How to Move Canon EF Lenses

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Preface

- This instruction is intended to be helpful to those who are interested in making modifications to camera lenses to explore/reproduce focus sweep, focal stack, and other related imaging techniques for research purposes.
- But we disclaim any responsibilities for the consequences of your following this instruction, so do it at your own risk!

Outline

- Overview & preparation
- Lens modification
- Wiring
- Software
- Putting them together

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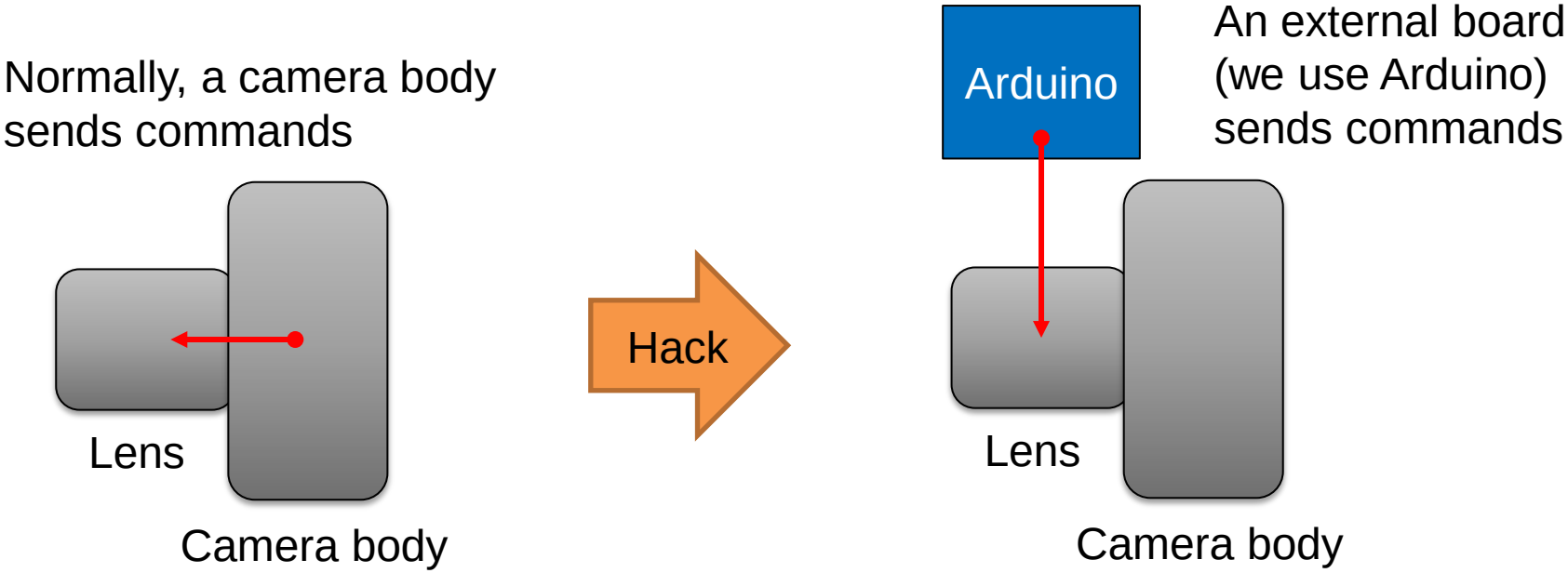
The Lens in This Instruction

- Canon EF-S 18-55mm f/3.5-5.6 IS II
  - Comes with a Canon EOS Rebel camera kit
- Any Canon EF lenses may be used

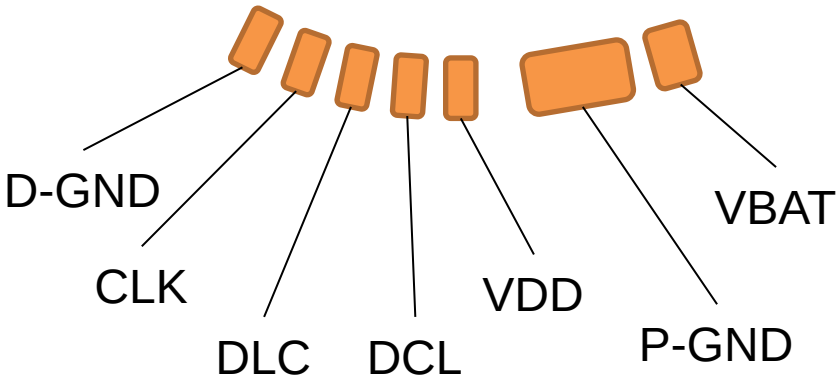
The Goal

- The lens has motors and control circuits inside, and operates according to commands from a camera body
- All you need is to intercept such communications and send “move focus” commands to the lens



Lens Pin-out

- Protocol: SPI (serial peripheral interface)
  - 8 data bits, 1 stop bit

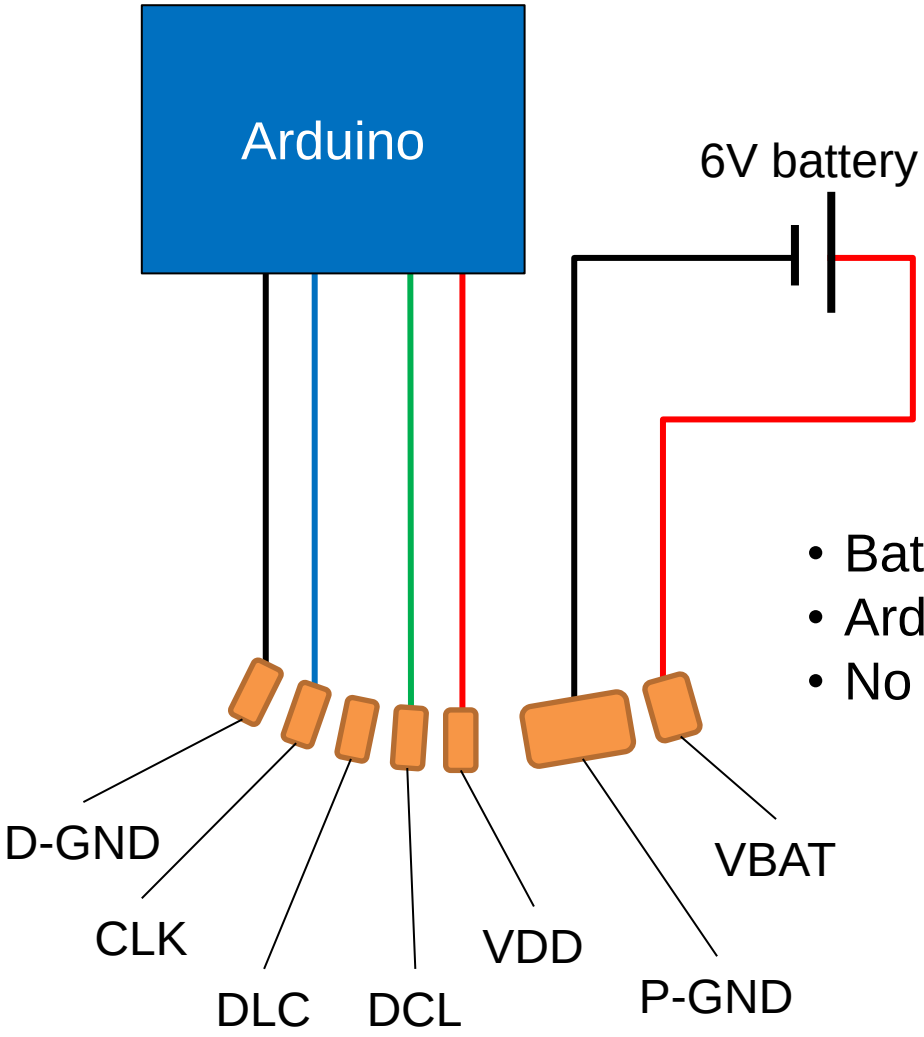


VBAT: 6V power for lens motors
P-GND: Ground for lens motors

VDD: 5.5V power for digital logic
DCL: Data from camera to lens (MOSI)
DLC: Data from lens to camera (MISO)
CLK: Clock
D-GND: Ground for digital logic

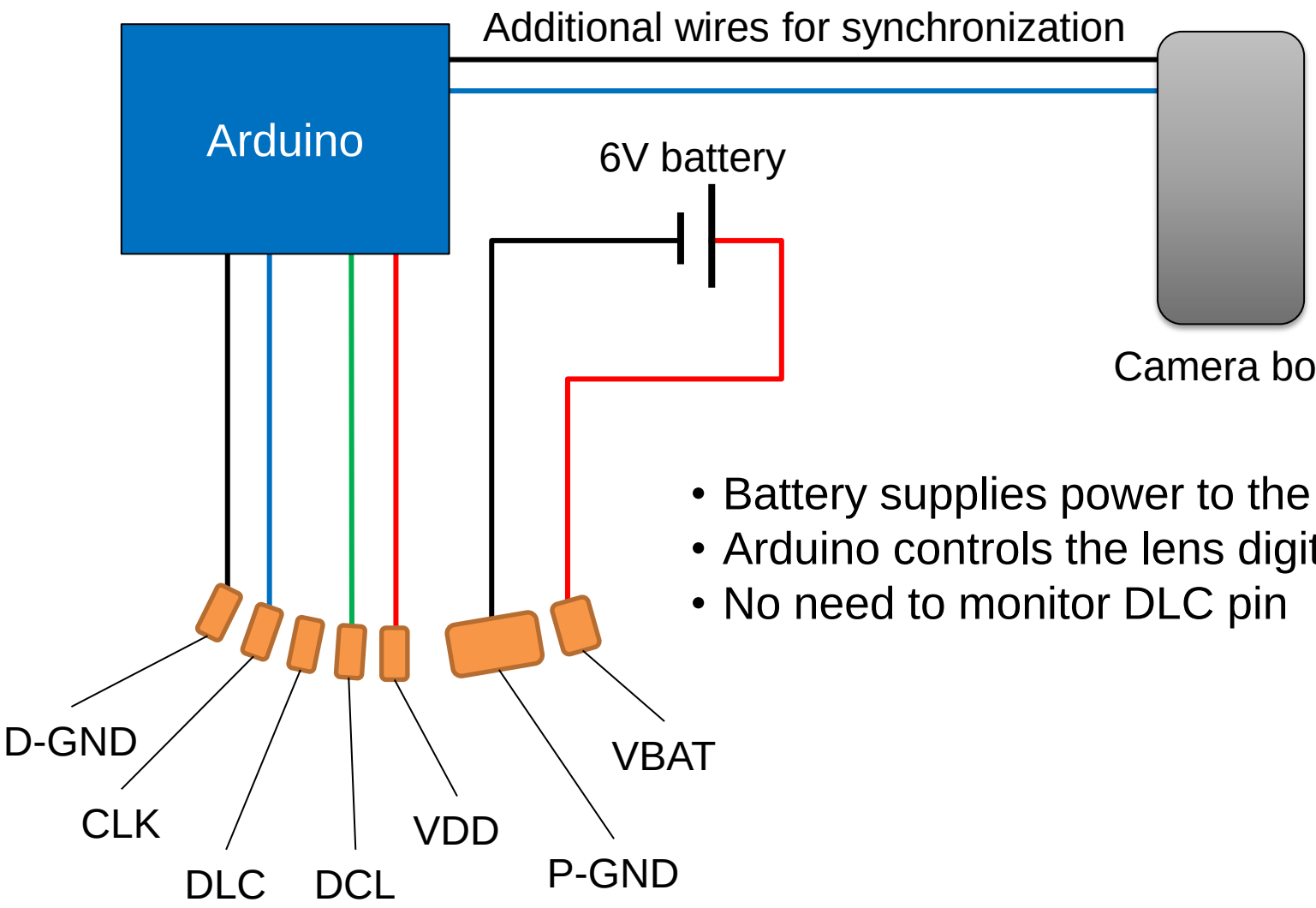
MOSI: master output, slave input
MISO: master input, slave output
master: camera in this case
slave: lens in this case

Rough Schematic



- Battery supplies power to the lens motors
- Arduino controls the lens digital logic
- No need to monitor DLC pin

Rough Schematic



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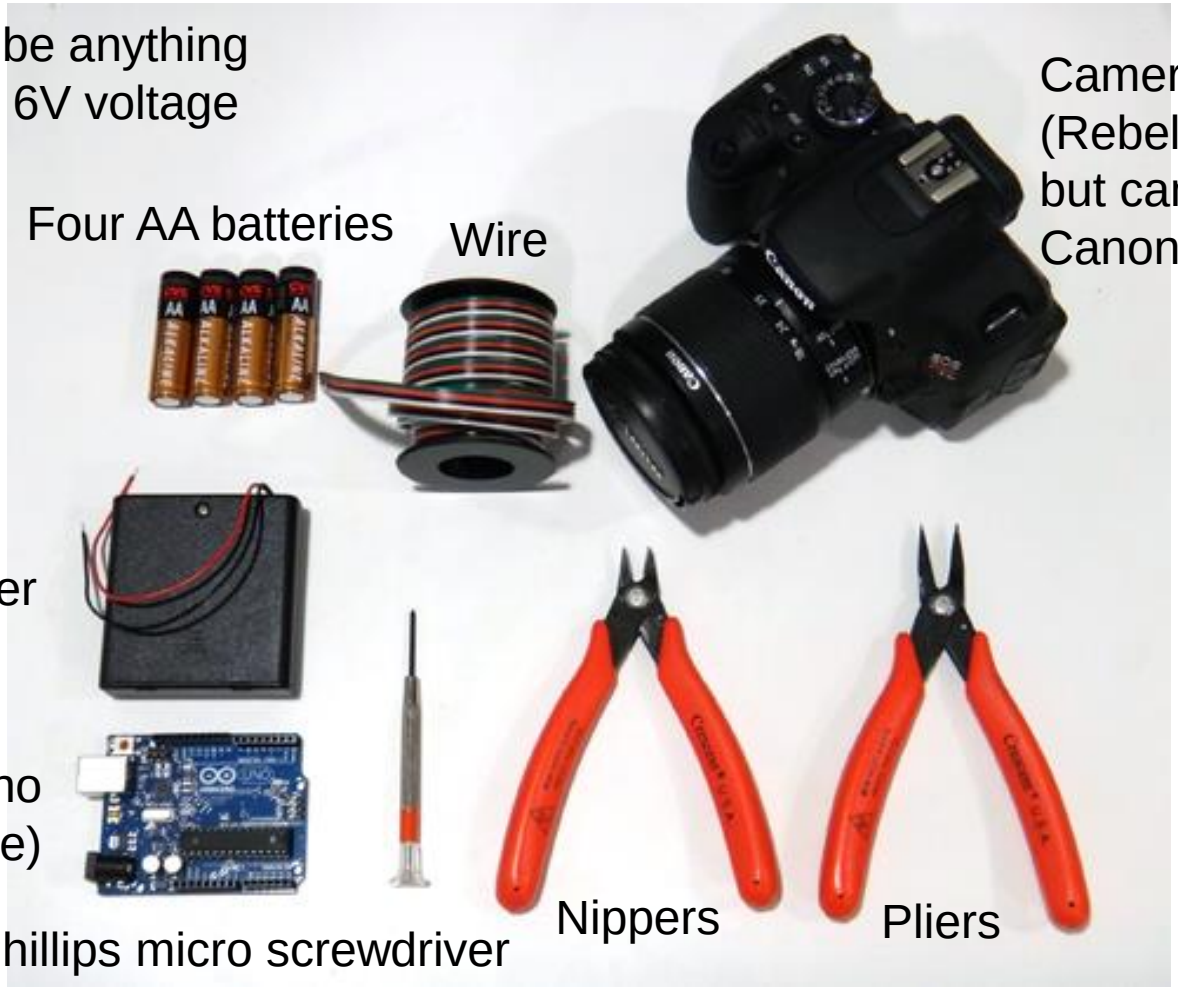
Tools & Parts

Batteries can be anything that produces 6V voltage



… and

- Solder
- Soldering iron
- Drill
- (Circuit tester)
- (Breadboard)

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Lens Modification

- Our sub-goal here is to wire the pins from outside so that we can send commands from an external board

Remove the Screws 1/2

- Remove the two micro screws beside the pins

Remove the Screws 2/2

- Remove the four screws on the back side of the lens

FYI

- Those four screws are tight
- You might want to use pliers to unscrew them

Detach the Back Cover

This cable is for image stabilization (anti-camera shake). You can remove it if it gets in your way.

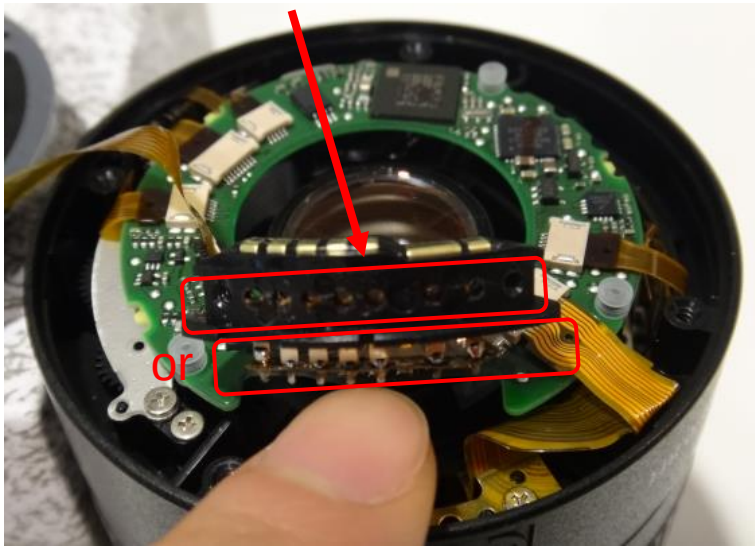
Insert Wires

- Drill six holes in the lens housing under the pins
- Pass six wires through the holes

Solder the Wires

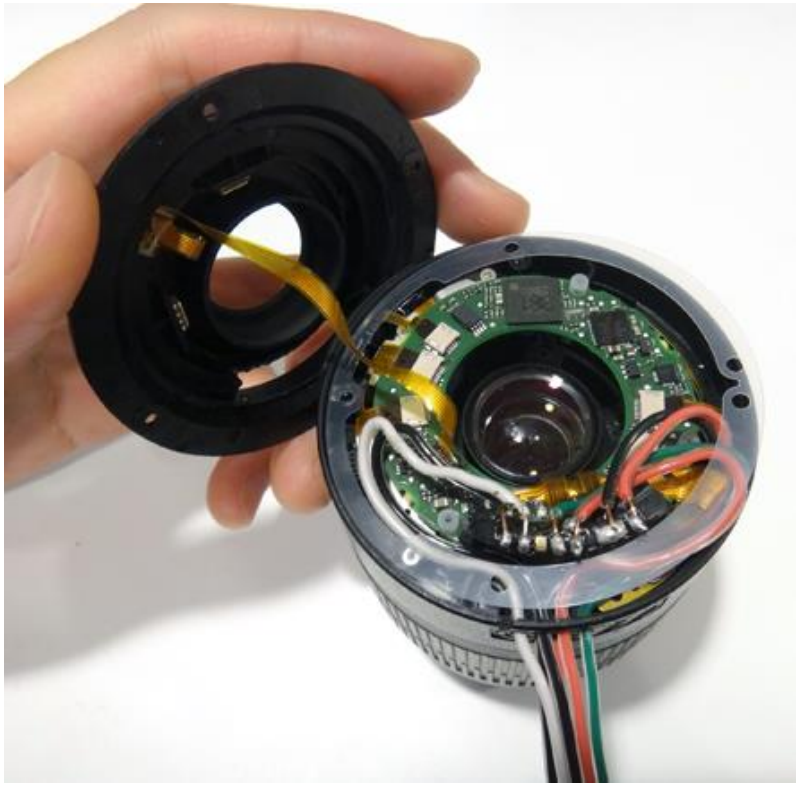
- Make sure to keep track of which wire goes to which pin
- Make sure they are electrically connected using a circuit tester

For ease of soldering, we directly attached wires on top of the pins, making the lens unable to talk with a camera body any more. We could instead solder wires to the lower part of the pins, in which case the lens can still be used as a normal lens.



Reassemble

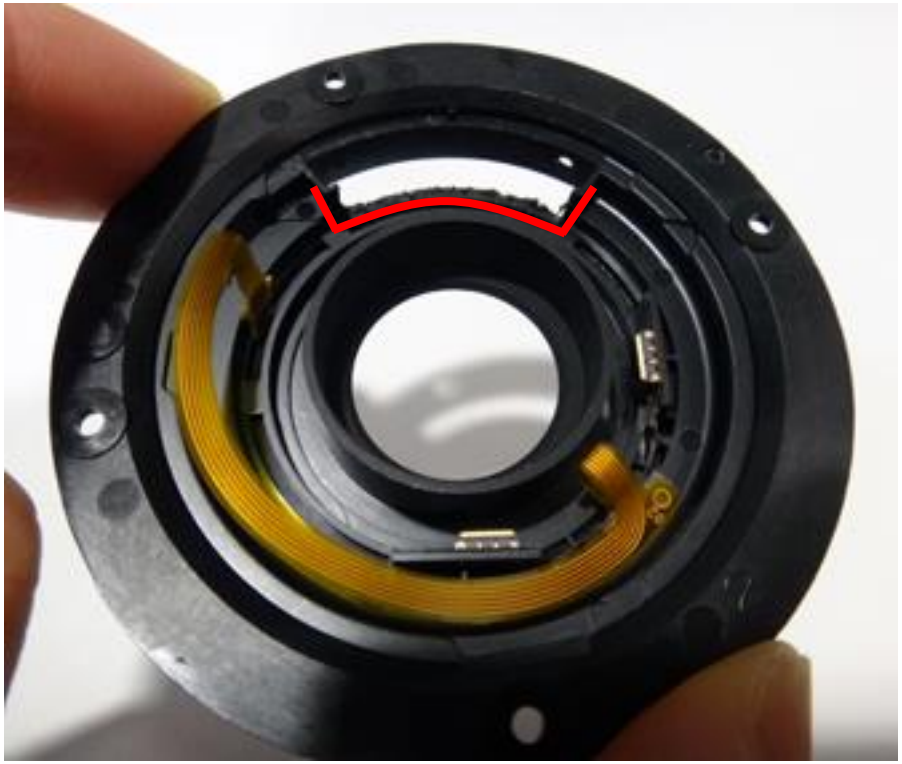
- Squeeze the wires into the lens housing
- Put the cover back with the screws



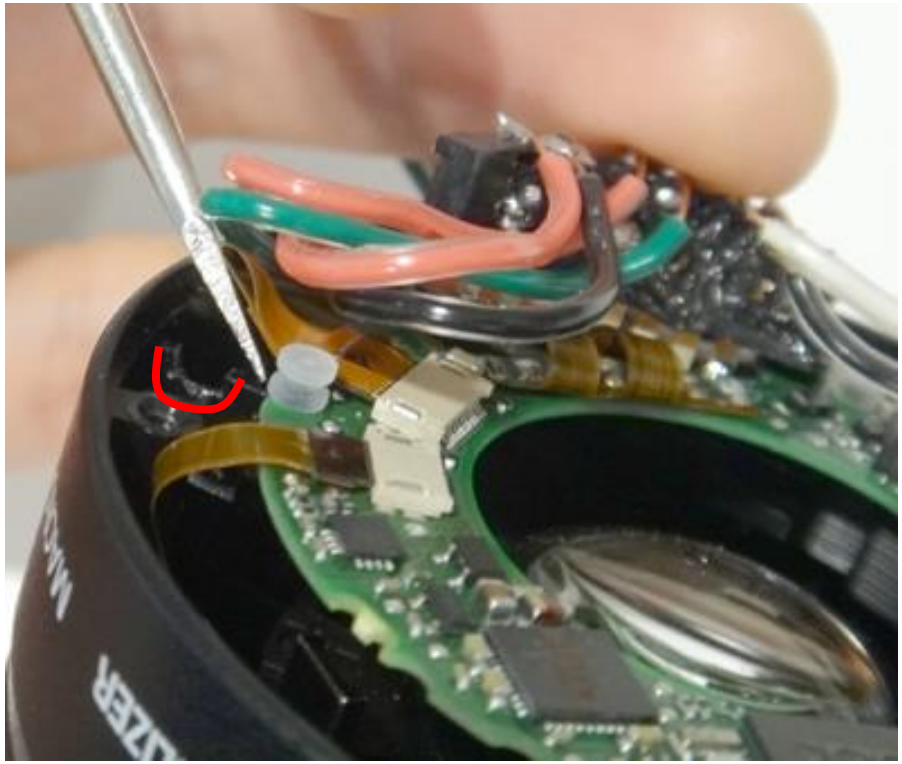
No need to put back the two micro screws for fixing the pins

Tricks to Fit the Wires

- Cut out portions of the cover and housing with nippers



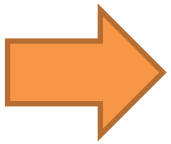
To make room for the wired/soldered pins



A few wires can be laid through this gap

Tape the Pins

- To make sure that the lens is electrically disconnected from the camera body



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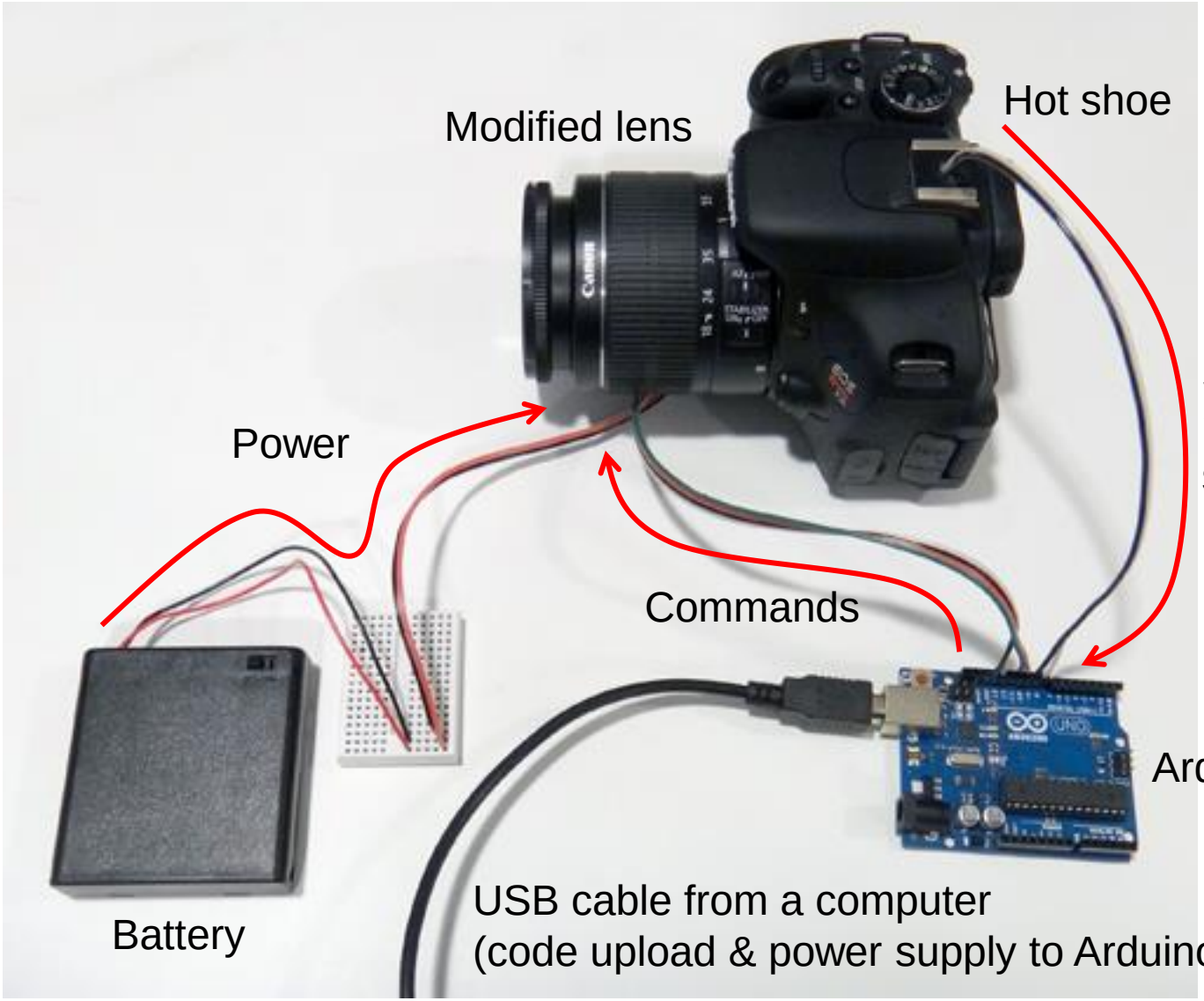
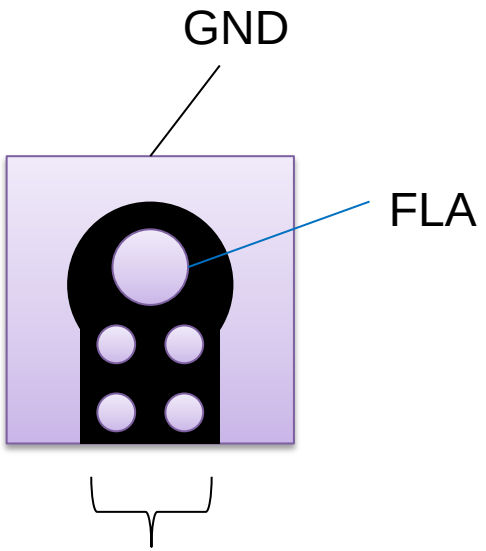
Overall View of Wiring



Hot Shoe Pin-out

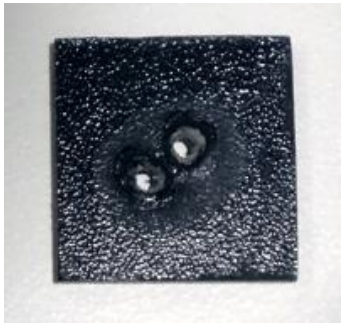
- Shutter release can be detected from flash trigger signal (FLA) at the hot shoe, which can be used for synchronizing lens control



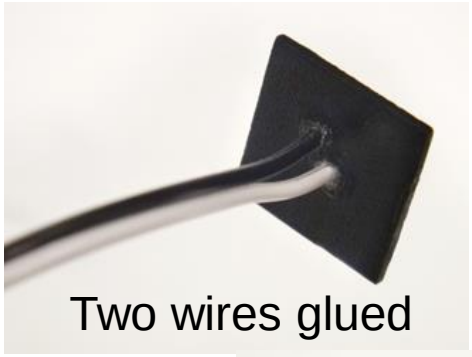
The other four small pins will not be used

Attach Wires to the Hot Shoe

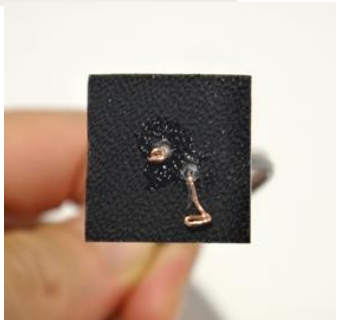
- Cut out a square piece of plastic with two holes and insert in the hot shoe with wires
- Or just directly solder wires to the pins



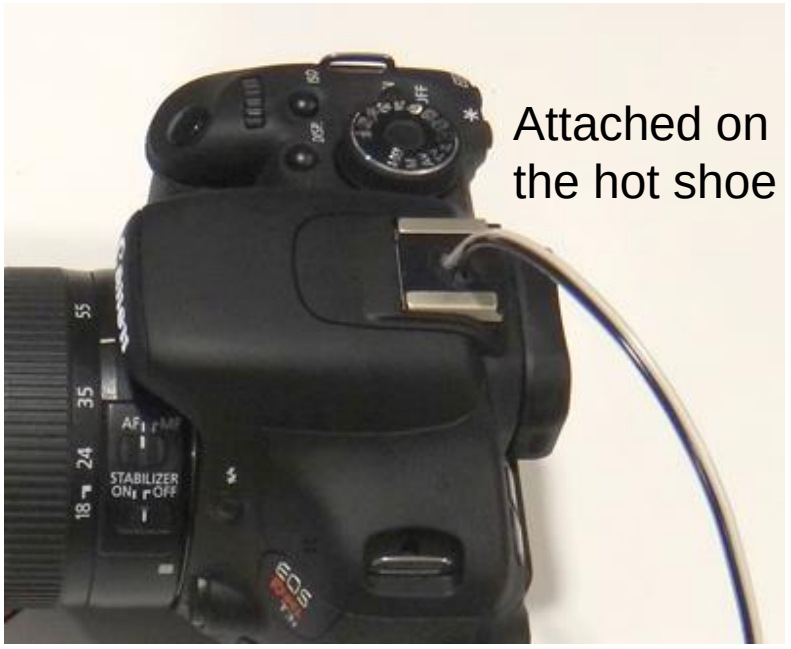
Plastic piece



Two wires glued

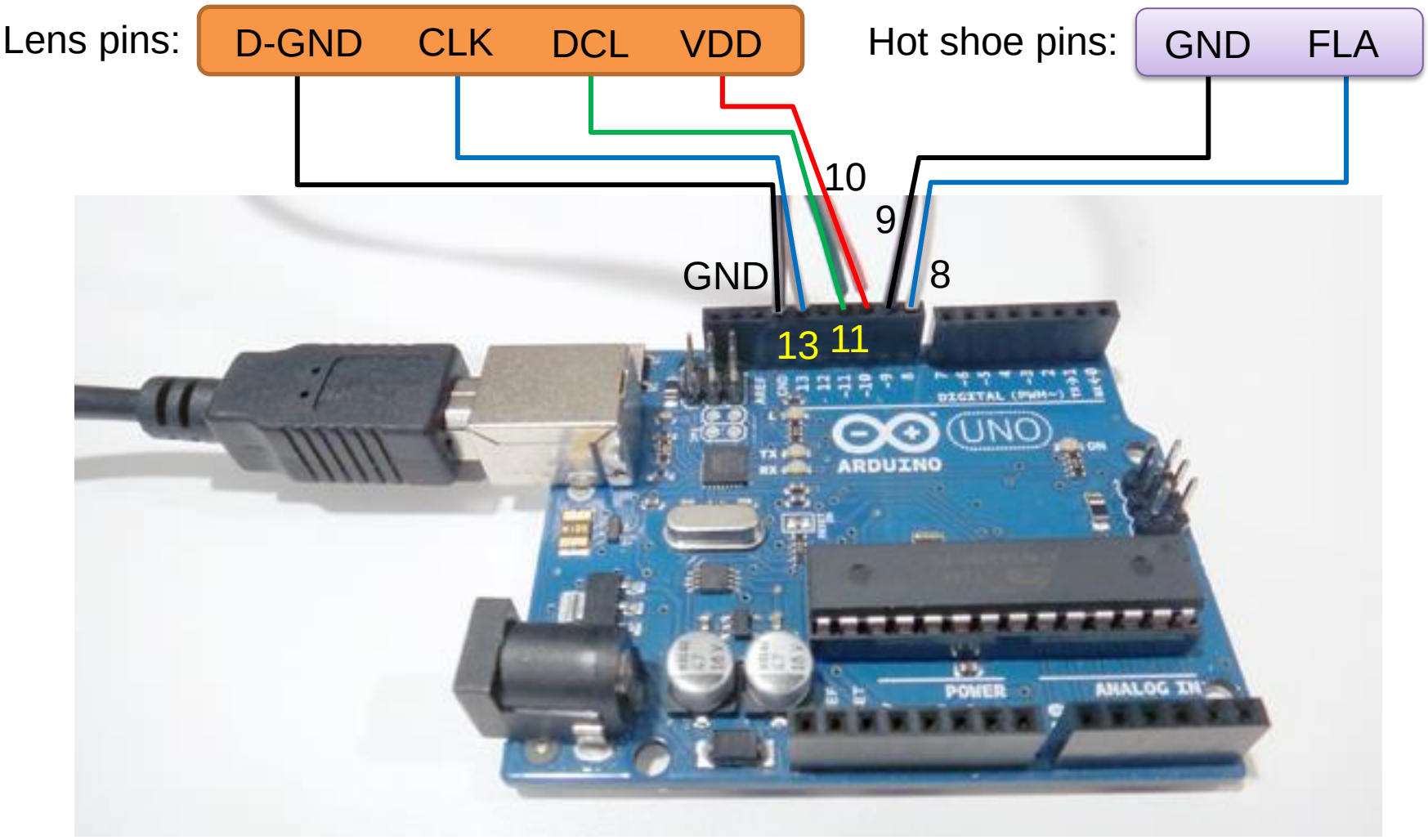


Seen from the bottom

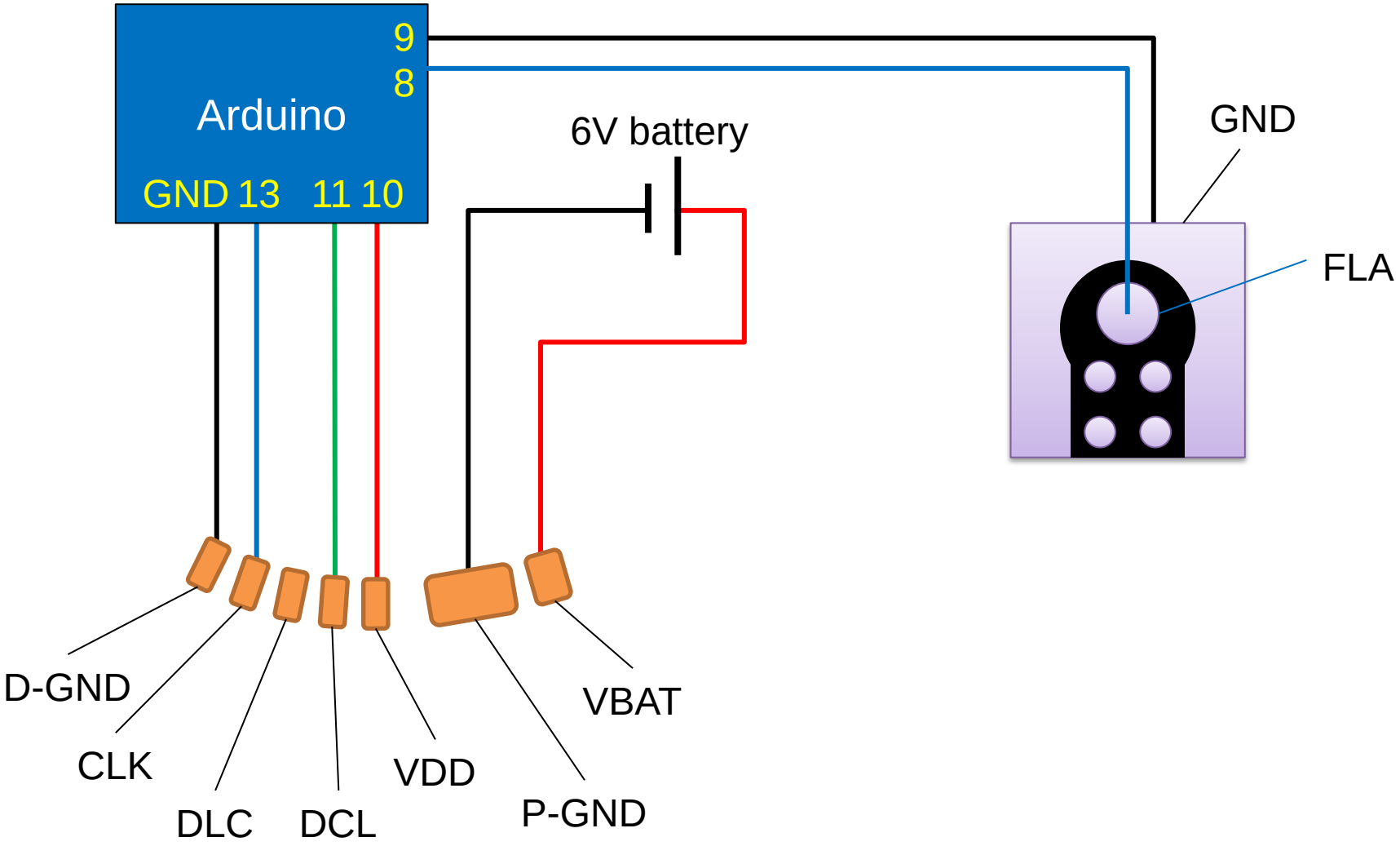


Attached on the hot shoe

Arduino Pin Assignment



Full Schematic



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Arduino Code

```
const int HotShoe_Pin = 8;
const int HotShoe_Gnd = 9;
const int LogicVDD_Pin = 10;
const int Cam2Lens_Pin = 11;
const int Clock_Pin = 13;


void setup() // initialization
{
   pinMode(HotShoe_Pin, INPUT);
   digitalWrite(HotShoe_Pin, HIGH);

   pinMode(HotShoe_Gnd, OUTPUT);
   digitalWrite(HotShoe_Gnd, LOW);

   pinMode(LogicVDD_Pin, OUTPUT);
   digitalWrite(LogicVDD_Pin, HIGH);

   pinMode(Cam2Lens_Pin, OUTPUT);

   pinMode(Clock_Pin, OUTPUT);
   digitalWrite(Clock_Pin, HIGH);

   delay(100);
   send_signal(0x??);
   delay(100);
   send_signal(0x??);
}
```

```
void loop()
{
   if(digitalRead(HotShoe_Pin) == LOW) // upon shutter release
   {
      send_signal(0x??); // move focus to infinity
      delay(1000);
      send_signal(0x??); // move focus back to nearest
      delay(1000);
   }
}


void send_signal(byte signal) // SPI command generator
{
   unsigned int i;
   for(i = 0; i < 16; i++)
   {
      digitalWrite(Clock_Pin, i & 1);
      if(i % 2 == 0)
      {
         digitalWrite(Cam2Lens_Pin, (signal >> (i / 2)) & 1);
      }
   }
}
```

We are asked not to disclose the commands in public.
Please contact me to get the values shown as ??.

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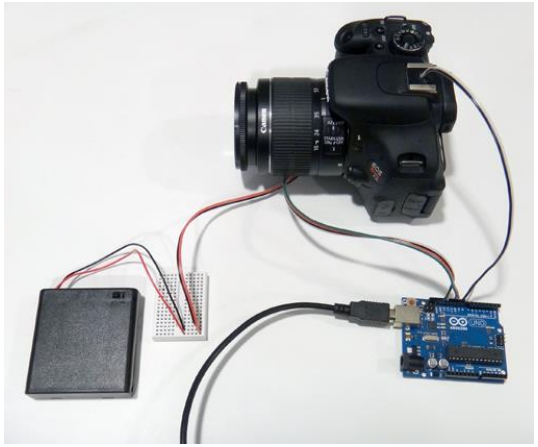
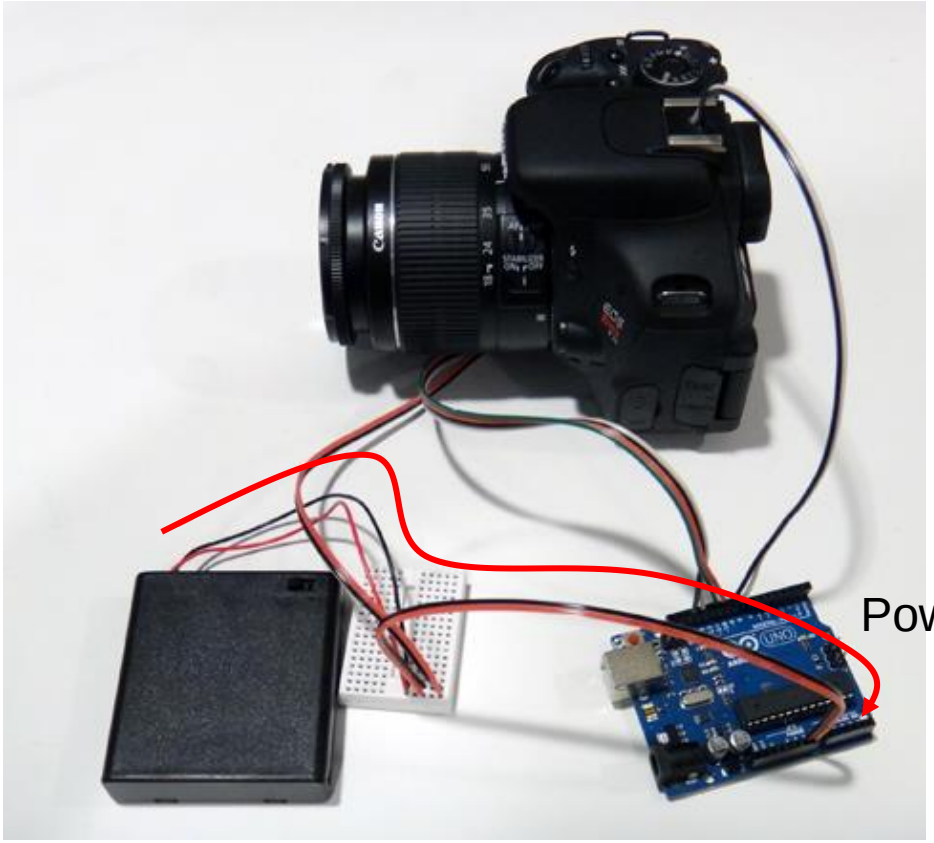
Put Them Together

- Attach the modified lens to the camera body
- Connect the wires
- Turn on the camera
- Turn on the battery
- Turn on the Arduino
- Upload the code to the Arduino
  - This step can be skipped from next time, as the code stays on the board
- Press the shutter button
  - The lens should move

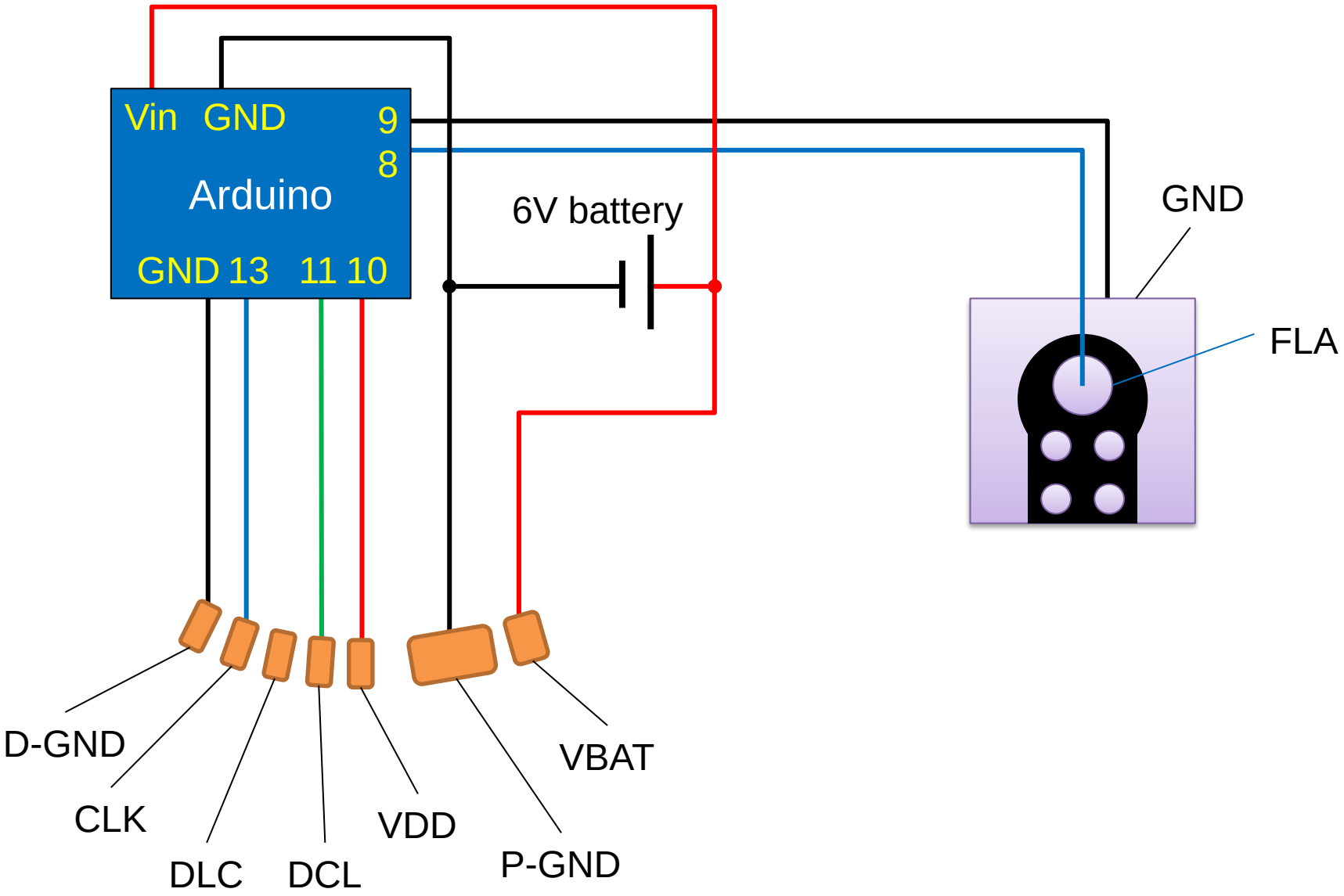


Make it Portable (optional)

- The 6V battery can also be used for supplying power to the Arduino



Schematic for Portable Setting



Mount Everything

The rubber cover can be ripped off and the parts can be screwed into the camera body