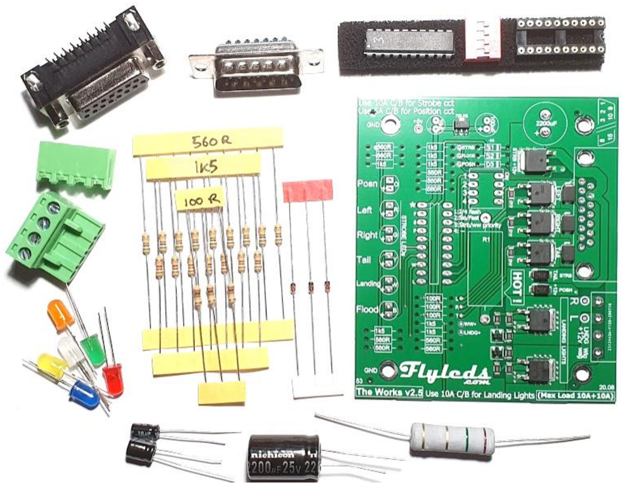
Part 2: Building the Controller Board

Congratulations for making it this far! The controller board uses smaller components than the wing boards, which believe it or not, means that everything is actually easier to solder.

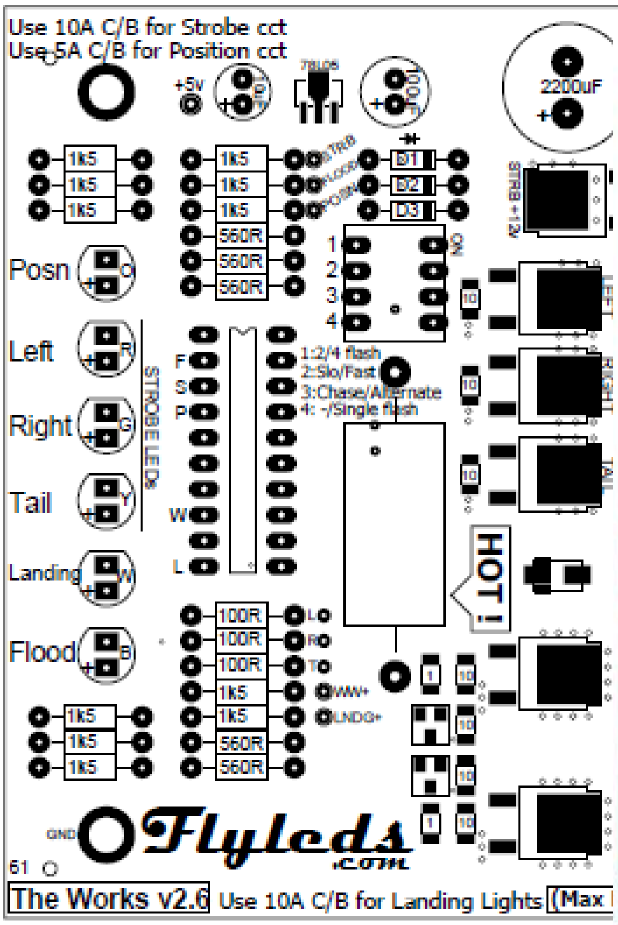
Surface mount components

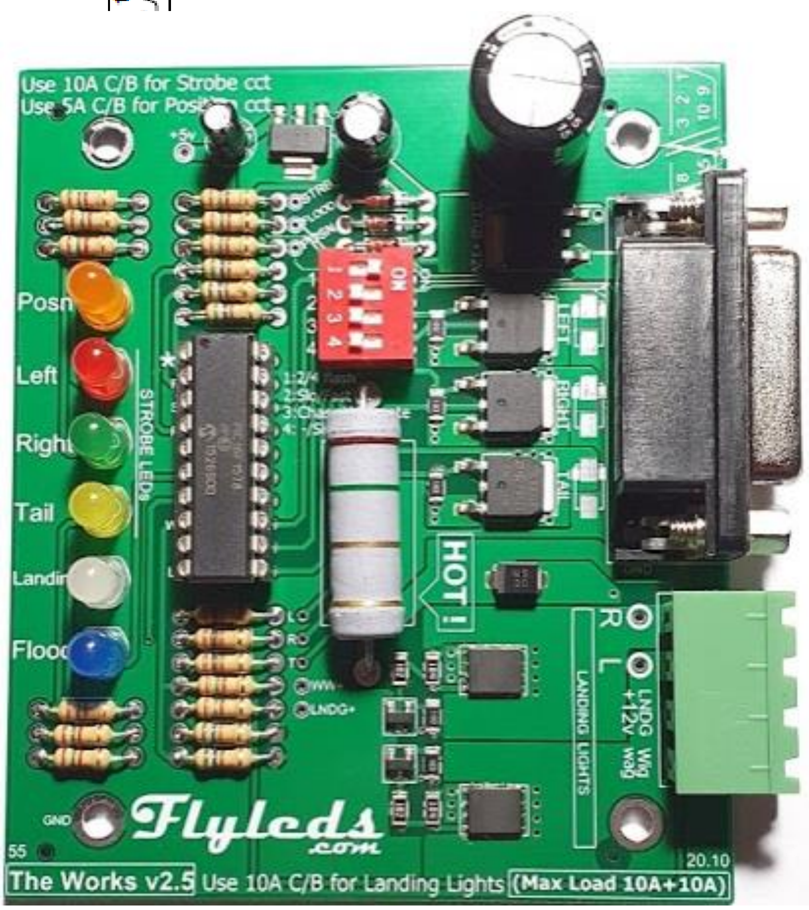
We supply the controller board with the surface mount components already reflow soldered onto the PCB. For your reference the components are:



- **Voltage regulator**. Converts the incoming 14 volt supply down to 5 volts for the microcontroller.
- **Diodes**. One diode is used to separate the Flood input power source from the Strobe input power source. Another smaller diode allows a Flyleds tail light to act as both a strobe and a position light.
- N-channel power **MOSFETs**. These little miracles will switch 60 amps of current all day long, and have an 'on' resistance of only 0.007 ohms. In this circuit, they only switch ~5-6 amps for the strobe flash duration so they generate very little heat. In years gone by, this control circuit would have required big switching transistors mounted on a large and heavy heatsink.
- P-channel power MOSFETs and the small components nearby switch power to the landing lights. This newest version of board is also capable of switching our Seven Stars lights, hence the conflicting fuse information there!

The completed board





Mounting holes

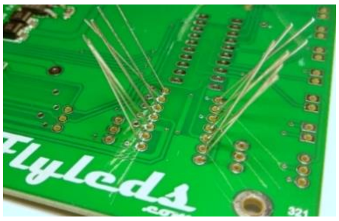
The first thing to do is adjust the mounting holes for the controller board if required.
The mounting holes in each corner are spaced to fit a Hammond 1591XXS box, available at Digikey, Newark or Mouser, but you could also fit it into any other box of your liking. You'll also need four #4 x ¼" self-tapping screws.
We supply four plastic stand-offs that simply require four holes to be drilled to mount the board somewhere out of the way in your plane. <u>To use the standoffs you will need to enlarge these holes to 4mm or 5/32"</u> or thereabouts.
If you are upgrading your controller board from an existing Flyleds kit, there are also small pilot holes nearby that align with the holes on the previous controller board. Drill these out to 4mm or 5/32" if required.

Assembly

> Please take care to double check that your components are in the correct locations before soldering them in. The component holes on this board are "plated-through", which means that trying to de-solder components can be very difficult! We also have a Troubleshooting Guide available to download from the Flyleds <u>Information</u> page.

With circuit board construction, it is easier to start off with the smaller components, and work your way up in size.
You can solder the resistors and diodes in all at once, or perhaps one group at a time.

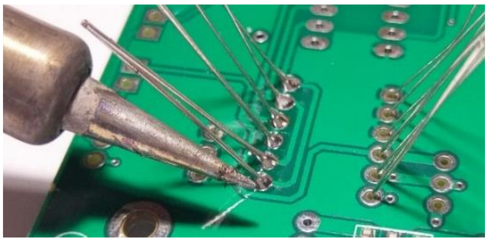
1: Resistors



The resistors are supplied taped together in groups and have been marked with their values, just to make it easy for you!

Pull the tape off a group of resistors such as the 100R resistors (R is shorthand for 100Ω or ohm). Fold their legs over and insert them into their allocated slots as marked on the board and the diagram on page 1.
We like to see them all oriented the same way please, gold band to the right! (Resistors *can* go either way around, but just like turning all the screws you can find to 90° angles, your plane will fly at least three knots faster.*)
Bend their legs apart slightly as shown so that the resistor stays in place tight to the board when you solder them in.

2: Solder them in!



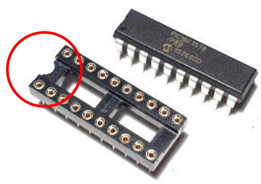
Touch the tip of the iron to **both** the circuit board *and* the resistor leg, and after a few seconds introduce some solder to the joint. You can cheat by adding the first little bit of solder directly to the iron tip so that the blob of solder gets the heat from the iron into the PCB and the component leg.
The rest of the solder that you add should then be melted **by the component and pad**, not the iron. Leave the iron there for a second or two more to let the flux inside the solder do its cleaning work and then remove the iron.
A few seconds later the solder will cool and set, and you should have a nice smooth looking joint around each leg.

> Remember: If the solder blob is clinging to the component leg and is acting like it's allergic to the PCB, it's because the PCB pad is not hot enough. Adjust your soldering iron's angle of attack so that you heat <u>**both**</u> the component leg *and* the PCB. The solder will then happily **flow** between both items, forming a nice conical shape.

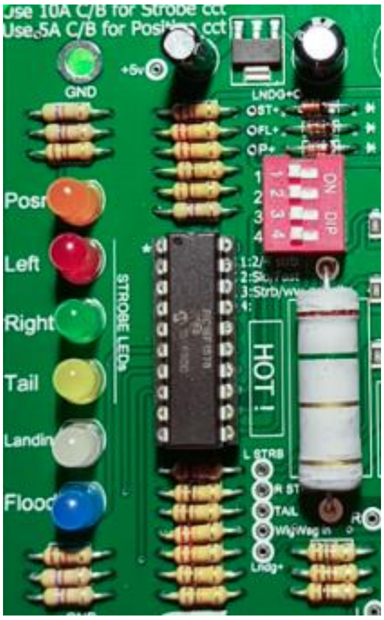
3: Diodes

Repeat the process above for the three **1N4148 diodes**. **Note** that the diode has a **black band** around one end.
The diodes *must* be mounted with the black band to the right, as marked on the PCB, otherwise there will be no blinking lights…

***Claim not verified! But we know you think the same way we do.**



4: You can now mount the **IC *socket*** for the microcontroller. One end of the socket has a notch taken out of it, which aligns with the asterisk (*) on the PCB. The holes in the PCB for the IC socket are plated-through, which means the top and bottom pads are connected together through the hole. With the extra metal involved you might observe that you need another second or three of heat to get a nice looking solder joint.
Solder one pin first, then check that the socket is still mounted flush to the board.
Reheat the joint and manipulate the socket if necessary to let it sit properly.
If you're still new to soldering, continue to solder the rest of the pins in place, but choose pins on alternate sides and/or ends of the socket. That way extra the heat build-up won't melt the plastic socket.



5: Insert the **LEDs**. The *longer* leg of each LED is the **+** lead and it goes in the lower hole. Again, bend the leads apart slightly to stop the LED falling out when you turn the board over. Solder them in!

6: Insert the four-way **DIP switch**, checking that it is oriented as shown. Solder one leg and re-check that the switch is still sitting flush before doing the rest.

7: Mount the large 1.5Ω **ceramic power resistor** for the tail strobe.
Hold the resistor and bend its legs so that the resistor will sit 1 or 2mm above the surface, rather than flush against the board. This allows it to keep cooler.

8: Mount the two smaller **capacitors**. 10uF goes above the resistors, 100uF above the diodes. Note the orientation as per the diagram on page 1, and the **+** symbol marked on the PCB. The *longer* leg of the capacitors is the **+** terminal. (The body of the capacitor highlights the – terminal, just to keep you on your toes!)

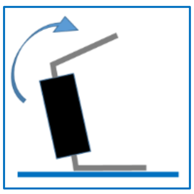
9: Next fit the **15 pin D connector**. Make sure the pins are straight and carefully push it into place. I start by anchoring one of the mounts at one end and then insert one pin at a time as you angle it into place. It will either drop straight in, or one pin will step out of line and do all it can to frustrate you!
These are plated through holes here as well, so a little extra heat/time may be needed with your iron.

10: The **green four pin socket** for the landing lights can be mounted and soldered in next. Allow a little extra soldering time for the heat to flow into the larger traces in the PCB.

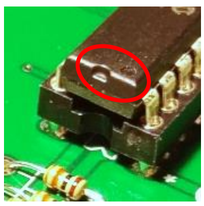
11: Mount the **2200uF** capacitor, by observing the + sign on the silkscreen and inserting the longer leg of the capacitor there. Double check this one before soldering it in!

12: The **PIC16F1578** microcontroller can now be inserted into the IC socket, however the legs are usually spread too wide to fit straight into the socket.

> If you've just realised you've soldered the chip to the board in step 4 above, STOP! All is good, leave it there.
> You will likely damage the PCB trying to remove the chip.



Hold the body of the chip so that one side of legs is against your workbench, and gently "roll" the chip forward so that the legs are *almost* 90^{o} to the body.
Turn the chip over and make the legs on the other side parallel with the first.
You can now carefully insert the controller IC into the socket. The IC is held in by a friction fit, and does not need to be soldered to the socket.



Note the small detent and notch in the chip, which marks pin 1 and corresponds with the * on the PCB.

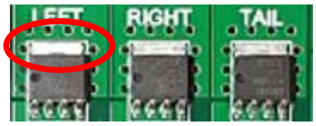
That's it! You're done!

The Blink Test

1: Using your square 9 volt battery, connect the battery– to **GROUND** (pin 1) and battery+ to **STROBE+** (pin 10). Change the red switches and you will see the different flash patterns in action with the on-board LEDs.
2: Applying power to **GROUND** (pin 1) and **FLOOD+** (pin 9), the Flood LED will illuminate, as well as the Left, Right and Tail LEDs.
3: Applying power to **GROUND** (pin 1) and **POSITION+** (pin 5), the Position and Tail LEDs will illuminate.
4: Applying power to **GROUND** (pin 1) and the green plug **LNDG +12v** pin, the Landing LED will light up.
5: Applying power to *both* **LNDG +12v** and **Wigwag** pins, the Landing LED will alternate between dim and bright, representing the left and right landing light outputs being active.

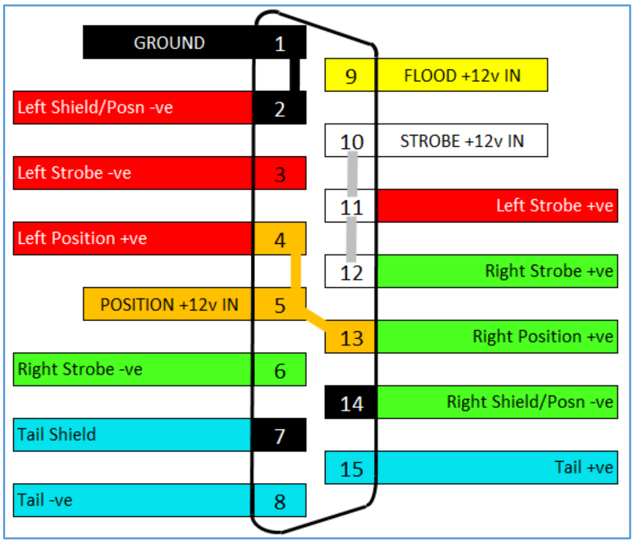
The Beep test

This test can be used as further proof that the controller board is working, and the principles can also be applied at the wingtip boards to troubleshoot later wiring harness issues, for example. The strobe LEDs out on the wings are sent +12 volts continuously, but they only flash when the MOSFETs on the controller board switches their *negative* lead to ground. This is why the Strobe- wires must only be connected back to the controller board and not be connected to ground.
1: Set your multimeter to the *diode/continuity/beeper* function.
2: Check that your meter ***beeps*** when you touch the test leads together.
3: Check for periodic beeps in time with the flashing LEDs with your black test lead on any ground connection, eg **pin 1 or 2**, and the red test lead on **pin 3** (left), **pin 6** (right), and **pin 8** (tail).
You can also test this by putting the red test lead on the metal tabs on the switch FETs, where the words LEFT, RIGHT, and TAIL are printed.



Connector pinout

The label colours shown at right describe the wire groups and functions.



- The red labels are the four connections to the left wing.
- The green labels are the four connections to the right wing.
- The blue labels are the + and - connections, plus shield, to the tail LED.
- Airframe Ground is connected to pin 1, which then connects to pins 2 and 14 for the ground return for the wing position LEDs and pin 7 for tail light wire shielding.
- **Position** light power is applied to pin 5 POSITION +12v IN, which then feeds +12v *out* to the red and green position LEDs on pins 4 &13. Power also feeds out to the tail light for position mode.
- **Strobe** power is applied to pin 10 STROBE +12v IN, which then feeds +12v *out* directly to the left and right wing strobe LEDs on pins 11 & 12, and the tail light on pin 15 via a small diode.
- **Flood** power is applied to pin 9 FLOOD +12v IN, which also feeds power out to the strobe LEDs on pins 11 & 12, and 15 via an on board diode.

- **LNDG +12v** is the power input for the landing lights, and it should be protected by a 7.5 or 10 amp fuse or circuit breaker.
- **L** and **R** are switched 12 volt outputs for the landing lights on each wing. The landing lights should be grounded locally out at the wing.
- Applying power to *both* LNDG +12v and Wigwag will enable the wigwag function.