Welcome to Flyleds!

This guide is aimed at those who are not 100% confident at their soldering abilities, so our apologies in advance to those who are already masters at it.
We're amazed at the various backgrounds and prior experience levels that the people we've met in the home-builder aviation community have. Most of you are now fully qualified rivet-bangers. With the aid of this guide and by building this kit you can add soldering to the list of specialist skills you never knew you had.

Part 1: Building The Original Kit wing boards

Before you begin soldering components to the boards, we'd recommend trimming the circuit boards to fit your plane's wing light coves. The final shape of your boards will end up being slightly different between the left and right wings due to manufacturing tolerances and the mould shape of the fibreglass wingtips. RV-9 and -10s are quite different from left to right sides.
The boards are marked along the straight edge as LEFT and RIGHT and facing either FWD or OUT in the top corners. Note that the boards are reversible by design, so we may have placed some red and green dots to help you remember which boards go on which side.
(**Please remember to remove the dots** once you're done mounting the boards to your plane!)

Shape the boards to fit your wingtips around the curved outside edges of the boards only.
Make minimal or no changes to the straight edges, as the position lights have a circuit trace along this edge.

The circuit boards are made from fibreglass with a thin layer of copper on either side, covered in paint.
You can use anything from sand paper or a hand file to a Dremel to shape the boards.
Use the same tools and safety precautions you would use for any other fibreglass work.

Clean any grease or dirt from the boards that may have accumulated during your fitting and filing, using some isopropyl alcohol, for example.

A note about soldering irons:

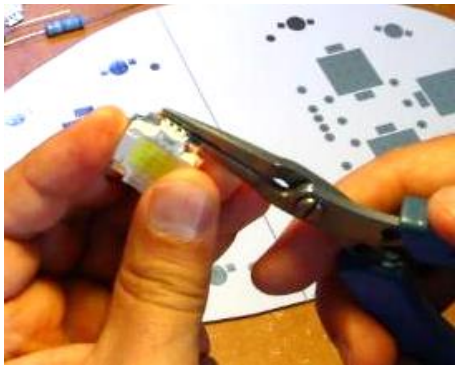
The soldering iron you use should be **temperature controlled**. This means it will have a dial that you can use to set a specific temperature. **Look for one marked in °C or °F!**
All but the most basic of these will have a sensor in the tip to maintain that heat setting.
We found examples on xtronicusa.com, Amazon and Parts-Express.com for around $60.

An el-cheapo 25/40/60 watt iron will not maintain a set temperature and is likely to run far too hot, which may result in damage to the circuit board.

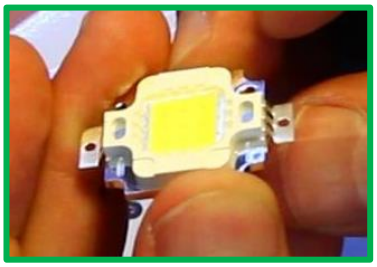
You should also use a conical or a 1 or 2 mm wedge shaped tip. If you last used your iron to take the blue plastic off your metalwork, please buy a replacement tip!

Before we can start soldering, we first need to do some preparation work on the white strobe LEDs.

1. Fold the connection tabs over 90° using your fingers
2. Now fold the edge of the tab back with pliers to be essentially flat, as per the pictures below.



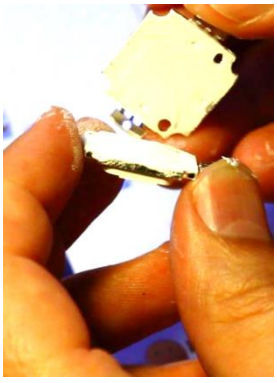
The end result:



When placed on a flat surface the LED should slide smoothly. The legs should be slightly higher than the base.

The Messy bit

Apply some GD33 Thermal Grease/paste from the syringe to one LED, and then share it with another! The amount shown on the picture on the left is enough for ***two or three*** LEDs! Rub two LEDs together to spread the paste all over the surfaces of both LEDs. It's (only just!) slightly less messy than using your finger to spread it around…



One customer also suggested using a pallet knife for a bit less mess!

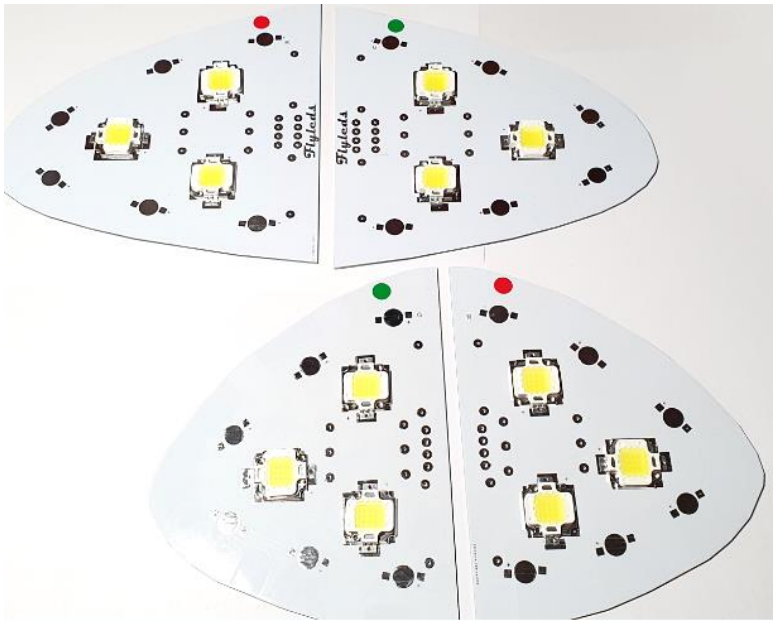
The thermal paste is only supposed to be a *thin* film between two almost perfectly flat surfaces. If you put too much on, it all simply oozes out from underneath when you mount the LEDs to the board.

Wipe any thermal paste off the *solder tabs* before placing them on the board.

When building kits for customers we place all four boards on the bench, opened out as left and right *Forward* facing boards, and left and right *Outward* facing boards. This way we guarantee we assemble one of each required board!

Then we place all 12 of the strobe LEDs on the boards, orienting the LEDs so that the + terminal on each LED matches up with the corresponding + symbol on the circuit board.

We then clean our fingers and come back and solder them all in place.
Read the instructions overleaf first!



Soldering 101

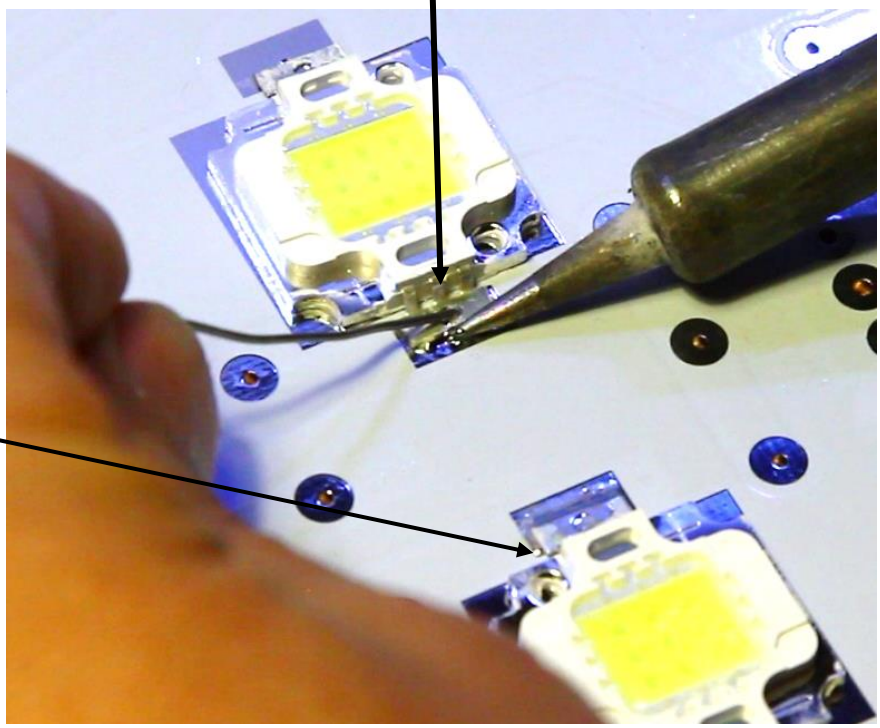
1: Solder is guaranteed to melt if you feed it straight onto the tip of the iron, but usually that's not very useful.

2: The key to making a good solder joint is for *the two parts you are joining* to be hot enough to melt the solder.

2a: This applies even if you are simply soldering two twisted wires together. You have to heat up the *wires* until *they* are hot enough to melt the solder.

Set your iron to 380°C/715°F, or about ¾ if there's no scale on your iron. (~360°C is a normal setting for my iron). The copper PCB tracks under these LEDs are large, which "steals" the heat from the tip of the iron. The "best" temperature setting for your iron may end up being a little different to mine…

Place the tip of the iron so that it is touching ***both*** the circuit board and the tab on the LED. **Cheat a little** by adding a touch of solder directly to the tip of the iron. This solder blob will help to transfer the heat to the board and the LED. Leave the iron there for about 5 seconds, and then feed some solder into the *hole on the tab of the LED*, not the tip of the iron, as shown below. When the solder begins to ***flow*** there, you know the two parts are hot enough.



Add solder (perhaps 1/3 inch) over another 5 seconds until you've nicely filled the joint. You are trying to get the solder between the LED leg and the PCB.

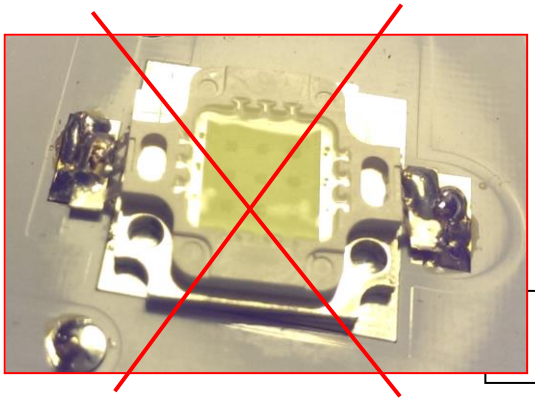
Remove the iron and after a few seconds the solder will cool and solidify.

You need enough solder (and heat!) to make a nice smooth solder joint, as shown on the LED below. If you can do this, consider yourself a master!

Give your iron 10 seconds to recover while you admire your work, and move on to the next connection.

Don't stress about using too much heat[1] or spending too much time here! These are all big components, and can easily handle the heat. We promise!

Continue to mount all of the white strobe leds this way.



As the solder melts and flows, ***if it acts like it is allergic to the PCB*** or the leg then that part is not hot enough. Reposition the tip of your iron or give it a little more time (ie heat) and the solder should happily flow across both parts. (Who knew solder had a personality!)

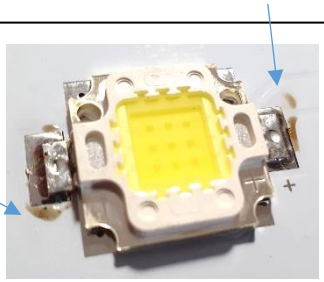
You shouldn't have to force solder to melt and end up with 'cold' lumps like the picture shown to the left.

In this picture the solder is not attaching to the circuit board, which is a good sign that the board was not hot enough, and the LED only just!

[1] There is, of course, a point where you can have too much heat! When you apply the solder, if you get *clouds* of smoke and sizzle, you're burning off the flux inside the solder before it gets to do its cleaning work. Some smoke is normal when you have everything set correctly, but the difference between 'nice' hot and too hot will soon become obvious.

Solder contains a flux agent that cleans the surfaces of the joint as it's being made, and it may flow out and settle as brown goop around the solder pad. This is a good thing! It means there were impurities that needed to be removed, and you now have a good clean solder joint.

After a few minutes when the board has cooled the residue can be easily removed by gently scraping it off with a small screwdriver.



Position LEDs

Put the two green LED (right hand) boards aside.
Open the "R" parts bag.

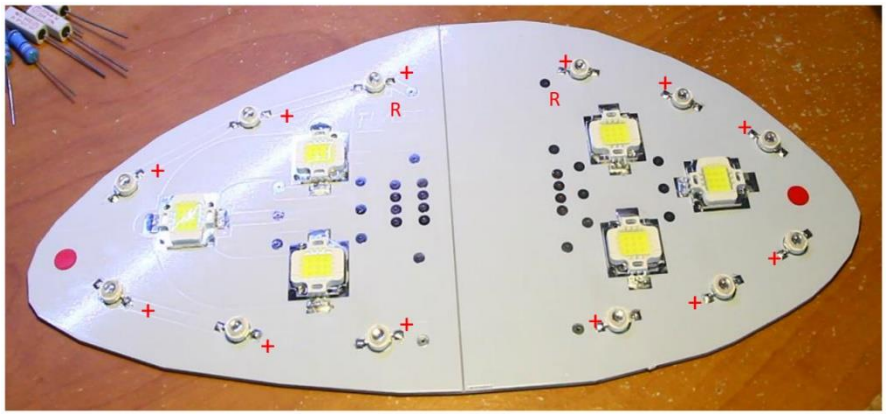
Place a small amount of thermal paste on the base of one LED, and again, share it with another, and perhaps another again! You'll be surprised at how little you need, and again if you've put too much on it just squeezes out from underneath when you place the LED on the board. If this happens pick the LED up again and move it to the next pad, leaving a blob of thermal paste behind for a new LED.
After you've done a few, you'll work out that it just requires a "kiss"* from the nozzle to leave enough on one LED. (*a metric unit)

While you have messy fingers again, place all twelve of the position LEDs on their pads <u>but don't worry about their orientation yet</u>! We deliberately leave them askew as a reminder to come back to them.
Once all of the LEDs are in place give your fingers another wipe clean…
The Position LEDs are wired in series in groups of three and must be oriented correctly. If one is soldered around the wrong way all three in that string won't work.
Rotate each LED so that the **+** leg stamped on their feet lines up with the **+** sign on the PCB.

The polarity of the LEDs can be identified by
* the tiny **+** and **–** stamped onto their feet.
* The *negative leg* has a small notch in it near the LED body.

You can turn your soldering iron back down to **350°C/660°F**. The position LEDs should be easy to solder and only take a few seconds per leg because they have much less thermal mass to them.

With your soldering iron approaching the board from the <u>outside edge</u>, work around the board and solder each position LED to the PCB.
This keeps the barrel of your iron from accidentally damaging the white strobe LEDs in the middle.
Let the tip of the iron touch *both* the circuit board and the LED leg, and after a few seconds introduce some solder. The solder should flow around the pad nice and neatly within a second or two. Easy!



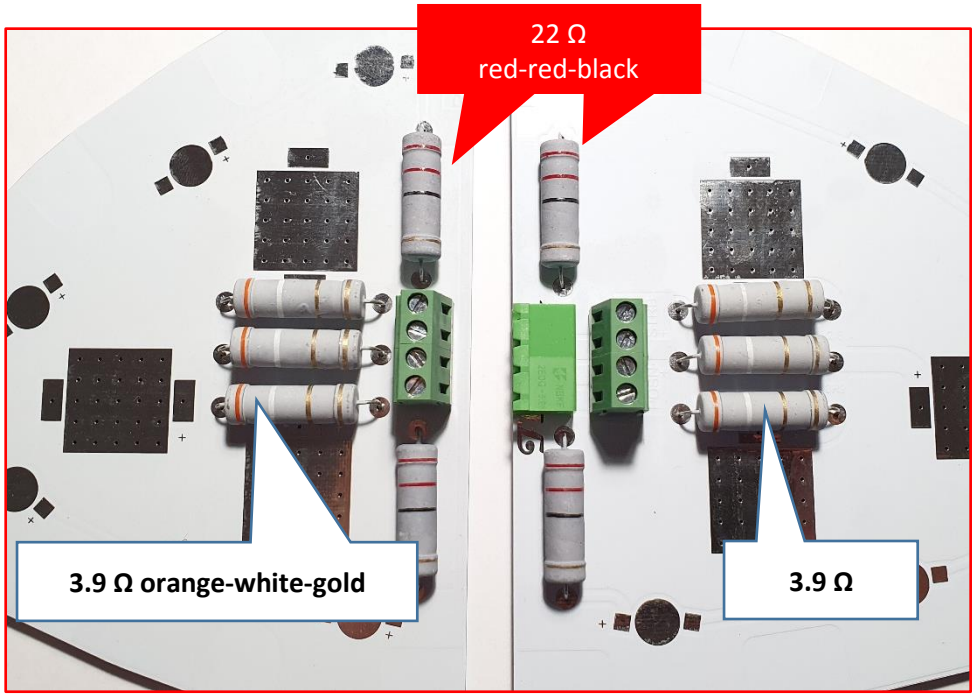
If the LEDs move out of position, simply reheat the solder with the iron and move them back into place by hand.

Resistors

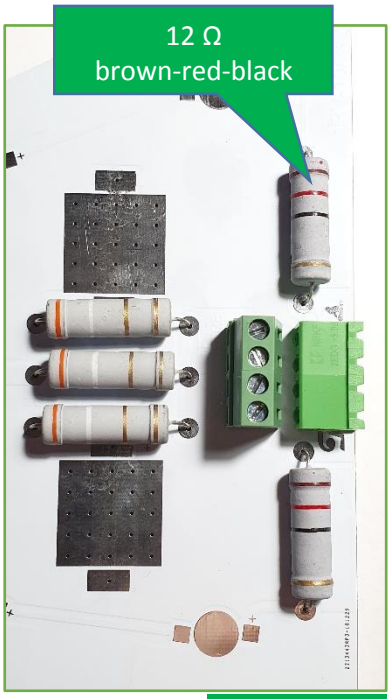
Flipping the board over, we can now put in the power resistors out of sight on the ***rear*** of the boards.
NOTE! Do not join the small number of customers who have put the resistors on the same side as the LEDs…

Resistors can go in a circuit either way around, but the neat freaks amongst us prefer to be able to read the resistor colour code from left to right as shown! Your plane will also fly two knots faster when everything is aligned this way.

The two Red/Left hand side boards are shown below: The 22Ω resistors are supplied in bag "R" with the red LEDs.



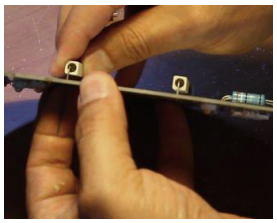
The rear of the Red boards is shown here.



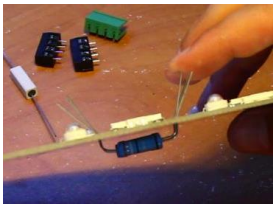
And the rear of the Green board(s)

Bend the leads at a small angle as shown using your thumbnail and a finger.

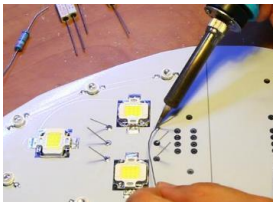
Mount the resistors, and splay the legs slightly to hold them in place.
(Showing earlier version components, but the principle is the same.)



The resistors are mounted a few* mm off the board[2] to aid in heat dissipation.
In normal operation they will get hot!
*(A popsicle stick is a suitably calibrated device for this measurement!)



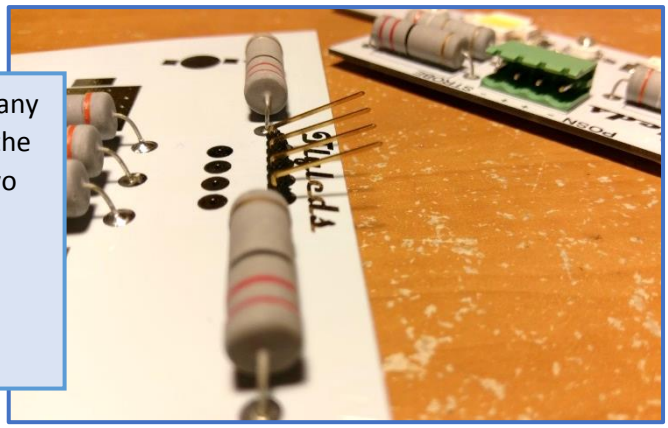
Turn the boards over (LED side up, resistors down), prop them up with perhaps a screwdriver, and solder the resistors in, remembering to heat both the pad and the resistor. Note the "angle of attack" of your soldering iron to make sure you don't damage any LEDs. Expect that some solder will flow through the hole to the other side of the board as the holes are 'plated through'. This is OK.



[2] If you think vibration could be an issue, you could come back later and use some silicon/RTV to hold the resistor body in place. It hasn't been a problem in our RV-10 for the last ten years!

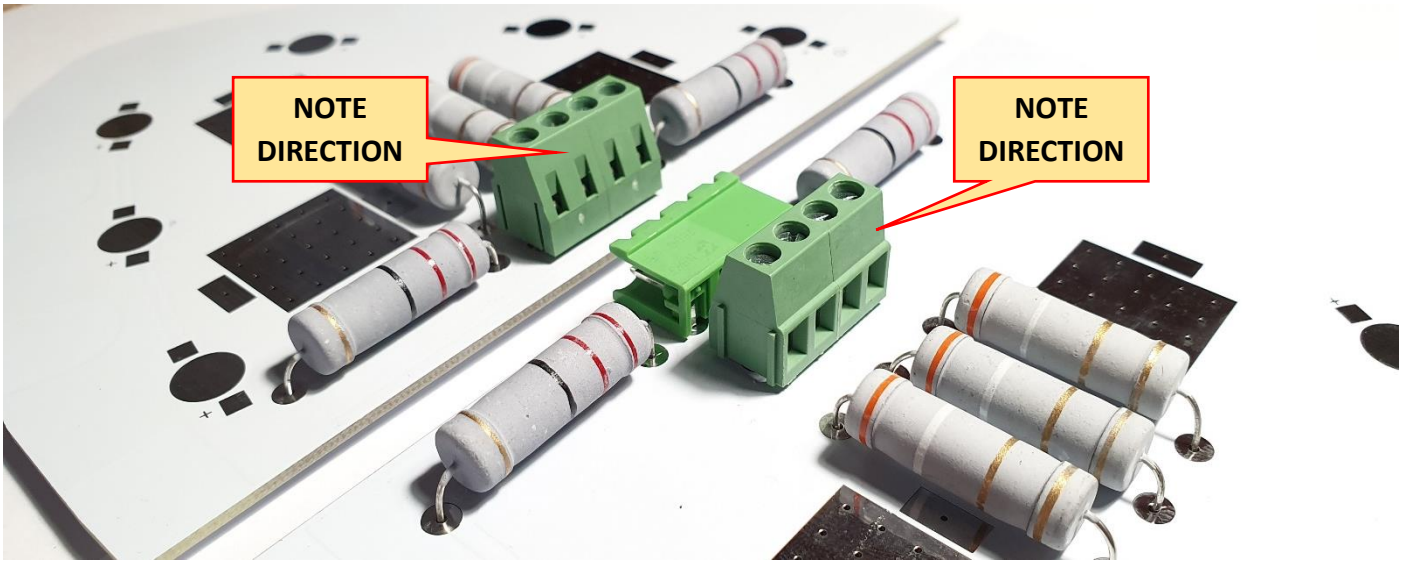
Terminal blocks

If you have purchased the Skinny boards kit, do not mount any green terminal blocks to the larger board. Instead, mount the four pin right angle connector as shown by soldering the two outside pins only. This will allow you to reheat the joins if required to get the correct angle.
Once set correctly solder all four pins to the board.
See the Skinny sheet for further details.

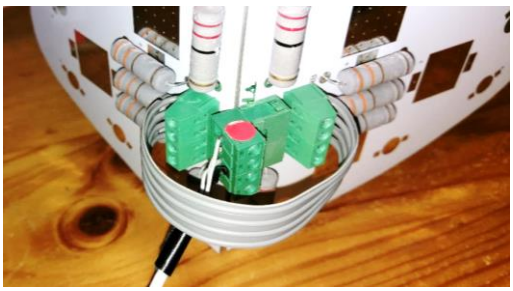


If your plane is on a serious weight loss program, you could save a few grams by soldering the interconnecting wires directly to one board, omitting one of the screw terminal blocks instead.

Mount the terminal blocks as shown, again on the **rear** of the board, **noting** that the wire entries for the screw terminals ***face the 3.9Ω resistors***.



Mounting them this way will give the interconnecting cable (or your own supplied wires) enough room to loop between the boards without interfering with the green wiring loom plug, as seen below.



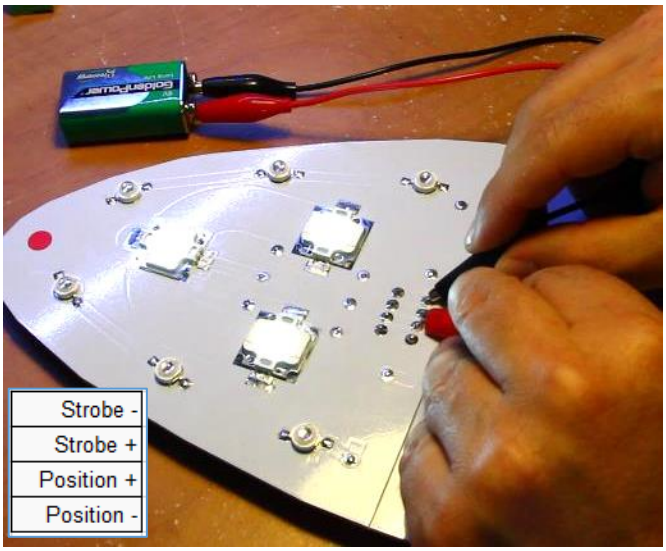
If you've just realised you've put the terminal blocks in facing the wrong way, **don't panic!**
It all still works the same with some individual lengths of 20AWG wire rather than the supplied ribbon cable.
Because the PCB holes are plated through to both sides of the board, solder makes its way into the holes right through the board.
Desoldering the terminal blocks will prove *very difficult* without the proper equipment and is likely to damage the PCB. Email us before you attempt to make any repairs…

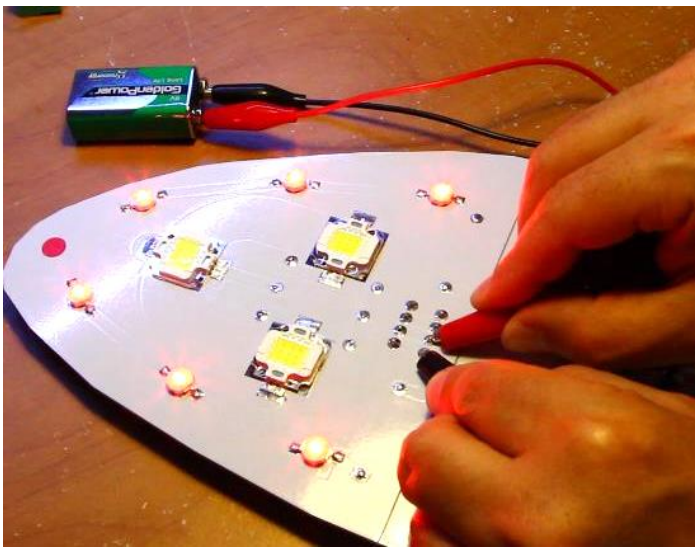
Congratulations! Your left hand/red wing boards are now complete, and it probably took you about 2 hours to do. The right hand green LED boards will take you less time now that you're an expert.

Testing.

- You can test your boards using a square 9 volt battery. This will light up each circuit without bruising your eyeballs. If you have a 12 volt source, you can test them at full brightness, but it *will* hurt! I promise.

You did get all of the position LEDs the right way around, didn't you?





- **NOTE 1: DO NOT test *individual* red/green LEDs this way!**
  The white strobe LEDs will cope with the limited power available from a small 9v battery, however you will quickly destroy the smaller red and green LEDs if tested this way.
  All LEDs require current limiting, which is the job of the resistors below the board.
- **NOTE 2:** If you stole the 9v battery from the smoke alarm, go and put it back!

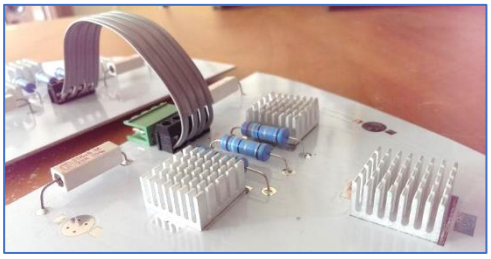
If you have one string of position LEDs that is not illuminating, you can check the orientation of each led using your multimeter. As they are connected in series groups of three LEDs, if you've soldered one LED the wrong way around, the whole string of three won't light up.

Set your multimeter to the ⊣▶⊢ diode/continuity range. With the meter's red test probe on the positive leg of the LED, you will see a reading[3] something like that shown here, and depending on the design of your meter, the LED may even illuminate slightly.
With the probes reversed, the meter will show "1" or "OL" or something similar, and the LED does not light up.
Referring to the picture on page 6, you'll note that the positive legs of the position LEDs all face towards the straight edge of the board. Using this method, you can quickly find the LED that took it upon itself to step out of line.
(Wait, who's fault was it?!)

[3] The reading shown on the meter is actually the Forward Voltage drop across the diode, in this case 1.642 volts. Green LEDs will drop more than 1.999 volts, so your meter might briefly flash a number like 1956 and then display a "1" on the screen. The meter in the picture still lights up green LEDs but another meter we have does not…
For interest, if you were to do the same test on your contactor diodes you'll see a reading of ~700 one way, again showing the forward voltage drop of the diode. (Black probe goes to the band printed around the diode body.)

Heatsinks

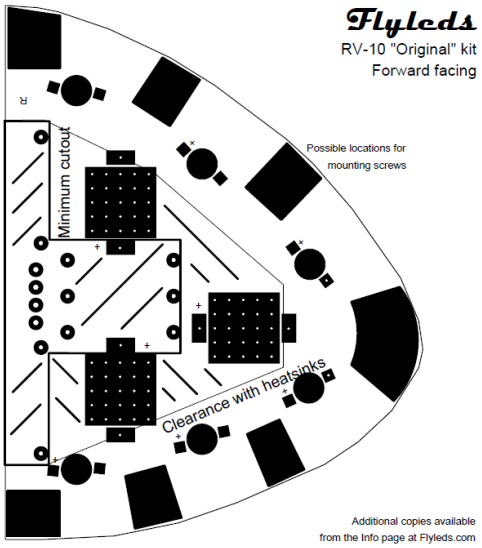
If you've purchased the optional WigWag heatsinks, now would be a good time to install them. They adhere to the board with strong 3M double sided tape. Orient the heatsinks as shown.



In normal (strobe) operation, heat generated by the LEDs is dissipated easily into the copper layers in the PCB, so the heatsinks are not needed. In wigwag mode, the LEDs are on for a longer period of time (~50% on/off time vs roughly 25%), and so they produce more heat. For an extra 2oz of weight, the heatsinks are just helping these LEDs outlast your airframe by that much longer!

Fitting to the wingtips

At this point, you can work out the cut-outs required in the light bay faces to clear the power resistors, heatsinks if fitted, and the power connections on the rear of the board. Dremel away!
Templates with suggested cutting lines are available to download on the **Information** page of our website.

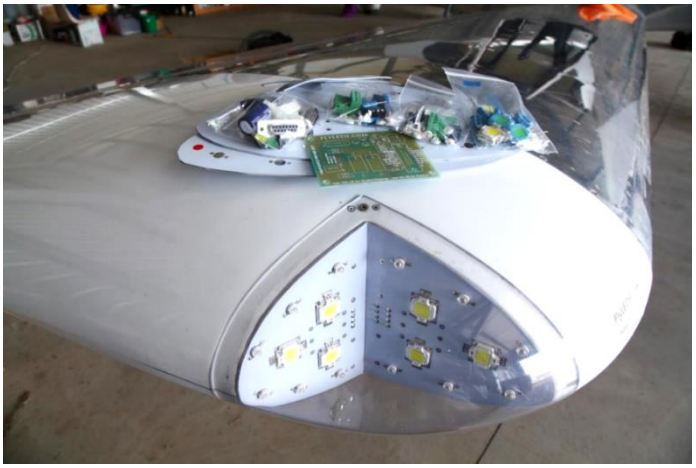


We mounted our boards to the wingtips using double-sided tape. You can source this from either an auto parts store as trim tape, or carpet joining tape also works well. The prototype wing boards were installed in the wingtips a year before our RV-10's first flight, and then had to be pried off after 50+ hours of flying time when we replaced the boards with the ones you see in the photo below. We've recently passed three hundred flying hours since the photo below was taken, with no change. The lights are not going anywhere!

You can also use your choice of adhesives, nutplates, rivets, etc. You can see that there are plenty of "open" sections of copper on the board for you to be able to use two or three fixings, as suggested by the black squares shown here around the outside of the board.
Be sure to avoid drilling through the PCB tracks that connect in between the position lights, or drilling between two adjacent areas of copper.

If you do use screws or rivets to mount the light boards, countersink or enlarge the hole slightly on the reverse side of the board. This will prevent the screw from making a short circuit from one side of the board to the other.

If your strobe LEDs still have any tape over them, please peel it off and discard it.



One last thing: You can also remove the red and green dots from the PCBs.

We'd love to see some pictures of your handiwork. Please share!