OXO ROBOT VISION DRONE Spaceship for Robots at OXO

The Ultimaker Robot on a Drone Spaceship takes off at OXO building 8 June 2016

the OXO quadri copter Drone for Lifting 45 Ultimaker Robots printed in 3d on Ultimaker2go machine

presentation to IOI.london MINIMAKER FAIR by Fablablondon

Tech spec for Drone:

In our new book *Make: Getting Started with Drones*, we guide the reader to assemble their own FPV-style quadcopter from scratch. In this excerpt we start the first-time drone builder on the construction of the frame and electronics for the Little Dipper, a 300-class autonomous flying rig.
The compact Little Dipper's airframe is made up of two subframes that help isolate the motor vibrations from the flight and imaging sensors. These subframes are called the clean and dirty frames. The dirty frame is the bottom

subframe, and it holds all the moving parts, such as the motors and the propellers. The clean frame sits on top and holds all the flight and communication electronics. The folding arms soften the impact in the event of a crash.

1. BUILD THE LITTLE DIPPER AIRFRAME

The frame is open source; you can download the laser- or CNC-cuttable design files from our companion website, where you can also find step-by-step video instructions. The following steps also work with most commonly available FPV racing drone frames.

(Editor's note: This was originally mistakenly titled "Build an FPV-Style Quadcopter with a 3D Printed Frame" The files we have are .dxf for a CNC cutter, but if you're interested in 3D printing this, .dxf files can be converted to .stl files. You can find a tutorial to do this here.)

2. MOUNT THE POWER DISTRIBUTION BOARD

The PDB lets a single battery send electricity to all the drone's electronic components — speed controllers, motors, camera, etc. We made our own PDB from copper-clad G-10, but there are many small, inexpensive versions on the market.

There's a 3mm hole in the middle if you'd like to add a screw for extra support. We found that the double-sided tape did a very good job and opted to not use a screw. If you do use a screw, try a small nylon screw and nut — it will save on weight and and it won't act as a conductor.

3. SOLDER ON THE BULLET CONNECTORS

This step is optional, but it can make the install a lot easier. Bullet connectors allow you to plug and unplug the ESCs and motors into each other rather than soldering them directly. The pros to using them include ease of use during maintenance, troubleshooting, and upgrades. The cons include failure due to loss of contact. If a bullet connector fails, it can cause a crash (one motor out of four stops

spinning and you fall like a rock). With this list of pros and cons, you can understand why people have sharp opinions about these connectors. We'll let you decide if you want to use them, but this project will assume that they are installed. If you decide not to, we recommend that you directly solder your connections and seal them with heat-shrink tubing. Just make sure they're right before you fire up that iron!

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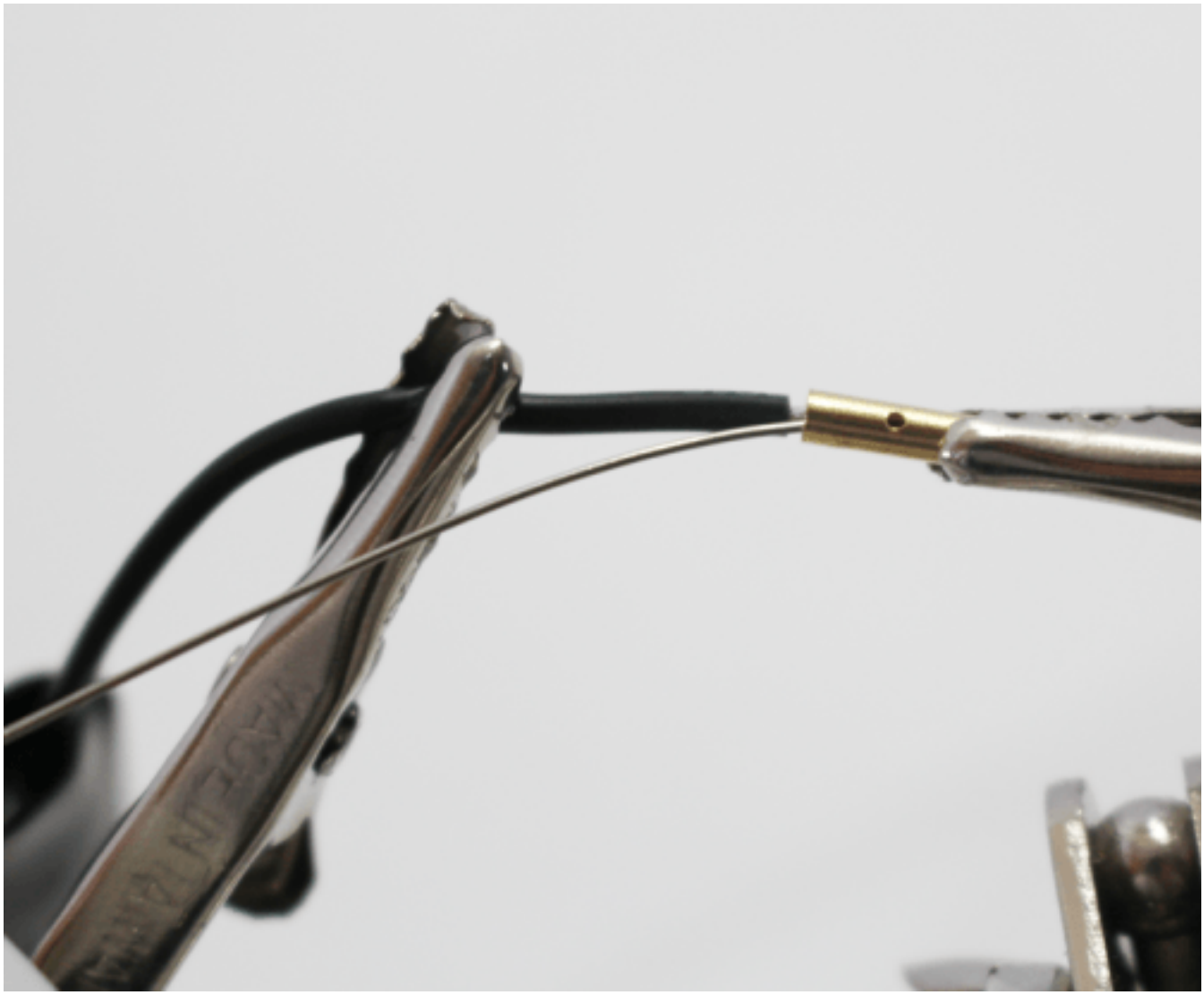
The Nationals: FPV Drone Racing Goes Big-League

Bullet connectors, like almost every other type of connector, consist of a pair: one female and one male. You'll be installing the male ends on your motors and the female versions on the ESCs. This is considered a best practice, as the ESC is the end providing the power and the female bullet will be shielded to provide protection when things are not plugged in.

Begin by taking one of your 4 motors and stripping away about ⅛" of the insulation from each of the 3 motor leads. Next, tin the wire tips by adding just a bit of solder to the tip of your iron and coating the outside of your motor leads with it.

Next, use your helping hands tool to solder the male bullet connectors to the motor leads. Clamp one bullet connector into one of the alligator clips and one of the tinned motor leads in the other. Once you have everything configured, place your iron on the outside of the bullet connector, allowing it to heat up for just a few seconds before applying some solder to the inside of the connector where the wire sits.

New to Soldering? Whether you're a beginner or just want a refresher course, check out our in-depth soldering tutorial.



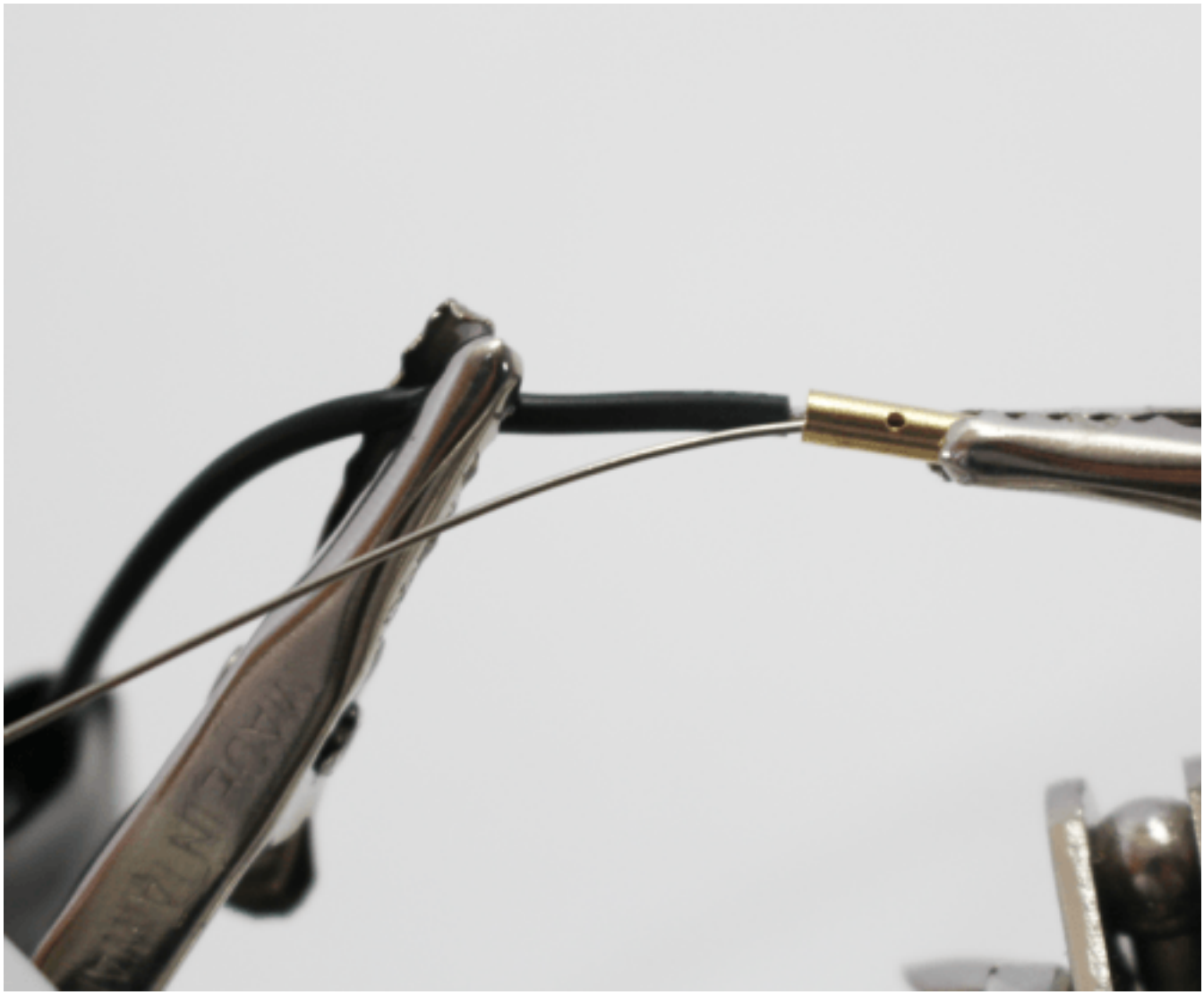
Once the solder has cooled, remove the motor lead and bullet from the helping hands and solder the other 2 motor leads and bullet connectors the same way.

Repeat these steps for the remaining 3 motors. When you're finished, you should have 4 motors with 12 male bullet connectors soldered to all the motor leads (1 on each lead).

Now it's time to insulate your soldered connections. Cut three ½" sections of ⅛" heat-shrink tubing and loosely fit them over, but without blocking, your newly soldered bullet connections. Carefully trim away any obstruction.

Once you have the heat-shrink in position, apply heat with your gun to shrink it. Apply this process to all 3 leads and you should end up with something that looks like the photo below.

Now it’s time to do it all over again with the female connectors on the ESCs. Depending on what ESCs you’re using, they may already have bullet connectors soldered on. If yours do have connectors in place already, check that they work with your male motor bullets. If everything seems to connect nice and snug, you can skip the rest of this step.
As with your motors, find the 3 black leads on your ESCs (the raw wires, not the servo plug), strip about ⅛” of insulation, and prepare the wire for soldering. Follow the exact same soldering steps you did for the motors, but with the female connectors.



After all the connectors are soldered, cut 1″ or more heat-shrink to insulate each. The heat-shrink should go just to the tip of the connector while still extending over the wire on the other end, allowing the male connector to make a solid connection.

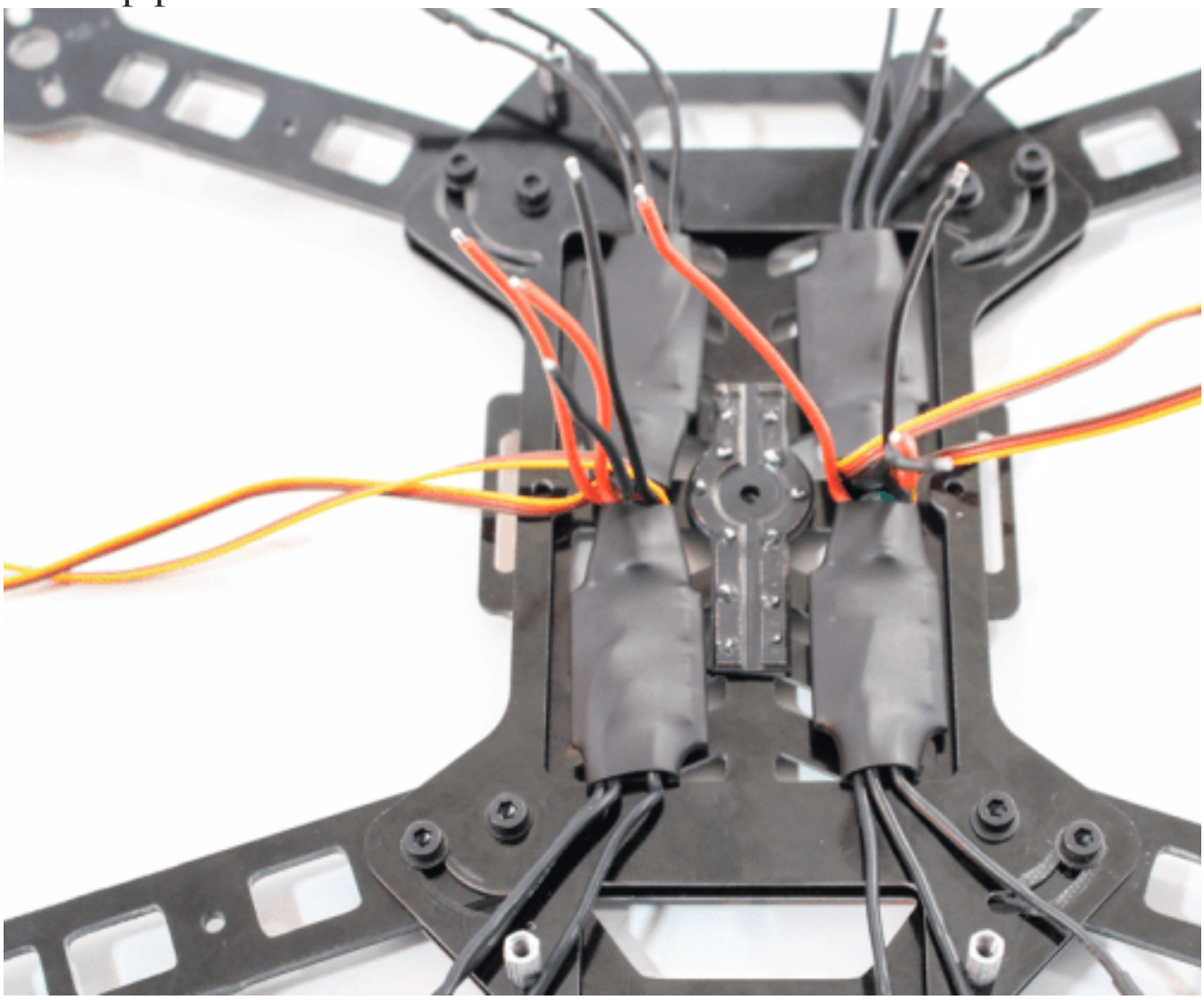
At this point, you have 4 motors with male bullet connectors and 4 ESCs with female bullet connectors. If you haven't done so already, try plugging them into each other and see how they fit.

4. MOUNT THE SPEED CONTROLLERS

Electronic speed controllers are typically mounted in one of 2 ways: on the frame itself, or on the booms near the spinning propellers to get additional cooling from the downdraft. Because the booms fold on this particular frame, you'll be mounting the speed controllers on the inside of the dirty frame. Apply a small strip of double-sided tape about ½" wide to a single side of each of the 4 ESCs. Sometimes ESCs can have a large round capacitor that sticks up on one side. If that's the case with yours, apply the tape to the other side to get as much surface coverage as possible.

Next, position the ESCs in the subframe. Take one of the ESCs and make sure the tape is peeled back and ready for mounting. Locate the open space in the dirty frame around

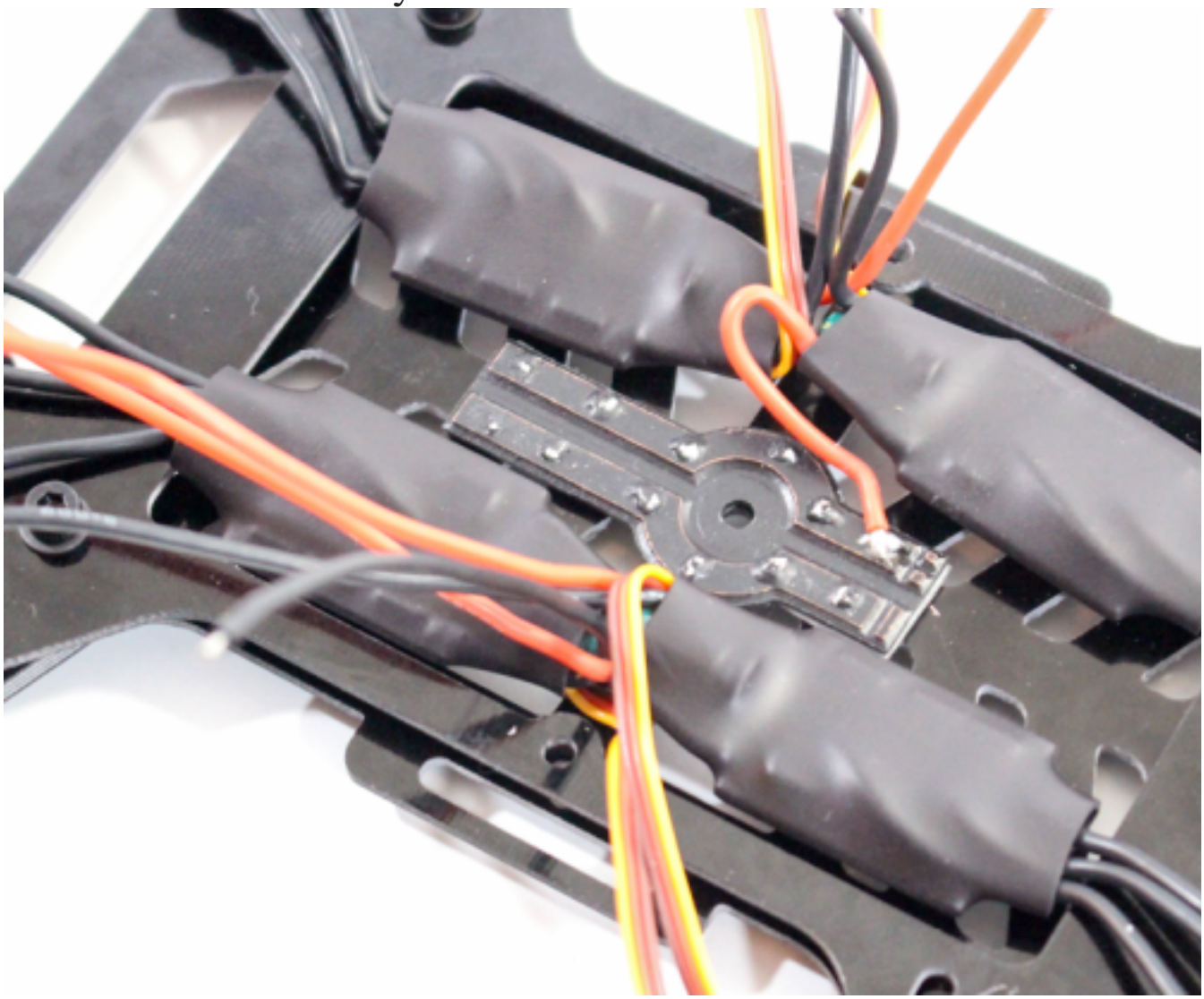
your PDB. Mentally separate this into quadrants and place each ESC into its own space. The red and black power leads coming off the ESC should be pointing toward the center of the frame, while the black motor leads you soldered in the last step point outward.

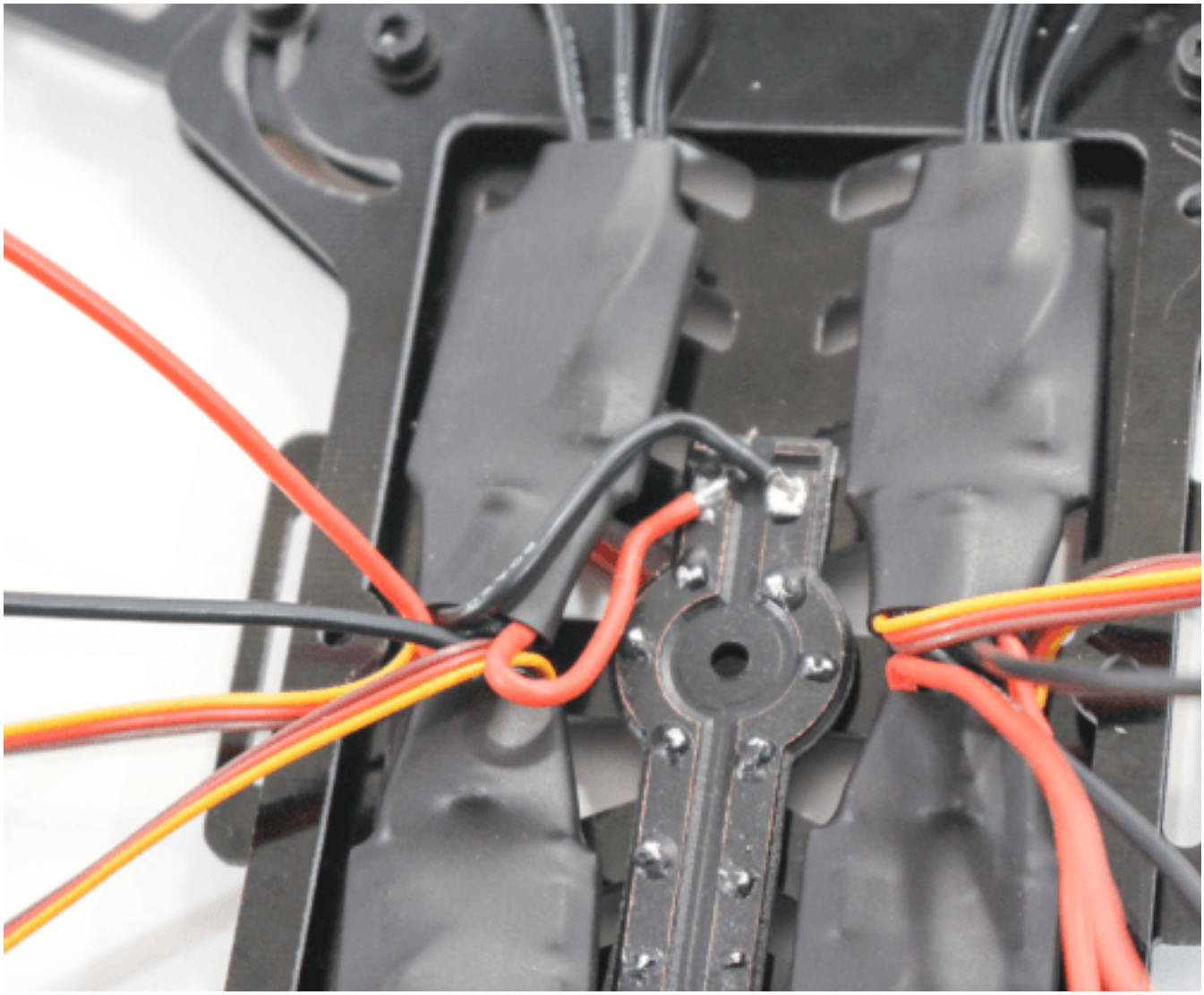


5. SOLDER UP THE POWER SUPPLY

The concept here is to connect the positive and negative leads (red and black wires, respectively) from each of the ESCs in a parallel circuit. If you aren't familiar with a parallel circuit, that's OK. It just means that all the red wires (positive) are joined together in one connection while all the black wires (ground) are on another connection. The photos below show how that works: There's one strip on the board

for positive leads and one for ground. All of the ESCs as well as the main battery lead will connect to the PDB.





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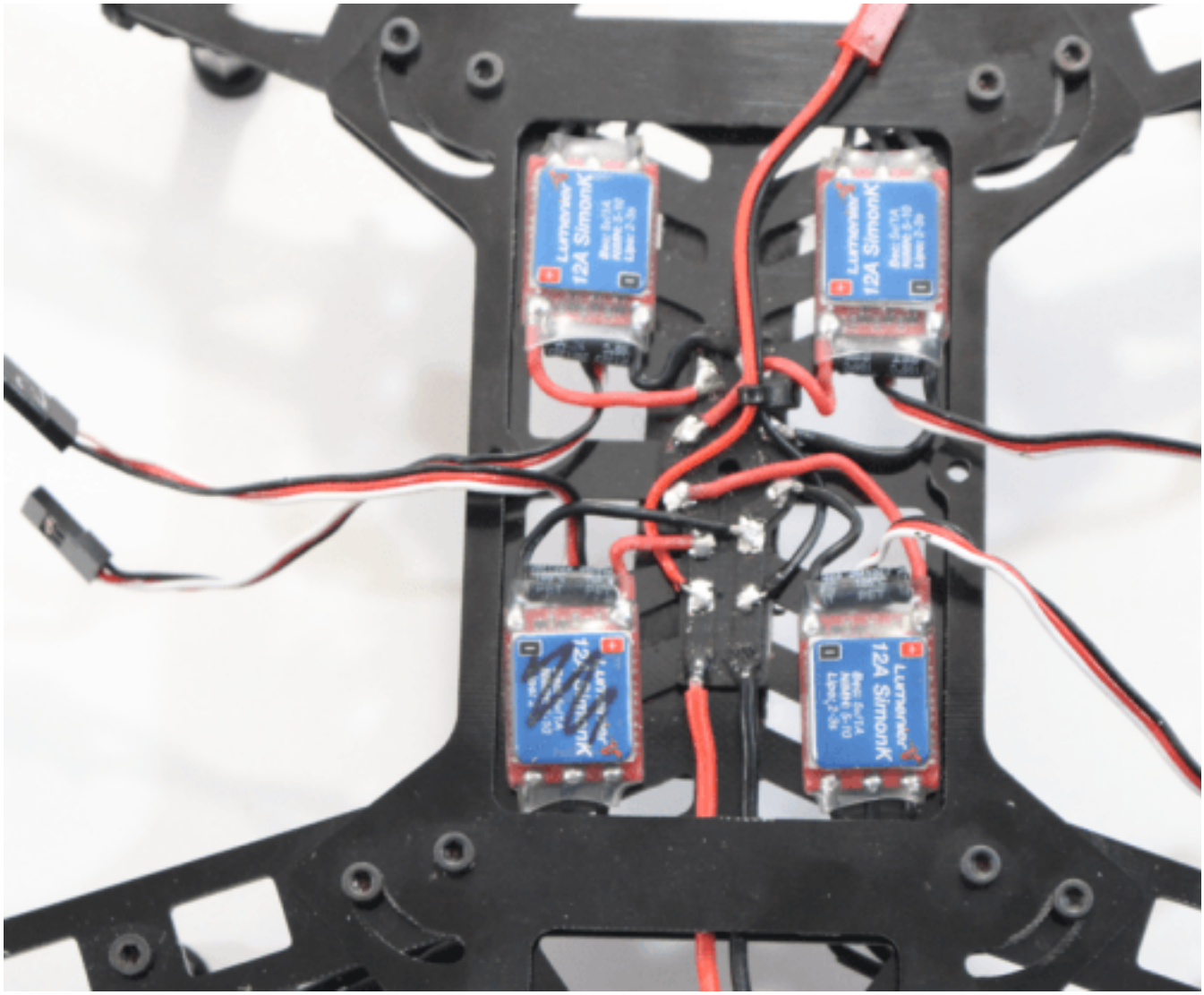

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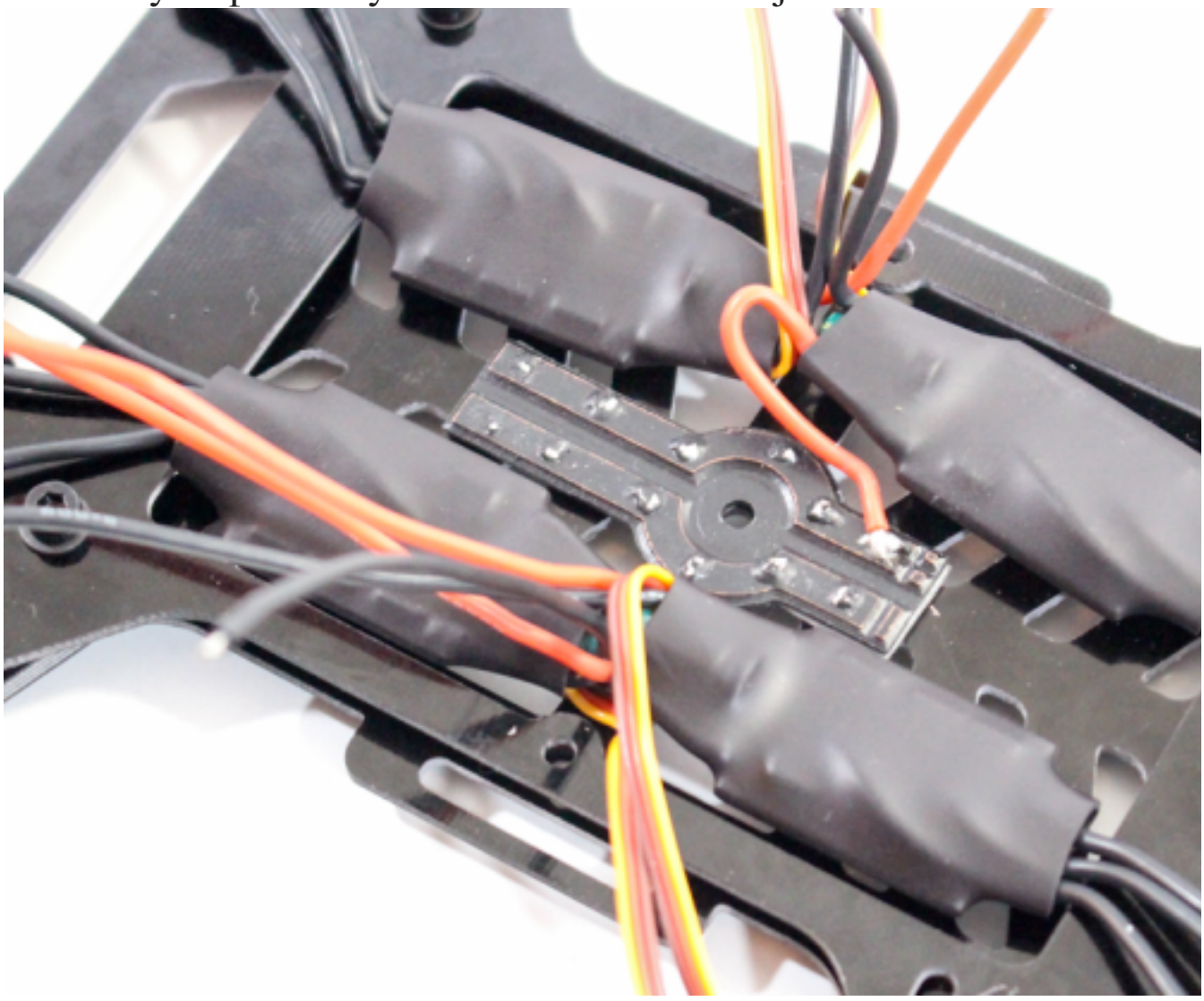
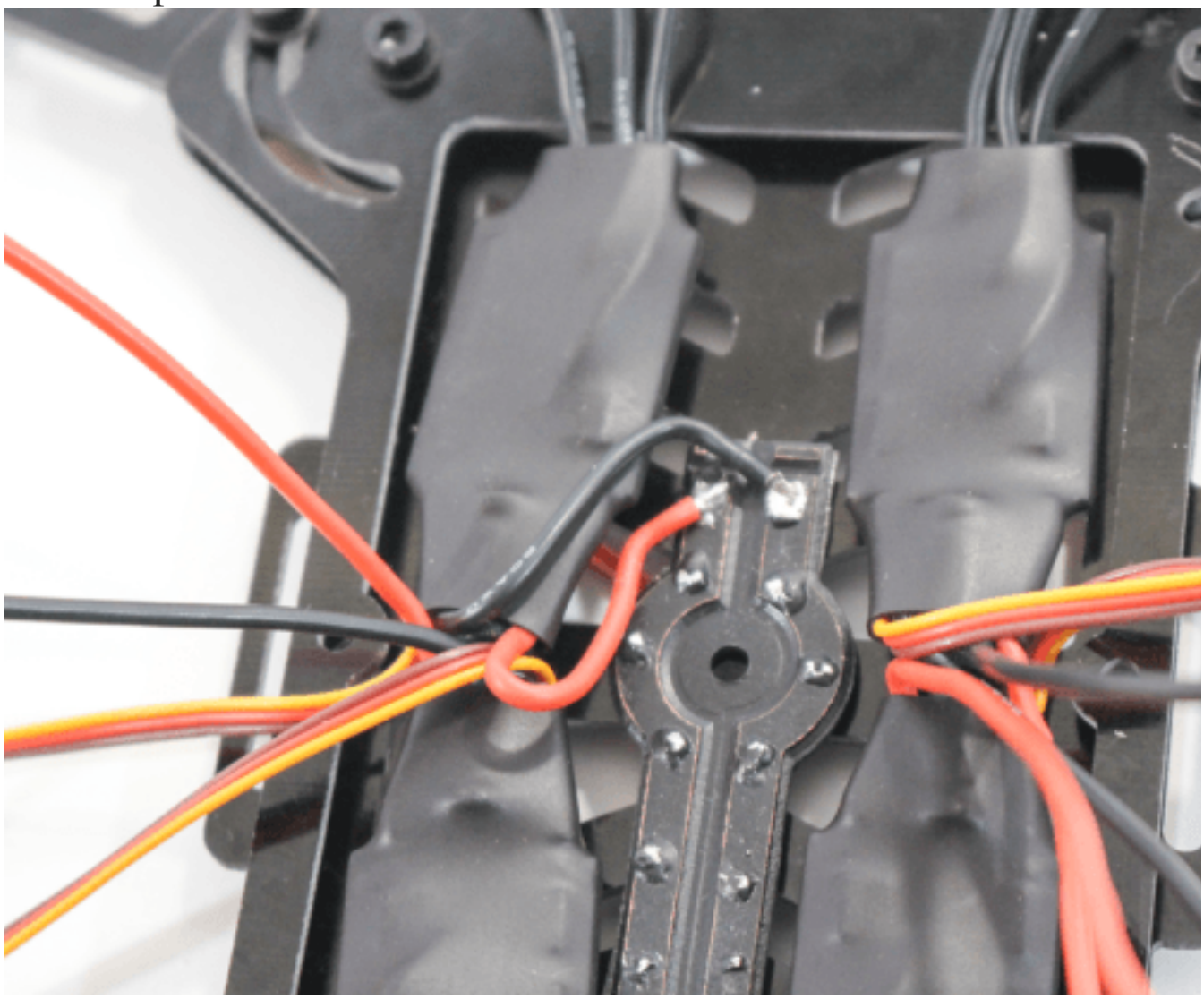
Start with a single ESC. Take the red wire coming out of your ESC and determine how long it needs to be in order to effectively reach a positive circuit on the power supply (in our case, the left-hand strip). Clip that wire to that length (or just a tiny bit longer, just in case) and strip off ⅛” of insulation from the tip. Now tin the exposed wire with your soldering iron and get it ready to be attached to the PDB. Next, take your needlenose pliers and use them to hold your ESC lead onto the PDB at the point where you want to make the connection. Make sure you are on the correct PDB circuit. This is our positive lead, so make sure it’s on the positive circuit. Finally, apply your hot iron (be sure to keep

the tip clean!) to the top of the positive lead, sandwiching it between your iron tip and the PDB. If you have applied enough solder to all the components, they should all melt together with no problem. Once that happens, remove your iron while continuing to hold the lead for a few more seconds with the pliers. If you pay attention to the solder, you'll see it cool in a matter of seconds. It will take on more of a matte finish look and less of a liquid appearance. Once this has happened, you can remove the pliers and check the connection. If it appears to be loose at all, repeat the necessary steps until you have a solid solder joint.



After you have the first positive lead in place, repeat the same steps to connect the negative lead from the same ESC

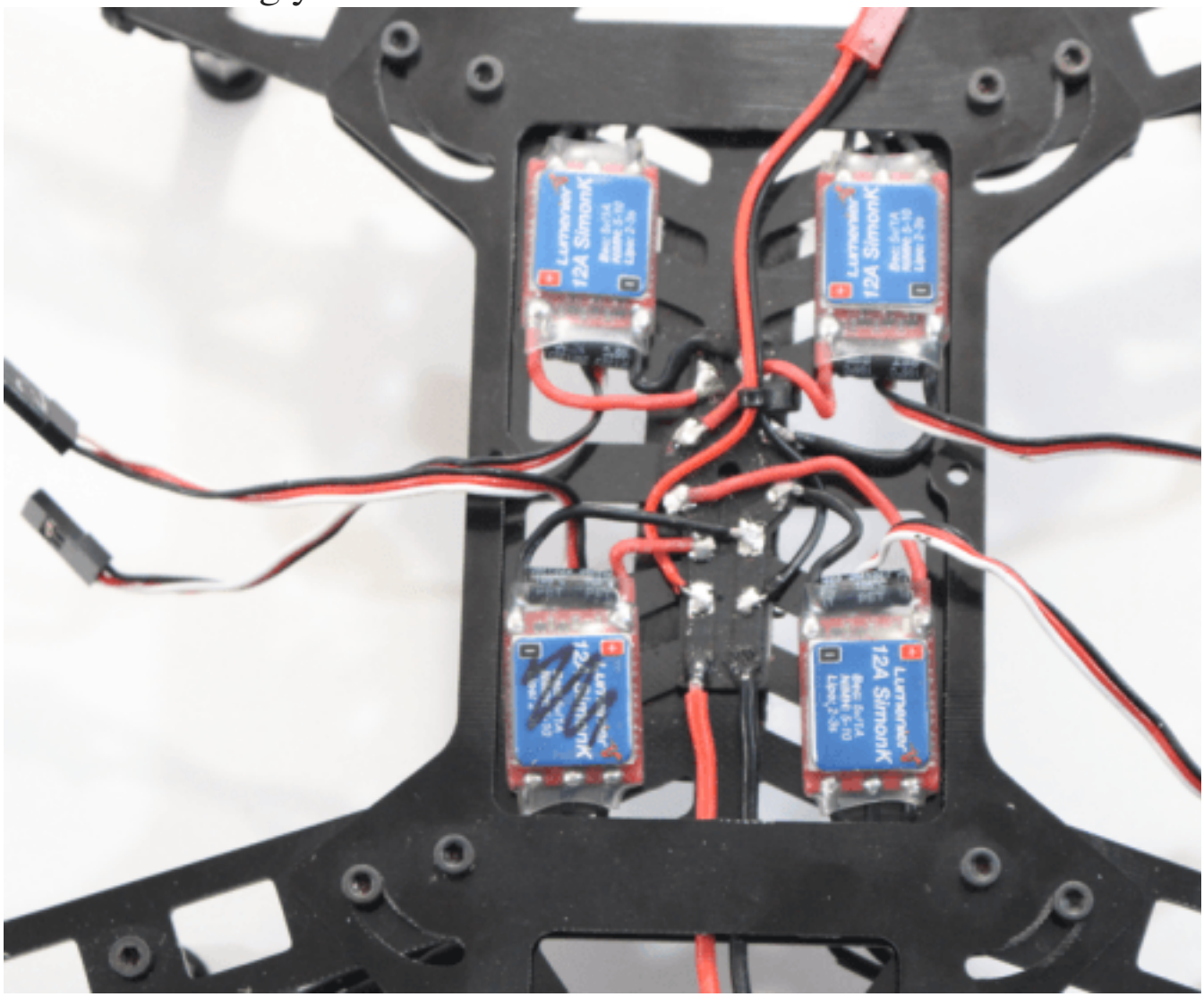
to the negative circuit on the PDB — in our case, the right-hand strip.



Do the rest of the ESCs in the same manner. Think about where you will position the wires for all of them. Don't make the mistake of cutting one of your wires too short in an attempt to save space. It's better to leave a little extra length at first.

The only thing left to solder is the main battery lead, which is attached exactly the same way as the ESC leads. Clip some insulation from the end, tin the wire, hold it in place with the pliers, and apply heat. Be sure that you're connecting to the right circuits and that your solder joints are nice and solid.

Future-Proofing your Drone



It's good to plan ahead by adding an extra, unused power lead to the PDB for items you want to include down the road. You'll notice that we have done exactly that. Try adding a JST power lead (readily available online for a few cents) to your power circuit and leaving it tucked neatly between the clean and dirty frames. Then when you want to add something like a video transmitter, all you have to do is pull that plug out and tap into your power right there. No need to get the soldering iron out again!

6. MOUNT BRUSHLESS MOTORS

Brushless motors for small drones such as the Little Dipper are constantly evolving. Due to this shifting landscape,

we’re not going to give specific instructions for one particular model of motor, but rather the overarching ideas that apply to all the different models.

In general, clockwise-spinning motors should have a reverse-threaded shaft. Counterclockwise motors work best with a standard thread. If you need to confirm the direction that your motor will be spinning, do so before attaching it to the frame.

One catch: Not all manufacturers make their motors this way. Many use only a standard thread — this will still work fine. Whichever style you have, be sure to tighten it well and check it regularly.

Start your mounting process by laying the motor flat on the top of the boom while lining up the mounting holes in the bottom of the boom with the threaded holes in the bottom of your motor. Make sure you have a motor with the correct thread direction for the anticipated motor direction. The motor leads should run down the length of the boom. Make sure they don’t run in any other direction.

Now manually feed the first screw through the boom's motor mounting hole and into the threaded holes on the bottom of the motor. Once the first one is done, feed the

opposite screw in, and keep going until you have all 4 in place.

Once you have all the screws manually fed into place, tighten them turn for turn on opposing screws, similar to tightening lug nuts on a car. Now that you have the first motor mounted in place, move on to the remaining 3.

PAY ATTENTION TO THE THREAD DIRECTION!

Notice that your motors have a shaft that holds the prop in place. This shaft is threaded, and a nut of some type (called the prop nut) fits over that thread and puts pressure on the prop. In the early days of small drones, those threads were all standard clockwise threads. But because quadcopter motors spin in both clockwise and counterclockwise

directions, manufacturers realized that if they created motors with standard and reverse threads, they could use the prop's spin direction to help keep it tight. Make sure you always have a thread that screws on in the *opposite* direction from that in which the prop will be spinning.

7. CONNECT BRUSHLESS MOTORS

Your brushless motors will connect to the speed controllers via the 3 black wires you attached your bullet connectors to earlier. If you're new to brushless motors, you may notice something funny at this point: The wires are not labeled. That's because there is no wrong way to connect a brushless motor to a speed controller, only different directions of motor rotation. You can connect those 3 wires in any possible combination and it would never damage the motor; it will simply spin in one direction or the other.

Our goal is to make the NE and SW motors spin in a counterclockwise direction. But because our build is not complete yet, just hook them all up the same and you can test them later and make any necessary changes — made easier by the bullet connectors between the components.

NO PROPS FOR YOU!

Be sure the propellers are *not* attached to the motors yet. That will be our very last step after we have confirmed everything is working as expected. This is an important safety measure.

8. CLEAN UP

At this point, it's a great idea to use a couple of zip ties and tidy your wiring job. It's also helpful to place identifying tabs on the servo leads out of the speed controllers before you button everything up. This will make your life much easier when working on subsequent projects later in the book. We usually use a fine-tip marker or paint pen and label the motor number on the ESC lead.

WRAPPING UP

Now that your speed controllers and motors are permanently mounted, make sure everything is firmly attached. Also check all soldering in your power harness/power distribution board to make sure nothing is loose. The connection between your motors and speed controllers is temporary at this point — you'll adjust it later when all the flight electronics are installed.

For the complete build, including the next section on adding the autopilot and battery, as well as facts, tips, and history on drone flying, pick up a copy of *Getting Started with Drones*.