Tent Light Instructor Guide

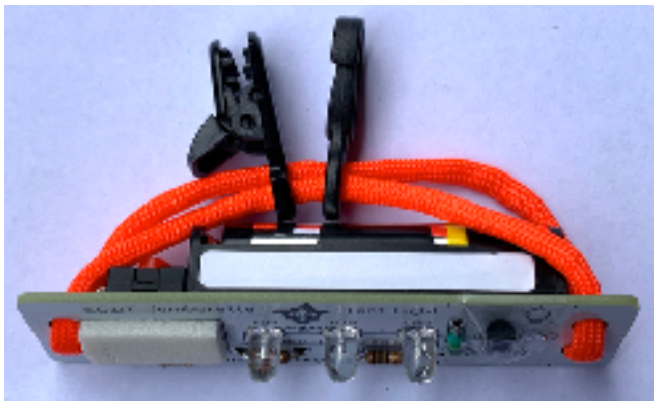
Design principles

The Test Light is designed to be built by young Scouting youth members with limited to no soldering experience. It has many design principles that should ensure lower assembly failure rate, and a longer lasting robust kit.
Design features

- Low profile on/off switch, partially shielded by the battery holder - to reduce the ability to be accidentally turned on, when squashed up against other things in a bag.
- PCB Mount battery holder
- Larger solder pads 2.5-3mm, to make soldering easier for Scouts
- Wide spacing for radial component leads to prevent solder bridges, and components laid down to prevent breakage.
- Wider tracks so that if through holes are delaminated, then the component lead can be soldered to the track - saves replacing the board and starting again,
- No more than 1 track connected to a through hole to reduce the number of tracks to be reconnected if a pad is delaminated.

Design notes

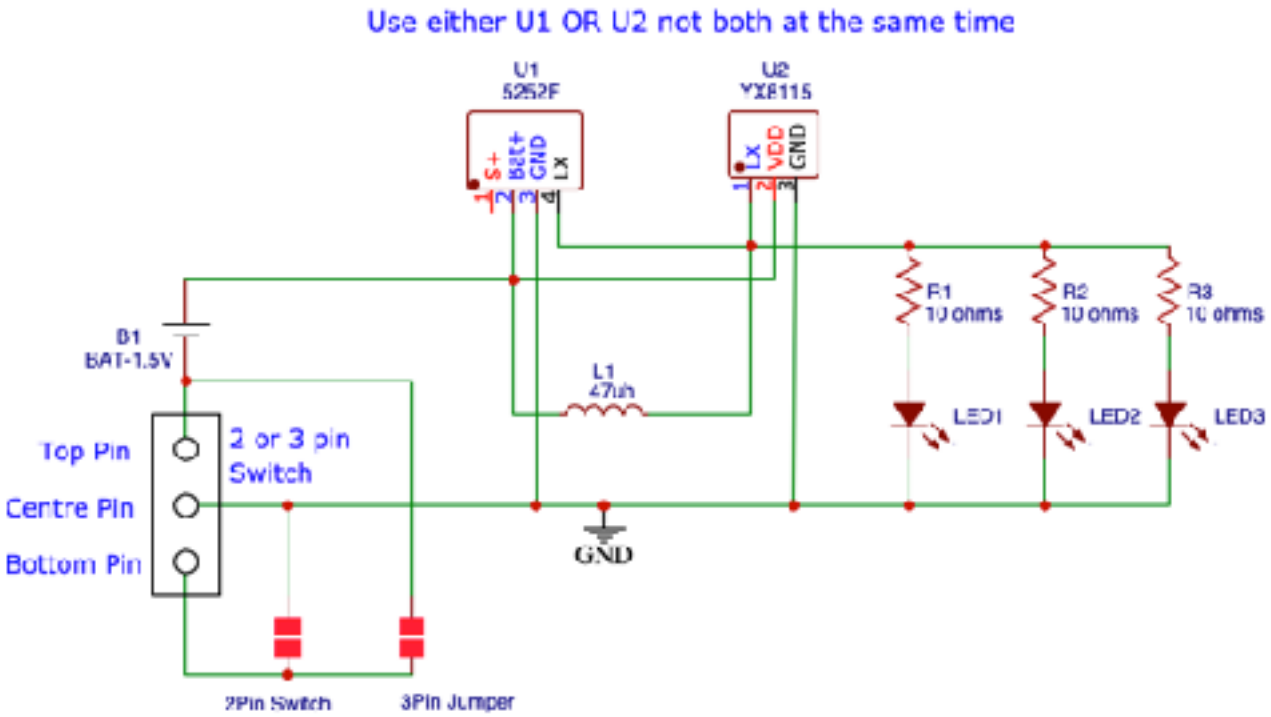
- It has been designed to be used in a Hike Tent with a typical height of about 1-1.2M.
- I have used 3 * 5mm through hole White Leds, there are not many available with sufficient brightness and beam width, check the parts list below for ones that work. The recommended ones have a width of 55 degrees, anything wider just does not have a bright enough output, and anything narrower only illuminates a small spot.
- The light will run in excess of 40 hours if you put a good quality AA battery in, however the light output is not very good after about 30 hours.
- It has a Paracord, with hook for hanging on a tent light loop, and also a clip for clipping to a tent seam if there is no loop. The hook and clip can slide on the paracord so the light can be used horizontally or vertically. In very low tents, the light works better, placed on a seam at the end so you are not shadowing it.
- Foam purlin tape over the switch pins, and battery -ve terminal to prevent injury to fingers when turning the light off and on.
- Clear tape over the IC to stop it lifting if knocked.



Circuit details

The tent light is based on a a YX8115, (can also use QX5252F) ic designed to boost the voltage from a 1.5V battery to 3.2Volts to run 3 white Leds. The YX8115 is the preferred IC, as the LEDS will be brighter as it runs at a higher duty cycle than the QX5252F. Increasing the inductance with the QX5252F does not seem to make a lot of difference. I have only included the extra solder pads for the QX5252F in case the YX8115 is not available. The best place to source these is https://www.aliexpress.com/, they are not readily available in Australia.

The basic principle of the circuit is to put an alternating current across the inductor which is in series with the battery. This creates a magnetic field across the inductor. The inductor blocks the AC current, by creating a back EMF. When the current is withdrawn the magnetic field collapses and creates a voltage across the inductor. As it is is in seres with the battery, you end up with a voltage high enough to run the LEDS. The resistors in series with the LEDS are there to reduce and balance out the current through the LEDS due to slight differences in the each of the LED specifications which is normal in manufacturing components.



Battery Holder options

The Board can accommodate different size battery holders, with a pin spacing of 50-52mm.
The battery holder is on the back of the board so that it does not shade the LEDS, and also so that it covers the pins from the components to try and prevent a short if the light is put in a bag/container that has keys or other metallic objects in it.

As the battery holder is on the back and above the soldered component pins, it will not sit flat on the board. It is highly recommended that you use a couple of pieces of soft 2-2.3mm double sided foam tape to hold it in place

Tape required
3MVHB 4991 (2.3mm Thick) 10-12 mm wide - you will need 2*10mm lengths per battery holder.
can get 3M lengths from aliexpress

(Or any equivalent double sided tape approx 2mm thick)

Name label

As the board is small, there is no room to put a white space to write the youth members name and group on. So if you order the following avery label and stick it on the side of the battery holder so that they can write their name and group name on it.
https://www.averyproducts.com.au/product/white-rectangle-stickers-932009

LED Options

The led used is a white 5mm led, with a 55 degree angle, **no standoff,** and up to 12CD output.
I have tested about 15 LED's from different manufacturers, and the only ones that really work properly are as follows

BEST LED
CREE - C513A-WSN-CW0Z0151

This is a bright LED and very white light output

https://au.element14.com/cree-led/c513a-wsn-cw0z0151/led-5mm-12cd-cool-white/dp/2579515?st=c513a-wsn-cw0z0151

2nd Best LED
CREE - C513A-WSN-CX0Z0231

This LED also works well, but is not quite as bright as the 1st LED, although it is hardly noticeable.

https://au.element14.com/cree-led/c513a-wsn-cx0z0231/4180-12000mcd-chrom-w2-w3-bulk/dp/3218373?st=c513a-wsn-cx0z0231

3rd Best LED
CREE - C513A-WSN-CY0Z0231

This LED works well, but is not quite as bright and the light output is slightly yellower than the 1st LED

https://au.element14.com/cree-led/c513a-wsn-cy0z0231/led-5mm-cool-white-12cd/dp/2840588?st=c513a-wsn-cy0z0231

Preferred Switch options

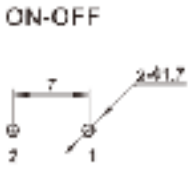
There are a few different switches you can use.

The main ones I have designed the board for, are made by HENGQI https://www.hqdz123.com/en/ and are available on Aliexpress and Amazon, they are all 12mm switches with 90 degree pins.
Depending on whether you are using a 2 or 3 pin switch, you must short out the appropriate jumpers on the board.

Jumper to short out

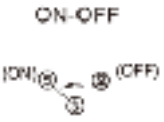
Option 1 - 1212-112DB - best option

Search for 1212-112DB on Aliexpress
2 pin on/off switch



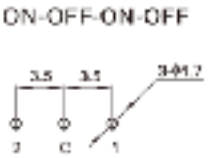
Option 2 - 1212-112YB

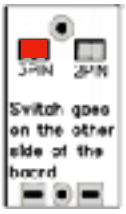
Search for 1212-112YB on Aliexpress
2 pin on/off switch
Pins are not as long as Option 1 so do not protrude much through the board.



Option 3 - 1212-223DB -

Search for 1212-223DB on Aliexpress
This is a 3 pin on/off switch
Same length and width pins as Option 1, but has 3 pins.





NOTE: This switch is designed to turn 2 lights off and on, one at a time. So “C” and Pin 2 are turned on, then disconnected, then “C” and pin 1 are connected then disconnected. If you are using a different 3 pin switch, then ensure that it conforms to this switching pattern.

Tape required for the Switch

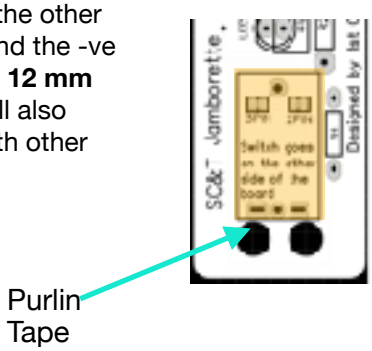
These switches only have pins on one side, so if they get knocked they may lift up. Ideally a piece of 3M VHB tape under them will help prevent this. Note 3M VHB tapes can take up to 72 hours to achieve full bonding strength, so it is advisable to stick this to the bottom of the switch a few days before they are due to be assembled by the Scouts.

- If using Switch Option 2, use 0.4 mm tape, anything thicker and the pins will not protrude enough through the board for soldering.
  - 3M VHB 5604 tape (0.4mm thick) 10-12mm wide
  https://www.aliexpress.com/item/1005004775152425.html

- If using Switch Option 1 or 3, they can take up to 0.8mm tape as the pins are longer.
  - 3M VHB 5608 tape (0.8mm thick) 10-12mm wide
  https://www.aliexpress.com/item/1005002745126695.html

Tape required for the Switch on the front side of the board

When you turn on the light, you tend to put one finger on the switch and another on the other side of the board to compress the switch, this means that the pins from the switch and the -ve battery holder pin will dig into your fingers. To alleviate this a piece of 3mm thick and **12 mm wide** (20mm length) single sided purlin tape is recommended to prevent this. This will also prevent shorting out the switch, and turning the light on, if the light is put in a bag with other metal objects.

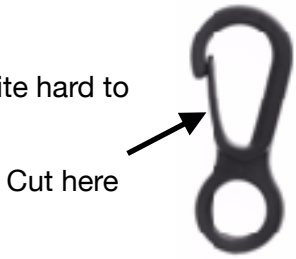


https://gardineraustralia.com.au/products/lapseal-tape-pe-foam - (3mm thick) **12mm** wide and 12 Metres long (enough for 600 kits)

Hook Clip and Paracord.

Hook

The hook is used to hang the light off a tent light loop. The clip is quite hard to press so it is recommended that you cut it off.



https://www.aliexpress.com/item/33000573423.html?spm=a2g0o.order_list.order_list_main.60.17501802CM0Aea

Clip

The clip is used to clip the light to a tent seam if there is no light loop. There are many types of clips available, but this one is relatively easy to open and close, by lifting and raising the back section. Get the "A Style", as you will be able to feed the paracord through it twice to hold the light level.

https://www.aliexpress.com/item/4000690454277.html?spm=a2g0o.order_list.order_list_main.65.17501802CM0Aea

Paracord

Standard 4mm Paracord is used for this project, you need a length of 25cm for each tent light

Protective tape over YX8115

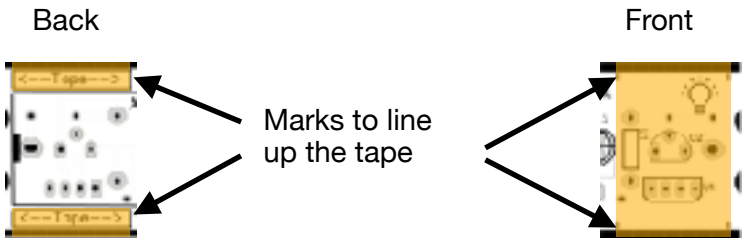
Protective tape can be put over the YX8115 to stop it lifting up if knocked, also it will insulate the +ve battery terminal. Tape width required is **18mm** and goes from the back of the board, over the front and then to the back of the board again, stopping at the battery holder on each end.

You need a length of 39mm - see the tools section for suggestions on how to cut this length.

This tape could be **18mm** wide Kapton tape (ebay or Aliexpress), or the following which is a clear tape - looks better than yellow Kapton tape.

https://www.swiftsupplies.com.au/3m-scotch-no.-5-clear-electrical-insulation-tapes

(Get the 18mm width)



Tools

If you are running this activity for a lot of youth members (100's), then it will make it a lot easier if you have the right tools.

Automatic tape cutter - Z Cut 9

For our Scout group we have purchased the following tape cutter that can be used for all projects that require quick and precise tape cutting.

https://www.vevor.com.au/electric-tape-dispenser-c_10891/vevor-tape-dispenser-zcut-9-automatic-electric-tape-cutter-220v-counting-p_010729727654?v_tag=dcfc0950-8cce-11ed-b7e8-e7d7baa28833.1

Bench mounted Hot Knife

We have also purchased a bench mounted hot knife. This will quickly and cleanly cut the required 25cm length of paracord that is needed, and also easily joins the ends together. This is done by putting the cut ends on each side of the knife for a few seconds until they melt slightly, and then slide them off and put them together. You can smooth the side of the join on the side of the hot knife. Much easier than juggling a lighter and hot paracord - no more burn't fingers !!!

It has also been used on many other paracord projects in our group.

https://www.ropegalore.com.au/hot-knife-rope-cutter-bench-model-adjustable-temperature-free-delivery/

To Do list before the Day

1) Order Boards
2) Order Components
3) Source and buy the 2- Double sided tapes, purlin tape, and tape to cover U1
4) Put the two pieces of double sided tape on the battery holder
5) Put the name label on the side of the battery holder.

5) Put the double sided tape onto the back of the switch

6) **Solder requirements** - 30cm solder (approx 1.2g) (Can do it with about 20cm)

7) Print one copy of the Component Sorter per Soldering station, and laminate them. These are used by the Scouts to sort the components, do not let them start soldering until you have checked that they have sorted them correctly

8) Print two copies of the Assembly guide (double sided) per table (4 - 6 scouts) - they can just share them. It is recommended that you laminate them.

9) Package only the following components
   - 3 * Resistors
   - 1 * Inductor
   - 1 * switch
   - 3 * Leds
   - PCB
   - Solder

   - Do not give out the battery holder, battery, or white purlin tape. When the youth members are assembling them, get the Youth to assemble all the components up to and including step 5, 1st (see assembly guide), then test the board by putting a battery in the battery holder and just putting it into the board and twisting is slightly so that it contacts the battery socket pads, and check that it works. Also check that the switch turns off and on alternately, if not then check the 2 and 3 pin shorting pads on the front for the correct ones that have been shorted. Once you have checked it then let them solder in the battery holder, feed through the paracord. Join the ends of the paracord for them, and then put on the purlin tape over the back of the switch and tape over U1