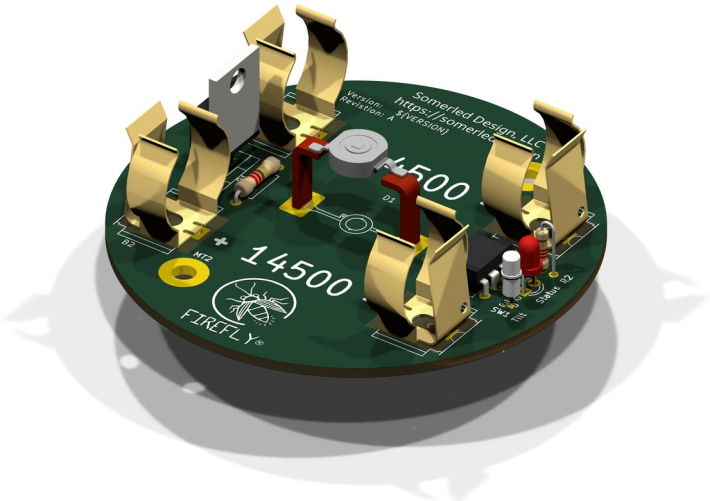
KIT ASSEMBLY MANUAL

FIREFLY®

LED Camp Light for a Wide-Mouth Jar

ATtiny85 · Through-Hole · v1.0 Rev A



Somerled Design

somerled.design

Welcome

Thank you for choosing the Somerled Design **FireFly** kit. In an evening you will build a small LED light engine that lives in a wide-mouth jar: a camp light, an emergency light, or a lantern for the patio. It has no buttons. You control it by turning the jar **upside down and back**.

This manual is written in the tradition of the classic kit manuals many of us grew up with. Every step has a check box, ( ). When you finish a step, mark the box. If you are interrupted, you will know exactly where to pick up again. Read each step all the way through before you do it, and do the steps in order.

Do not hurry. Kit building is meant to be enjoyed, and careful work the first time is much faster than finding a mistake later.

What the kit does

A pre-programmed **ATtiny85** microcontroller watches a small **tilt switch**. When you flip the light, it switches the 1 W LED on or off through a logic-level power MOSFET, **M1**, and sets its brightness. A 3 mm **status LED** shows what the light is doing. Two 14500 lithium-ion cells power the light.

- **Flip** (upside down and back): on or off.
- **Hold upside down**: adjust the brightness.
- When it has been off for ten minutes, the light goes into a low-power **sleep** to save the batteries, so it is ready when you need it.

You will need a WIDE-MOUTH jar

IMPORTANT: The board is a circle **2.70 in (68.6 mm)** across. It needs a **wide-mouth** mason jar, or a wide-mouth pickle jar. **Regular-mouth jars are too small: the board will not go through the opening.** Measure the inside of the mouth of your jar before you start. It must be at least 2.70 in (68.6 mm).

What you supply

- A **wide-mouth** jar with its lid (see above).
- Two **14500** size 3.7 V lithium-ion rechargeable cells, and a charger for them.

- Mounting supplies for fixing the board in the jar (for example screws and standoffs through the two mounting holes, MT1 and MT2).

About this manual

The pictures are 3D renderings of the circuit board made from the actual design files. Each group of steps shows the board with only the parts installed so far. Your parts may look slightly different from the pictures (body colours, markings and shapes vary between makers), but the values and placements will be the same.

An interactive placement guide (iBOM) for this kit is at **shop.somerled.design/support/ibom/firefly-ibom.html**. It shows where every part goes on the board.

Tools You Will Need

( )	Tool	Notes
( )	Soldering iron	25–40 W pencil iron, or a temperature-controlled station set to about 650–700 °F (340–370 °C). Fine conical or small chisel tip; a larger tip helps on the battery clips and lofts.
( )	Solder	Rosin-core electronics solder, 0.020–0.031 in (0.5–0.8 mm) diameter. Never use acid-core solder.
( )	Iron stand and tip cleaner	A damp sponge or brass wool.
( )	Diagonal cutters	Small flush cutters for trimming leads.
( )	Long-nose pliers	For bending leads and forming the lofts.
( )	Safety glasses	Clipped leads fly. Solder can spit.
( )	Good light and a magnifier	For inspecting solder joints.
( )	Multimeter	Helpful for checking the battery clips, the LED and the solder joints.
( )	Optional	Desoldering braid or a solder sucker, in case you need to correct a mistake.

CAUTION: Work in a ventilated area, keep your fingers away from the hot tip, and wash your hands after handling solder. Most kit solder contains lead.

Static electricity

The microcontroller U1 and the MOSFET M1 can be damaged by static electricity, the same kind of spark you feel from a doorknob in dry weather.

- Leave them in their packing until the step that installs them.
- Before you pick them up, touch a large grounded metal object to discharge yourself. An anti-static wrist strap is even better.
- Work on a bare wooden or laminate surface, not on carpet or plastic sheeting.

Soldering

A good solder joint is the single most important thing in a kit. Almost every kit that does not work on the first try has a poor solder joint somewhere. Take the time to learn the method below and you will have few problems.

How to make a good solder joint

( ) Keep the tip clean and **tinned**: wipe it on the sponge and melt a little fresh solder onto it.

( ) Touch the tip so it heats **both** the component lead **and** the copper pad at the same time.

( ) After one or two seconds, feed solder into the joint, **not onto the iron tip**. The solder should flow smoothly around the lead and over the pad.

( ) Remove the solder first, then the iron. Do not move the part while the solder cools (a few seconds).

( ) Trim the lead just above the top of the solder joint with diagonal cutters. Hold the lead end so it does not fly.

What to look for

Good joint	Poor joint
Smooth, shiny (or satin with lead-free) and shaped like a small volcano or tent around the lead.	Dull, grainy, lumpy, or a ball of solder sitting on the pad.
Solder wets the whole pad and climbs the lead.	Solder only on the lead, not the pad (or the reverse). A dark ring around the lead means a cold joint.
Nothing touches the next pad.	A bridge of solder joins two pads that should be separate.

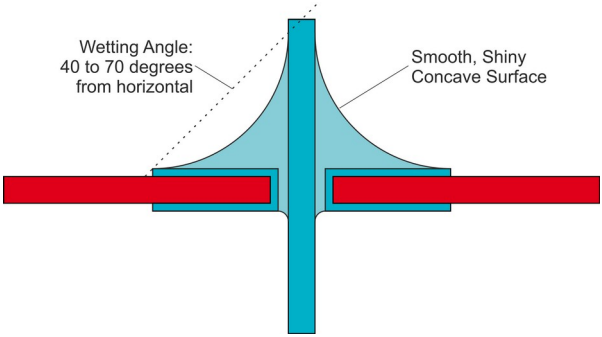


Figure 1. *An ideal solder joint in cross-section. Image: "Solder Joint en.svg" by SLUB Dresden / Carsten Pietzsch, based on an Adafruit diagram by Bill Earl. CC BY-SA 4.0 (creativecommons.org/licenses/by-sa/4.0), via Wikimedia Commons. Converted to PNG.*

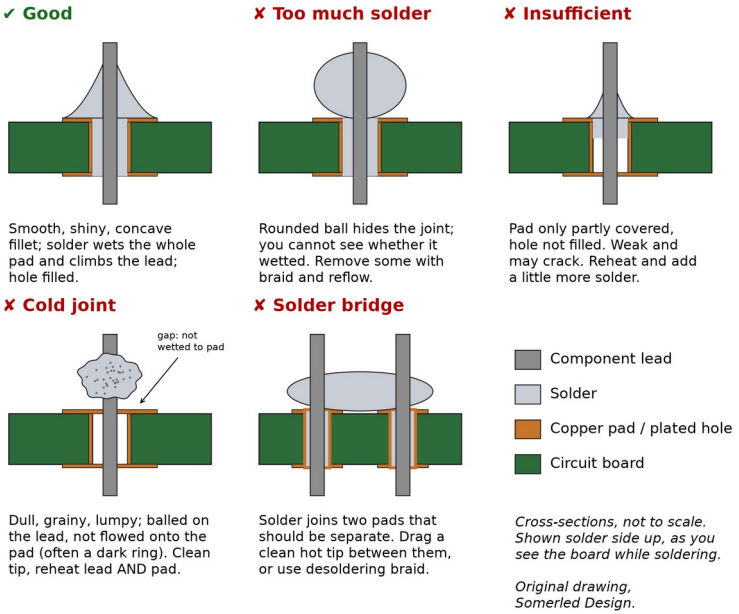


Figure 2. *A good joint and the four most common faults.*

To fix a poor joint, reheat it and add a small amount of fresh solder. To remove a bridge, drag a clean, hot tip between the pads, or use desoldering braid.

Large joints: battery clips and lofts

The battery clips and the copper lofts are big pieces of metal on large copper pads. They soak up heat. Use a larger tip, or turn the iron up a little, and hold it on the joint until the solder flows freely all round. A

joint that sets the moment the solder touches it is cold. Let these parts cool before you touch them: copper and brass stay hot for a long time.

NOTE: Heat is the enemy of semiconductors. Do not hold the iron on the LED, the chip socket or the MOSFET leads for more than a few seconds. If a joint is not right, let it cool, then try again.

Unpacking and Parts Inventory

Open the kit over a tray or a light-coloured towel so small parts cannot roll away. Check each part against the list below and mark its box. The **Ref** column gives the reference designator printed on the circuit board.

( )	Qty	Ref	Description
( )	1	—	FireFly circuit board, v1.0 Rev A, round, 2.70 in (68.6 mm) diameter
( )	2	R1, R2	220 Ω resistor, ¼ W, ±5% (red-red-brown-gold)
( )	1	—	8-pin DIP IC socket, for U1
( )	1	U1	ATtiny85 microcontroller (ATtiny85-20PU), 8-pin DIP, **pre-programmed**
( )	1	D2	Status LED, 3 mm
( )	1	M1	IRLZ44NPBF logic-level N-channel MOSFET, TO-220 (black body, metal tab, 3 leads)
( )	1	SW1	Tilt switch with wire leads
( )	4	B1, B2	Keystone 92 battery clip (two per cell)
( )	1	D1	1 W high-power LED
( )	2	—	Copper LED lofts (pre-formed copper straps that hold D1)

U1 comes **pre-programmed**. It cannot be replaced with a blank ATtiny85.

NOTE: Not included: the two 14500 cells, the wide-mouth jar, and mounting supplies. If a part is missing, check the packing material again, then email **support@somerled.design** with your kit name and the missing part.

Identifying the Parts

Resistors

R1 and R2 are both 220 Ω, so they cannot be mixed up. Resistor values are shown by coloured bands. Hold the resistor with the **gold** tolerance band on the right and read from the left: **red** (2), **red** (2), **brown** (×10) = 220 Ω. Gold means ±5%.

U1 and its socket

U1 is an 8-pin chip. A **notch** (or a small dot) at one end marks **pin 1**. The socket has a matching notch, and the board outline has a notch too, at the end with the **square** pad.

M1, the MOSFET

M1 is a TO-220 power MOSFET: a black plastic body with a metal tab and three leads. It is the **IRLZ44NPBF**, a “logic-level” type that switches fully on from the microcontroller’s 3.7 V. Do not substitute an ordinary IRFZ44N or IRF530N: they need about 10 V on the gate and will run the LED dim and hot.

D2, the status LED

D2 is a small 3 mm LED. Its **longer** lead is the **anode (+)**. The rim of the body has a **flat** on the cathode (−) side.

SW1, the tilt switch

The tilt switch is a small sealed cylinder with two wire leads. Inside, a contact closes when the switch is upright and opens when it is turned over. That is how the light knows it has been flipped. It is not polarized: either lead can go in either hole.

Battery clips

The four **Keystone 92** clips hold the two cells. Each cell, B1 and B2, sits in two clips, one at each end. The clips are not polarized; the cell’s direction is set by the + and − printed on the board.

D1, the 1 W LED, and the lofts

D1 is a 1 W high-power LED with two solder tabs, an **anode (+)** and a **cathode (−)**. Find the + mark on the LED or on its seller's drawing, or check it with a multimeter on the diode range: the LED glows faintly when the red probe is on the anode. The LED is not soldered to the board directly. It sits on top of two copper **lofts**, which carry the current and hold the LED up in the jar.

The Copper LED Lofts

The kit includes two copper **lofts**, made by hand at Somerled Design from copper strap. Each loft has a straight leg at the bottom that goes through one of the two large slotted pads marked D1, a vertical post, and a short top that supports one tab of the 1 W LED. The two lofts are the same; either can go in either pad.

Item	From the board design
Slot in each D1 pad	0.031 × 0.118 in (0.8 × 3.0 mm)
D1 pads	0.16 × 0.24 in (4 × 6 mm) copper pads, 0.71 in (18 mm) apart, centre to centre
LED height in the design	About 0.41 in (10.5 mm) above the board

( ) Find the two lofts in the kit and compare them with Figure 11. Check that they are straight and the same height, so the LED will sit level. If one has been bent in the post, straighten it gently with long-nose pliers.

( ) Try each leg in its slot before you solder. It should slip through without force.

NOTE: Copper is soft. Handle the lofts gently. If they are tarnished, clean the leg and the top with fine abrasive or a fibreglass pen so the solder will flow.

Circuit Board Assembly

Look over the bare circuit board (Figure 3). All the parts mount on the **top** side, the side with the FIREFLY logo, and are soldered on the bottom. The parts go in from the lowest to the tallest, so the board rests flat on the bench while you solder.

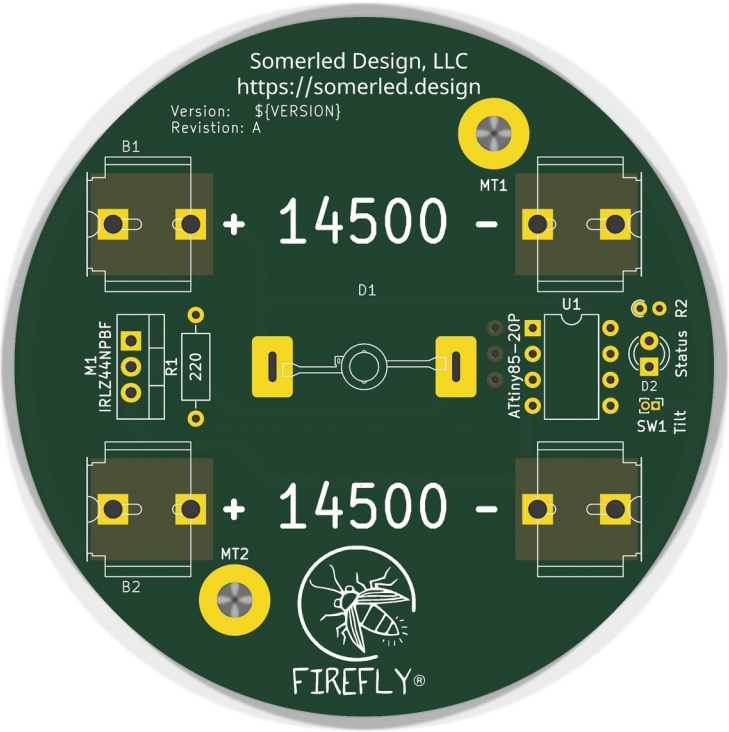


Figure 3. *The bare FireFly v1.0 Rev A board, top view.*

NOTE: Install each part flat against the board (or at the height given in the step), solder all of its leads, then trim the leads. Mark the ( ) box as you go.

Resistors

( ) **R1**: 220 Ω (red-red-brown-gold). R1 lies flat beside M1 on the left. Bend the leads at right angles close to the body to fit the holes 0.4 in (10.16 mm) apart, insert, solder and trim.

( ) **R2**: 220 Ω (red-red-brown-gold). R2 **stands up**, at the top right, beside the label R2. Bend one lead down alongside the body. Put

the **body** in the hole inside the printed circle (the left hole), and the bent lead in the other hole. Solder and trim.

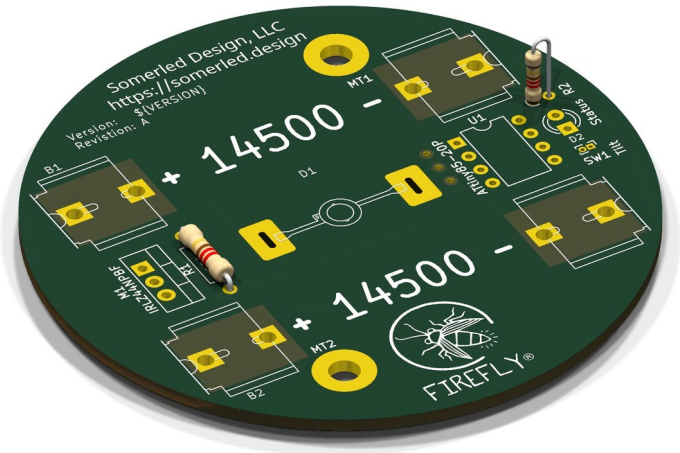


Figure 4. *R1 and R2 installed.*

IC socket

( ) **U1 socket**: 8-pin. Insert it with its **notch** toward the top of the board, matching the notch on the printed outline. Hold it flat, solder two opposite corner pins, check that it is flat, then solder the other six. Do not put U1 in yet.

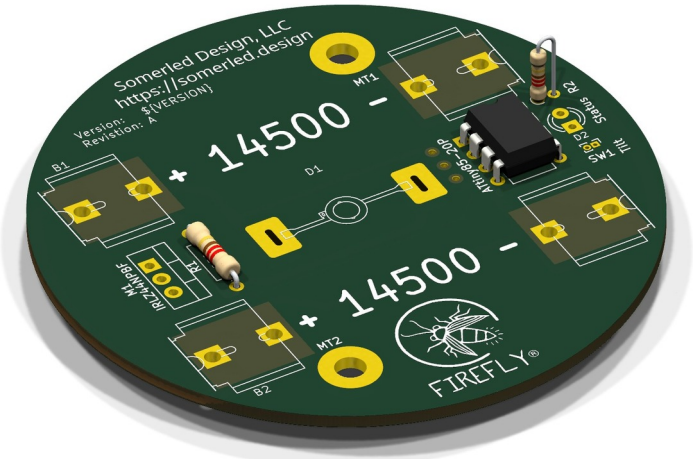


Figure 5. *The U1 position. The picture shows U1 in place; fit only the socket now.*

Status LED

( ) **D2**: 3 mm status LED, below R2, beside the label **Status**. Fit D2 **reversed** from the usual way: put the **long lead (anode, +)** in the **square** pad, and the short lead in the round pad. The flat on the LED rim will be on the opposite side from the flat printed on the board. Fit the LED a little above the board, about 1/16 in (1.5 mm), solder and trim.

NOTE: This is a known quirk of the v1.0 Rev A board: the D2 markings are the wrong way round. It will be fixed in the next board revision. Fitted the usual way, D2 will not light.

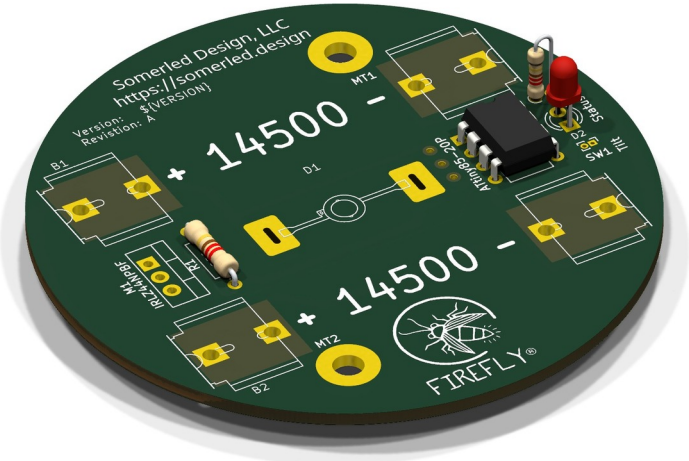


Figure 6. *D2 installed.*

MOSFET M1

( ) **M1**: IRLZ44NPBF. It stands upright at the left, inside the outline marked M1 IRLZ44NPBF. Turn it so the **metal tab** faces **R1** (toward the centre of the board) and the printed face faces the board edge, as in Figure 8. Push it down until the leads' wide shoulders stop on the board, solder the three leads and trim.

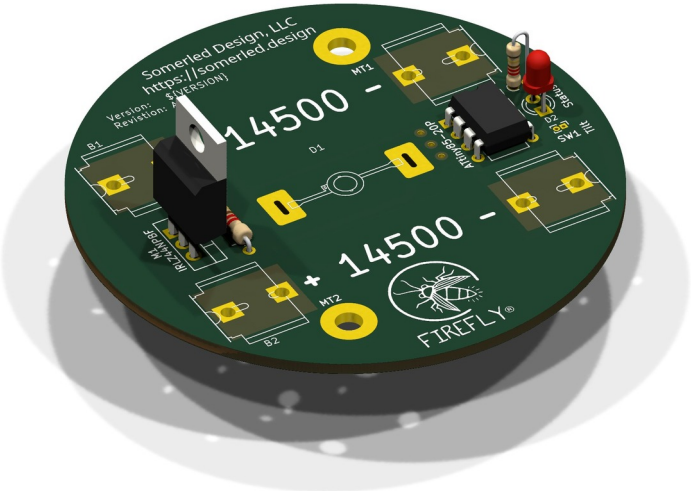


Figure 7. *M1 installed.*

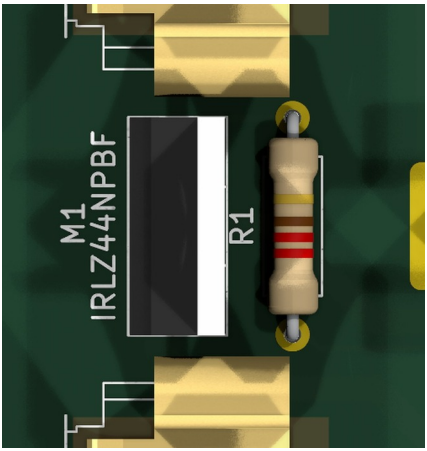


Figure 8. *M1 and R1, top view. The metal tab (light) faces R1.*

Tilt switch

( ) **SW1**: tilt switch, beside the label **Tilt**. The two holes are 0.039 in (1.0 mm) apart and 0.020 in (0.5 mm) across. Bend the wire leads gently so they drop into the holes.

( ) Stand the switch **upright**, square to the board, with its leads at the bottom, as in the picture. The light reads “upright” and “upside down” from this switch, so do not leave it leaning. Solder quickly (the switch is sealed) and trim.

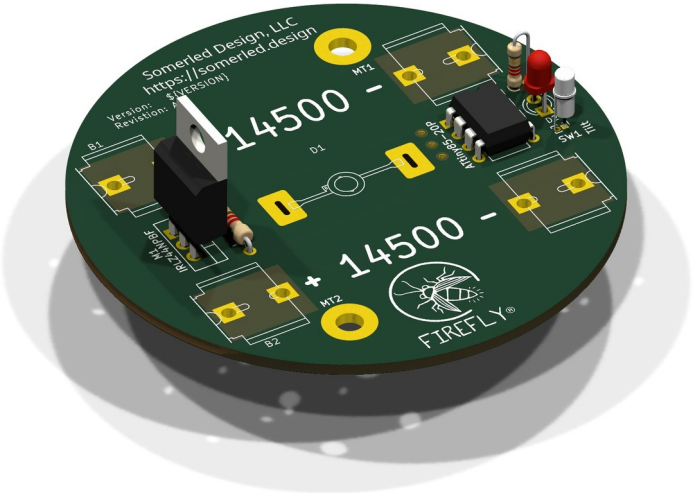


Figure 9. *SW1 installed, standing upright.*

Battery clips

( ) **B1**: two Keystone 92 clips, one at each end of the B1 outline (top). Each clip goes in the two holes at its end of the outline, over the printed clip shape. Hold the clip square and flat, solder both of its pins, and check it has not tilted.

( ) **B2**: two more clips at the B2 outline (bottom), in the same way.

( ) Check that each pair of clips lines up so a cell will sit straight, and that every clip is solid.

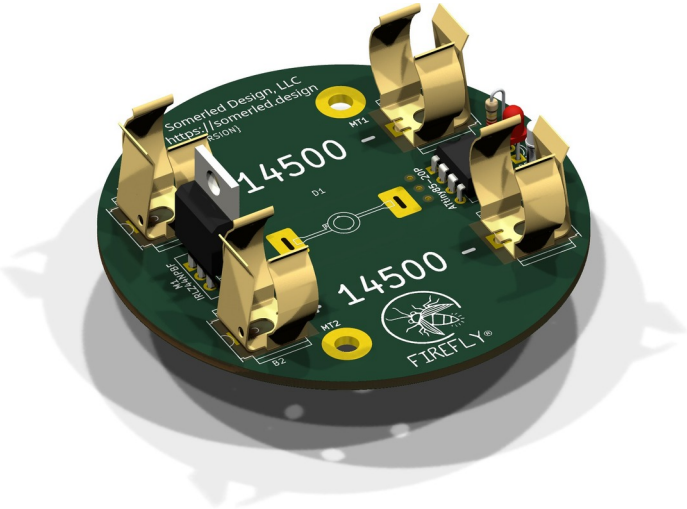


Figure 10. *The four battery clips installed.*

Lofts and the 1 W LED

( ) Push one loft through each of the two large slotted **D1** pads, from the top, so the posts stand straight up and the tops turn in toward each other. Solder each loft to its pad from the bottom and the top, with plenty of heat.

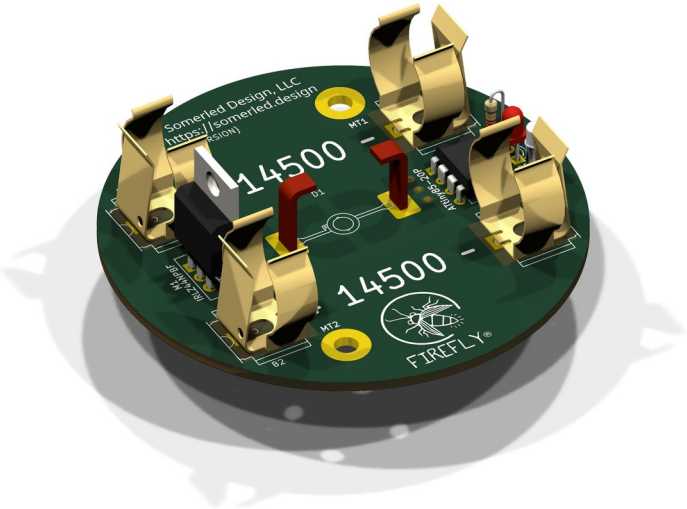


Figure 11. *The two copper lofts installed.*

( ) Find the + (anode) tab of the 1 W LED. The anode goes on the **left-hand** loft as the board is shown in Figure 3, on the B1 + / B2

+ side. The cathode goes on the right-hand loft, the one nearest U1.

( ) Set the LED on top of the lofts, LED face up. Tin each tab and the top of each loft, then solder them together. Work quickly so the LED does not overheat.

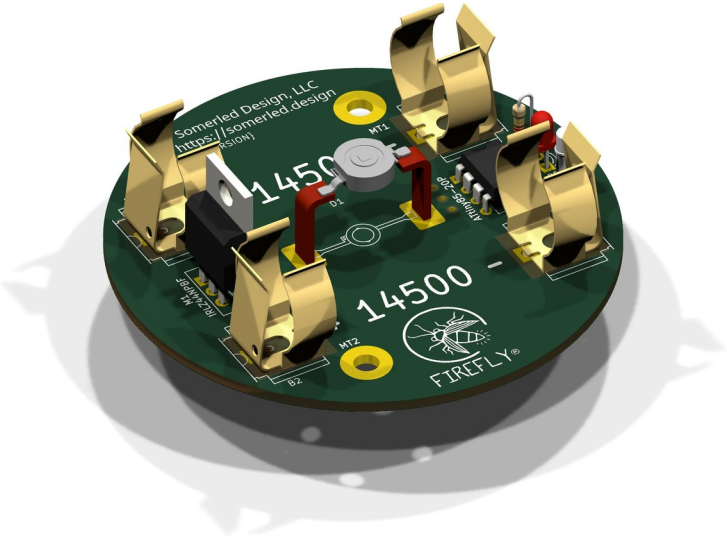


Figure 12. *The finished FireFly board.*

Final Inspection

Before you put in the cells, go over the board carefully with a magnifier and good light. Most problems are caught here.

( ) Every lead is soldered: R1, R2 (4), socket (8), D2 (2), M1 (3), SW1 (2), clips (8), lofts (2), and the two LED tabs.

( ) No solder bridges between the socket pins or the M1 leads.

( ) M1 tab toward R1. Tilt switch upright. LED anode on the left-hand loft.

( ) **U1**: touch a grounded metal object, then press U1 into its socket with its **notch** toward the top, matching the socket. Check that all eight pins went in and none folded under.

( ) No clipped leads or solder splashes on the board. Brush it off.

( ) With a multimeter on resistance, check from a + clip to a − clip. It must **not** read a dead short (0 Ω).

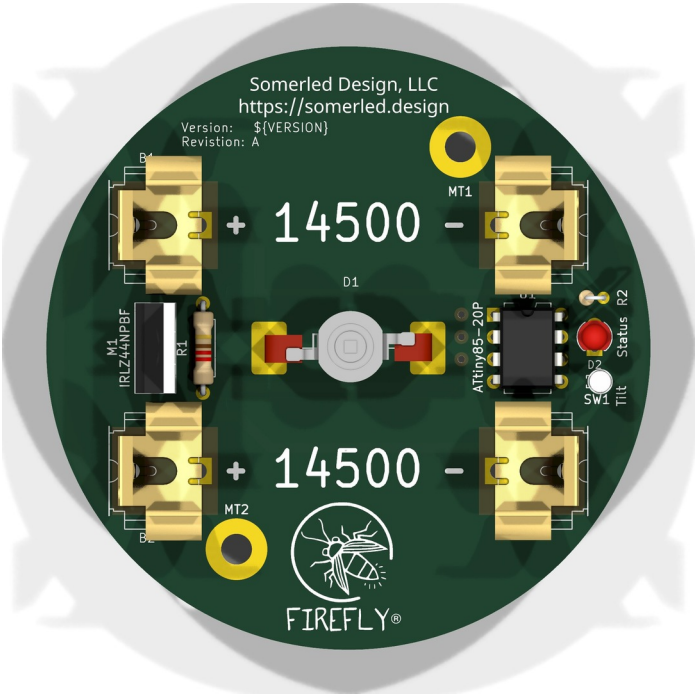


Figure 13. *Finished board, top view.*

Using the FireFly

Batteries

WARNING: Use only **14500 size 3.7 V lithium-ion** cells. Ordinary AA cells are the same size but only 1.5 V, and the light will not work properly on them. The two cells are connected **in parallel**: each cell must go in with its **+** end at the **+** printed on the board. **A cell put in backwards is shorted by the other cell.** Lithium-ion cells can get very hot, vent or catch fire if they are shorted. Check both cells every time you put them in.

( ) Charge both cells fully before first use, in the charger made for them.

( ) Put one cell in B1 and one in B2, **+ end at the +** on the board.

First power-up

( ) Stand the board upright on the bench (LED up). Then turn it **upside down and back**. The LED should come on.

( ) Turn it over and **hold** it upside down. The brightness changes. Turn it back upright when you have the level you like.

( ) Flip it again to turn it off.

CAUTION: The 1 W LED is very bright. Do not look straight into it.

Into the jar

Mount the board in the jar using the two mounting holes, MT1 and MT2, which are 0.138 in (3.5 mm) across. How you mount it is up to you; the mounting supplies are not part of the kit. Make sure nothing metal can touch the battery clips or the lofts.

REMEMBER: Once more: only a **wide-mouth** jar will do. The board is 2.70 in (68.6 mm) across. Regular-mouth jars are too small.

Troubleshooting

Most problems are caused by solder joints or by parts installed the wrong way round. Recheck the Final Inspection list first.

Symptom	Check
Nothing happens when flipped	Both cells charged, + at the + mark? Check the clip joints. U1 in its socket the right way (notch at the top), no pins folded under? Check the socket joints.
Status LED works but the 1 W LED does not	LED anode on the left-hand loft? Check the loft and LED tab joints, the M1 joints, and R1.
LED on all the time, cannot be turned off	Look for a bridge between the M1 leads. Is M1 the IRLZ44NPBF?
LED dim, M1 warm	Check that M1 is the logic-level IRLZ44NPBF, not an IRFZ44N or IRF530N. Check the cells are charged.
Does not respond to flips	Is SW1 upright and both leads soldered?
Status LED never lights	D2 is probably in the usual way round. On this board it must be **reversed**: long lead in the **square** pad (see the D2 step). Unsolder it and turn it round. Also check R2 and the joints.
A cell or clip gets hot	Remove the cells at once. A cell is in backwards, or there is a short between the + and − clips.

Still stuck? Email **support@somerled.design** with your kit name (FireFly, v1.0 Rev A), what you see and, if you can, clear photos of both sides of the board.

How It Works

The two cells, B1 and B2, are in parallel and supply about 3.7 V. The 1 W LED, D1, runs from the cells through **M1**, a logic-level N-channel MOSFET that acts as a switch in the LED's negative lead. U1 drives M1's gate through R1 and switches it on and off rapidly to set the brightness.

The tilt switch SW1 connects one of U1's inputs to negative when the light is upright. U1 times the flips and holds and decides what to do, and puts itself to sleep when the light has been off for a while. The status LED D2 is driven from another U1 pin through R2.

Specifications

Item	Value
Controller	ATtiny85, pre-programmed, in an 8-pin socket
LED switch	M1, IRLZ44NPBF logic-level N-channel MOSFET (TO-220)
Light	1 W high-power LED on the supplied copper lofts
Control	Tilt switch: flip, flip-and-hold
Power	Two 14500 3.7 V lithium-ion cells in parallel (not included), in four Keystone 92 clips
Board	Round, 2.70 in (68.6 mm) diameter; two 0.138 in (3.5 mm) mounting holes
Enclosure	Wide-mouth mason jar or wide-mouth pickle jar (not included). Regular-mouth jars are too small.
Board version	v1.0 Rev A
Firmware	Somerled Design (proprietary), pre-programmed in U1

Credits

Kit design, board, firmware and manual: **Somerled Design, LLC** (Kevin Murphy).

Firmware © 2026 Somerled Design, LLC. All rights reserved. The firmware in U1 is proprietary, an original Somerled Design program, and is supplied pre-programmed. It may not be copied, read out or redistributed without permission.

Support

Email **support@somerled.design**. Interactive placement guide: **shop.somerled.design/support/ibom/firefly-ibom.html**

Illustrations: 3D images rendered from the KiCad design files. Good/faulty joint drawing: original, Somerled Design. Ideal joint diagram: “Solder Joint en.svg”, SLUB Dresden / Carsten Pietzsch after Bill Earl (Adafruit), CC BY-SA 4.0, commons.wikimedia.org/wiki/File:Solder_Joint_en.svg (converted to PNG).

Manual revision: October 2026, board FireFly v1.0 Rev A.