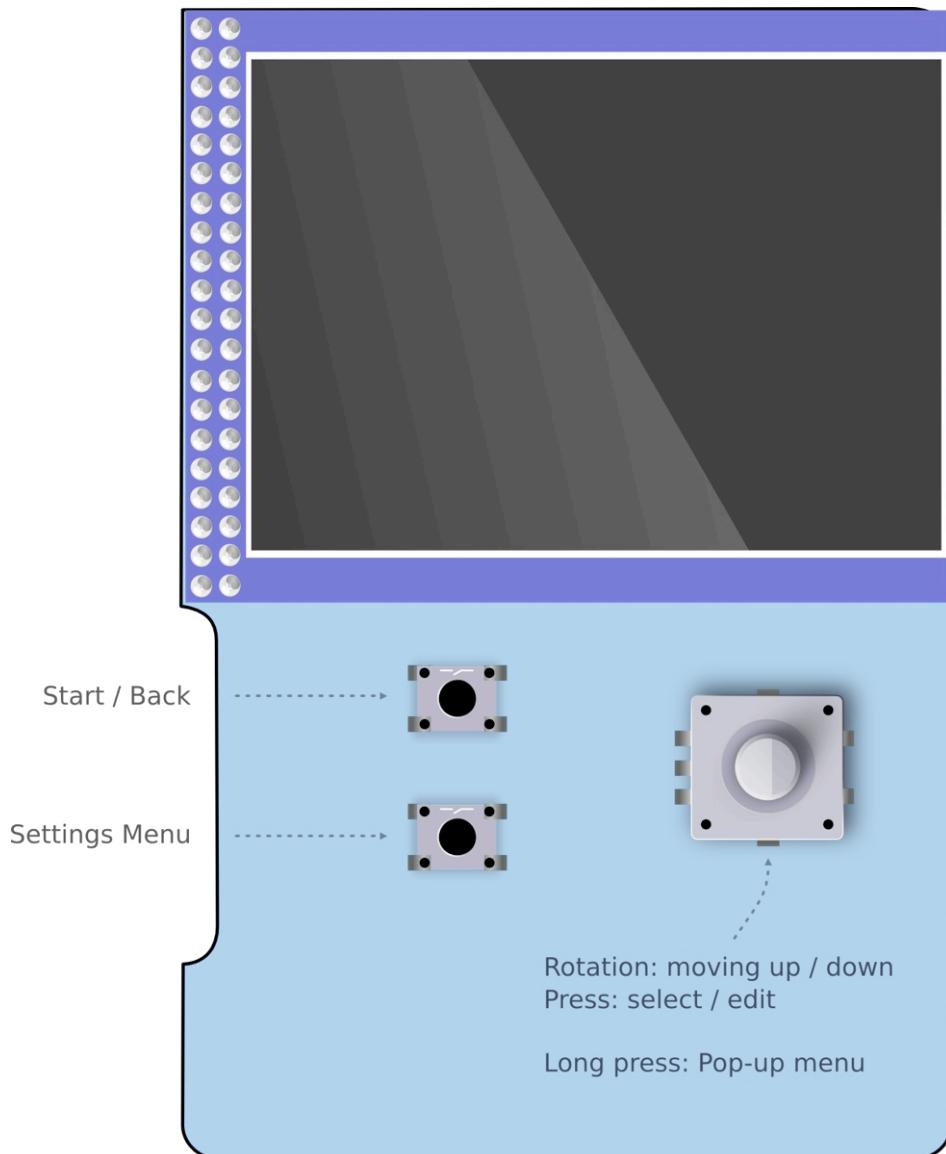
For uploading the software to your Arduino DUE board, connect your Arduino DUE with the „Programming port (the right one) to your computer (for details about connecting the Arduino DUE, please check the Arduino website and the *Arduino documentation*). Now press the upload button:



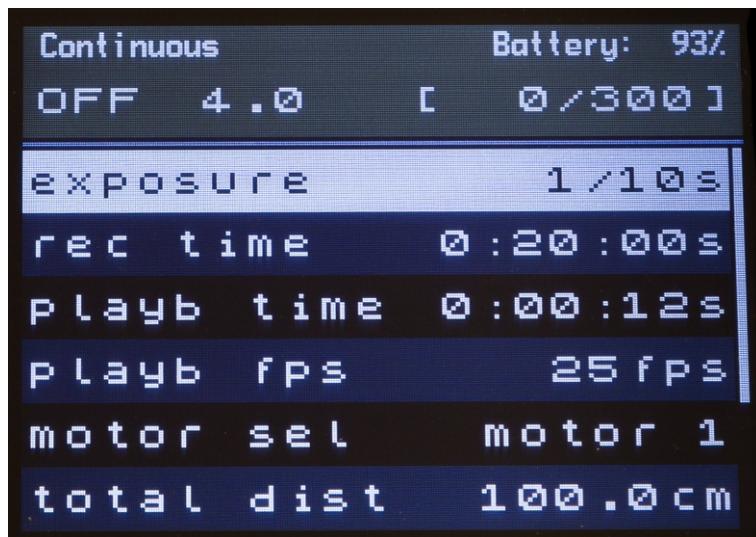
After the code was successfully uploaded, your Arduino board is ready for doing timelapse photography for you.

### | 3.2 | How to use the system

The graphic below describes the functions of the 3 main input elements of the miniEngine 2 shield.

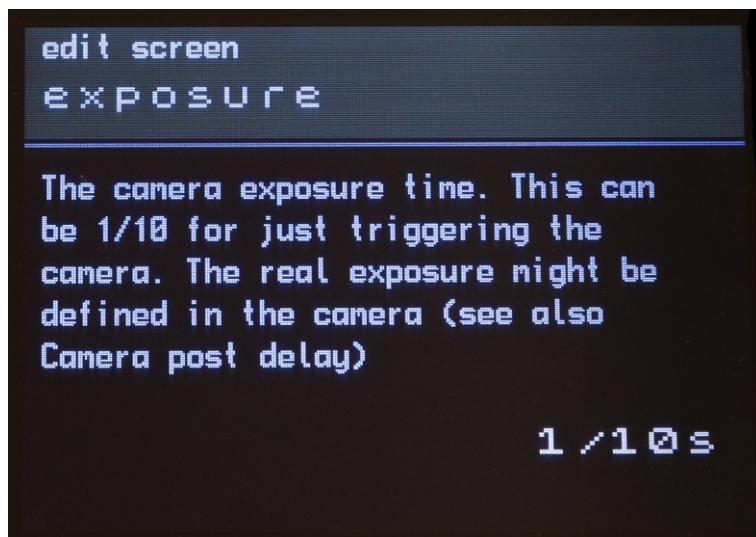


The following pictures show the main screens of the system. You will also find a brief introduction on how to navigate through the system:



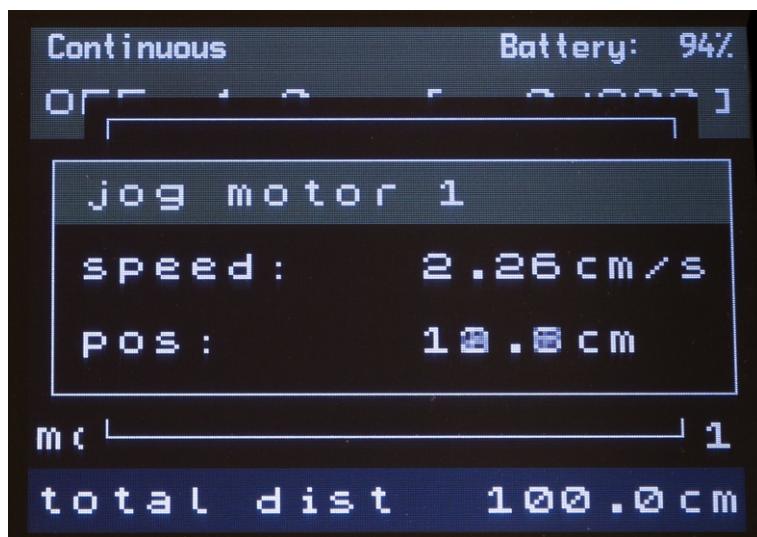
This is the main screen of the miniEngine 2. In the header it shows in which mode the system is at the moment (here: System is not running, „Continuous mode“, The interval is 4 seconds and the programmed run will execute 300 pictures of which zero are done).

Pressing the rotary switch („Select / Edit key“) will lead you to the following screen where you can edit the selected setting (in this case the Camera exposure):



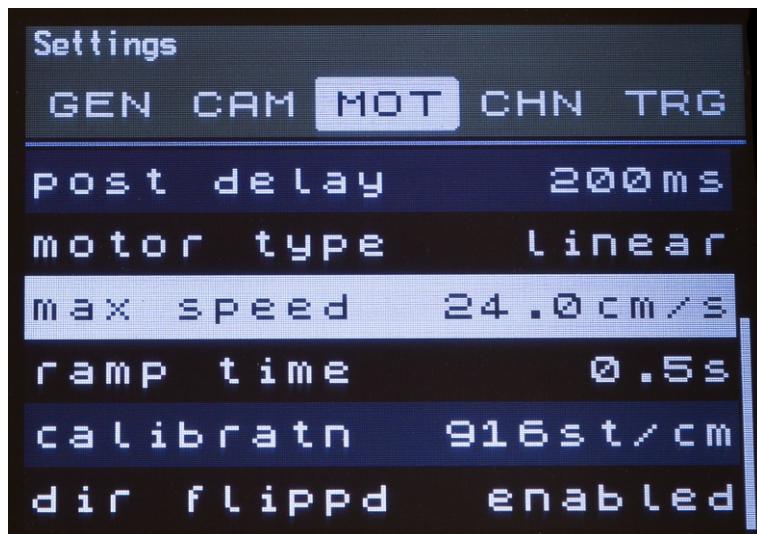
All of the edit screens show a short description of the setting you can change there - in this case the Camera exposure. The setting can be changes with the rotary encoder. Pressing the „Start / Back key“ will bring you back to the previous screen.

Back on the main screen you can press your rotary encoder down for about half a second to come to the popup menu. From there you can access different often needed functions such as manual motor movement (jog function) by pressing the rotary encoder down („Select / Edit key“):



Pressing the „Start / Back key“ will bring you back to the main screen.

If you are on the main screen, pressing the „Settings menu key“ will open the Settings screens. There are 5 different settings screens and repeatedly pressing the „Settings menu key“ will browse through the different screens.



Pressing the „Start / Back key“ will bring you back to the main screen.

### | 3.3 | Motor calibration

The miniEngine 2 offers the possibility to calibrate the motors you are using. This calibration takes the motor and its specifications itself as well as the rig it is driving into account. This chapter is aiming at helping you finding the correct calibration value for your motor(s). The calibration values needed, should be given with the following units:

- steps per centimeter for linear movements
- steps per degree for radial movements

As stepper motors come in a variety of form factors and specifications we need to add the most important of these specs to our calibrations. This is the degrees been moved by one full motor step. The most common one is  $1.8^\circ$ . This means that such a motor needs 200 full steps to do one full revelation:

$$\frac{360^\circ}{1.8^\circ} = 200$$

Because we are using multi-stepping to achieve a finer resolution, we need to multiply this full-step-value with the amount of sub-steps done. In this example we are using 1/16th stepping (which is the default for the recommended Big Easydriver):

$$200 \times 16 = 3200$$

Ok - so we need 3200 steps to do a full revelation with the stepper motor in micro-stepping-mode. Now let's add the rig that this motor is driving to the calculation. For now we are assuming we are driving a toothed belt with the stepper. The gearwheel has a circumference of 3.5cm. This means that 1 stepper revelation moves the belt 3.5cm. Here is how we get how much steps are needed for 1cm - which is also our final calibration value:

$$\frac{1\text{cm}}{3.5\text{cm}} \times 3200 = 914.29$$

So we need to enter 914.29 steps / cm as the calibration value into the system.

If we had a motor that would do a radial move, the calibration-calculation would just differ in the last step. Assuming you are not using the motor to rotate your axis 1:1 but with a reduction of 1:4 (four revelations of the motor rotate the axis one time) , the final calculation-step would look like this:

$$4 \times \frac{3200}{360} = 35.56$$

So the final calibration value for the radial setup is 35.56 steps / degree.

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