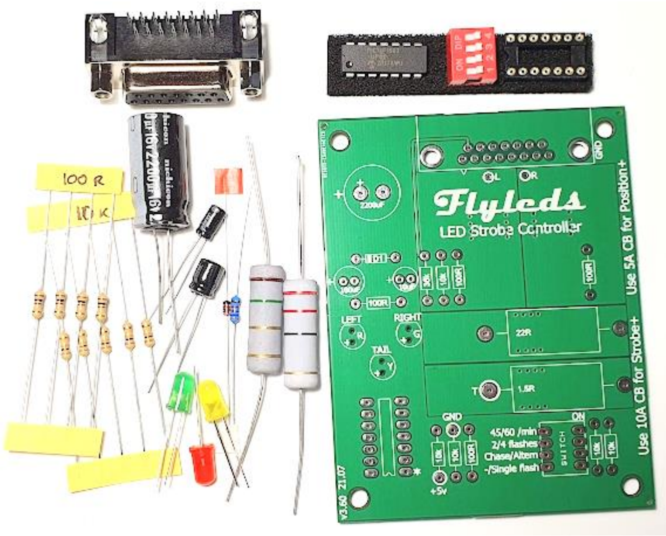
Part 2: Building the Controller Board



Congratulations for making it this far! The controller board uses smaller components than the wing boards, which means that everything is actually easier to solder, although your eyesight may disagree with that last statement!

Surface mount components

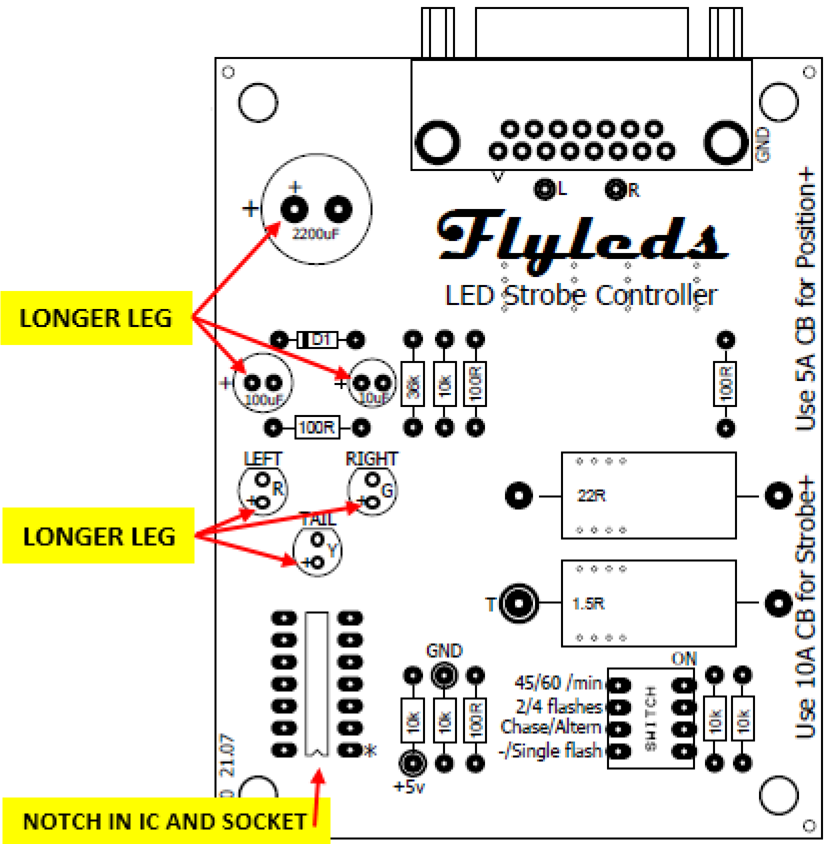
We supply the controller board with the surface mount components already reflow soldered onto the PCB.
For your reference the components are:

Voltage regulator: Converts the incoming 12 volt supply down to 5 volts for the microcontroller.

Diodes. These are part of the circuit that allows the tail LED to act as both a strobe and a position light.

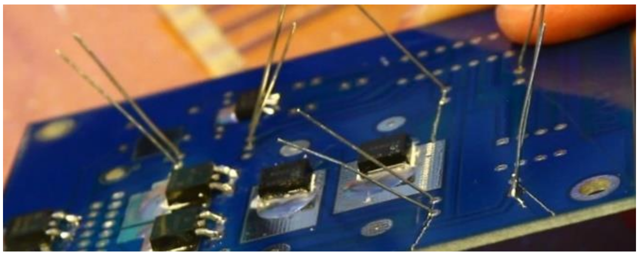
N-channel power MOSFETs. These little miracles will switch 45 amps of current all day long and have an "on" resistance of only 0.006 ohms. In this circuit, they only switch ~5-6 amps for the strobe flash duration, so they generate very little heat. In years gone by, this control circuit would have required large switching transistors that came in steel bodies, all mounted on a large and heavy heatsink.

Component side



With circuit board construction, it is easier to start off with the smaller components and work your way up in size.

1: Resistors



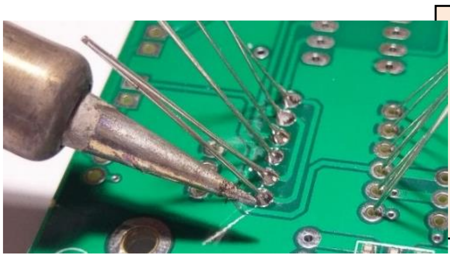
- Begin by inserting the 5x **10kΩ** (ohm) resistors (Brown/Black/*Orange*/ Gold).

Bend their legs apart slightly as shown so that the resistor stays in place tight to the board when you solder them in.

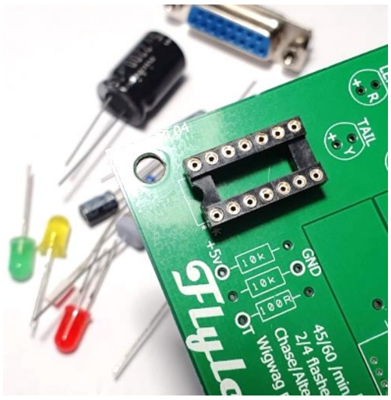
- Next insert the 4x **100Ω** resistors (Brown/Black/*Brown*/ Gold)
- The last resistor to insert is the **36kΩ** resistor. We may have supplied a 33kΩ instead (Orange/ Orange / Orange)

2: Insert the **1N4148 diode** in the position shown, now marked on the board as D1. **Note** that the diode has a **black band** around one end. This must be mounted with the band to the left, otherwise there will be no blinking lights!

3: At this point you can solder all of these components. Let the tip of the iron touch **both** the circuit board and the component leg, and after a few seconds introduce some solder. Leave the iron there for a few seconds more and then you should have a nice smooth looking joint around each leg.



If the solder acts like it is 'allergic' to either the board or the resistor leg and does not want to flow smoothly around the component leg and the PCB pad, it is telling you that one part is not hot enough.
You might need to adjust the 'angle of attack' of your soldering iron to ensure both the component and the PCB are getting the heat from the iron.



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. Solder one leg first, then check that the socket is still mounted flush to the board. Reheat the joint if necessary to let it sit properly.

Continue to solder the rest of the legs in place, alternating legs as you would tighten up a cylinder head on a car… that way if you're still a bit slow with your soldering the heat build-up won't melt the plastic socket.

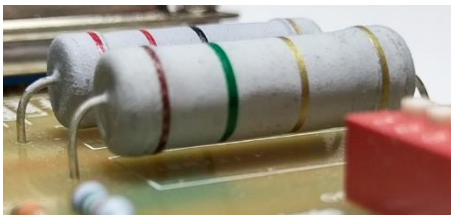
5: Mount and solder the four-way **DIP switch**, checking that it is oriented as pictured on page 1.

6: Insert the red, green and yellow **LEDs**. The *longer* leg of each LED mounts in the hole closest to the IC socket.

7: Mount the two **smaller capacitors**. 100uF closest to the outside of the board, 10uF on the right. Note the orientation as per the diagram, and the + on the silkscreen on the PCB. The ***longer*** leg of the capacitors is the **+** terminal. (And the white stripe on the body printing highlights the **–** terminal, just to keep you on your toes!)

8: You can now fit the **15 pin D connector**. The screw holders on each end may be a tight fit, but they do push in! Obviously if one pin is a little bent it's going to do all it can to frustrate you too…
I start by anchoring one of the mounts at one end and then insert the plug one pin at a time, with a little persuasion for the one pin slightly out of line.
…either that or it just falls straight in!

9: Mount the **ceramic power resistors** for the tail strobe. Leave a millimetre or so of air gap under them to allow for heat dissipation.



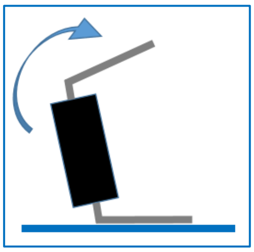
22 ohm	Red/Red/Black/ Gold
1.5 ohm	Brown/Green/Gold/ Gold

If you purchased the Stand-Alone Tail Strobe (**#15045**) with its own PCB and custom flash patterns, you can omit these resistors. Wire the Stand-Alone Tail Strobe directly to the strobe and power switches, and ground it locally.

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

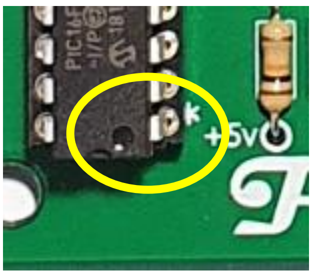
11: The **microcontroller chip** can now be inserted into the socket,

If you've just realised you've soldered the microcontroller chip to the board instead of the socket in step 4 above, STOP! Don't panic! All is good, leave it there. You will likely damage the PCB trying to remove the chip.



…however the legs of the chip may be spread too wide to fit straight into the socket. 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^{0} to the body. Turn the chip over and again straighten the other row of legs.

You can now carefully insert the controller IC into the socket. Note the small detent and/or notch in the chip, which marks pin 1, and corresponds with the (*) on the PCB.



The IC is held in by a friction fit and does not need to be soldered to the socket.

That's it! You're done!

The Blink Test

Using your square 9 volt battery, you can connect the battery**+** to **STROBE+** (pin 10) and battery**–** to **GROUND** (pin 1). Configure the switches and you will see the different flash patterns in action with the on-board LEDs. Hours of fun!

To enable the WigWag mode, you need to connect *both* WIGWAG+ (pin 9) *and* STROBE+ (pin 10) to the positive + terminal of the 9v battery. Switch 4 adds an extra wiggle (what else could we call it?!) to the wigwag pattern.

The Beep Test

The strobe LEDs on the wings and tail flash when the switching MOSFETs switch the ***negative*** side of each LED circuit to ground. This is why the STROBE- wires from the wings and tail light must come back to the controller board.

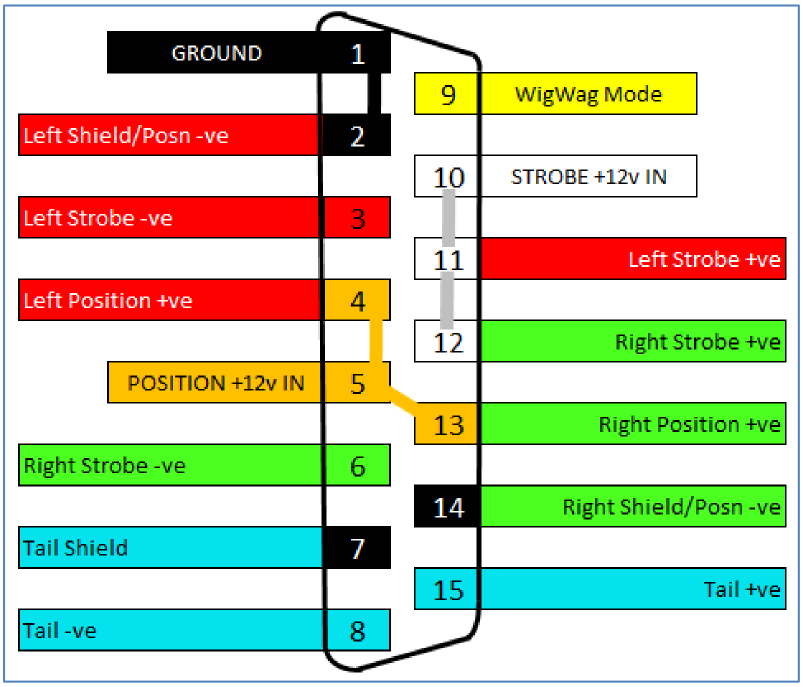
1: Set your multimeter to the *continuity/beeper* function.
2: Check that your meter *beeps* when you touch the test leads together.
3: Check for periodic beeps in time with the flashing LEDs with your black test lead on any ground connection, eg **pin 1 or 2**, or the metal body of the DB15 socket, and the red test lead on **pin 3** (left-) or **pin 6** (right-).

It's likely that the beep test *won't* work with **pin 8** (tail-), as the ceramic resistors may be seen as a "high resistance" to your meter. Put your red test probe on the left hand leg of the 1.5 ohm resistor instead.

If everything beeps as expected here, that's it, you're good to go!

Another possible test is to wire an automotive turn signal or interior light bulb in place of the strobes. Connect one side of the bulb to pin 11 or 12, and the other to pin 3 (left), pin 6 (right), pin 8 (tail).
Be aware that your 9 volt battery might be starting to run out of steam by now…

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 light.
- Airframe Ground is connected to Pin 1, which then connects to pin 7 for tail light wire shielding, and to pins 2 and 14 for the wing strobe wire shield (which is the ground return for the position LEDs).
- **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.
- **Strobe** power is applied to pin 10 STROBE +12v IN, which then feeds +12v *out* directly to the strobe LEDs on pins 11 & 12.