# The SOLARBOTICS Pumlantern Charge all day & pulse all night with a solar-powered night-light!



The PumLantern's SCC3733 solar cell stores power all day to release it in pleasant "pumms" of multicoloured light all night long!





td.



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This page is intentionally left semi-blank. Yeah, it was going to be *completely* blank, but we needed to put that boring legal-type stuff somewhere. We were going to say "use this marvelous empty page as you blank canvas with which to create such illustrations or notes as to change the very fabric of society." Instead it's now a partially text-populated page with a large and awkward empty portion in the middle. Feel free to use it however you want.

Boring Legal-Type Stuff:

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### Parts

Let's get started. Start by opening your bag of parts, and dumping them into a safe place like an egg-container (remove eggs), pie-plate (eat the pie), or cat-food bowl (give cat away to gypsies). Don't simply spread them about on a table-surface where they'll roll away, because then you'll think we forgot something in the kit and have to call us. Then we'll tell you to look under your chair, and you'll find it there and think we have magic powers. In short, keep your parts safe when you dump them out - they're small, and will try their hardest to hide from you!



#### PARTS LIST

CKU	Nome
SKU	Name
74HC1240	Octal Inverting Buffer
BattAAA	Rechargeable AAA Battery 2
BHoldAAA	2 x AAA Battery Holder1
CP0.47µF	0.47µF Monolithic Capacitor
CP1000µF	1000µF Electrolytic Capacitor
D2	Schottkey Barrier Diode 1
DC-20 Pin	20 Pin DIP Socket Carrier 1
DSST	Double-Sided Sticky Tape (1" Square)1
KPL-PCB	PumLantern PCB1
Lantern Sides	
Lantern Top	
R100k	100k ohm resistor (Brown, Black, Yellow)1
R1.5M	1.5M ohm resistor (Brown, Green, Green)1
R2.2M	2.2M ohm resistor (Red, Red, Green) 1
R4.7M	4.7M ohm resistor (Yellow, Purple, Green)
R6.8M	6.8M ohm resistor (Blue, Grey, Green)
SCC3733	37 x 33mm Polycrystalline Solar Cell
SBLED	Super Bright LED 4
SWire	5" of Twisted Wire
Vellum (8" x2.875" rectangle)1	

1-866-276-2687

### SOLDERING TUTORIAL

The most important skill needed to successfully construct your device is soldering. Make sure you start by using electronics solder, not plumber's solder. The main trick to getting a successful solder connection is to heat the junction up before applying the solder to the heated area. Do NOT try to melt some solder onto the tip of the iron and smear it onto the joint - you won't get a strong joint. You're a roboticist, <u>not</u> a painter!

If the heat is applied unevenly, you will get solder blobs (see below). To better apply heat,keep your soldering iron tip clean by wiping it frequently on a damp sponge or cloth. The tip should always be shiny, and not covered in tarnish and burned crud (don't burn crud - bad!).



Remember to <u>take your time</u>. Don't rush. It's almost impossible to "burn up" these parts!

### **BUILDING IT!**

Did you pay close attention to those soldering instructions? Well, now it's time to put your new skill to use...

#### STEP 1: CHIP CARRIER

Let's start with mounting the chip carrier to the printed circuit board (PCB).It makes it easier to install the actual chip later.

Note the notch on the carrier, and make it match the notch on the PCB.

Installation hint: Put the carrier in, then fold over a leg or two to keep it locked in. It keeps it from falling out!



#### STEP 2: THE FINE ART OF RESISTOR SELECTION

The way the PumLantern "Pums" is determined by resistors R1 and R2 - the bigger the resistor, the longer the time interval between Pums. Some people like frequent blips; others more sleepy longer intervals. Or mix 'em up for a more random light show.

Choose what Pum interval you'd like:

- 0.3 seconds use 1.5M (Brown, Green, Green)
- 0.6 seconds use 2.2M (Red, Red, Green)
- 1 seconds use 4.7M (Yellow, Purple, Green)
- 1.5 seconds use 6.8M (Blue, Grey, Green)

R1 controls the Pum behavior of LED1 & LED2; R2 controls LED3 & LED4. Not that it really matters, but some people like to have fanatical control over how their devices work.

May we suggest you start with the 2.2M and 6.8M?



#### STEP 3: RESISTOR & DIODE INSTALLATION

Start by installing your selected R1 and R2 resistors. Put the 100k resistor (Brown / Black / Yellow) for position R3. R3 sets the dark "turn-on" sensitivity. Lower values make it turn on earlier in the evening. <u>Be careful</u> installing the D1 diode! Note the position of the band, and make it match the position printed on the PCB!



#### STEP 4: 0.47µF CAPACITORS

Four capacitors work with the R1 and R2 resistors to make the timing circuit that drives the PumLantern. The fifth capacitor works with the 100k R3 resistor's "dark turn-on" circuit.

These capacitors don't care which way they are installed. Just snug them down to the PCB, solder them in, and clip off the extra leads.



Step 4: Install 0.47µF capacitors in locations C3, C4, C5, C6, and C7.

(Yes, we know we skipped C1 and C2, but we'll get back to them - honest)

#### STEP 5: LEDS 101 - OR "HOW SILICON LIGHTS UP MY LIFE"

Light Emitting Diodes ("LEDs") make the light. The ones in your kit are *sooper-dooper* bright, designed for maximum PUM. Some have a flat top, which makes them spread their light even wider than the regular type.

Important things to learn about LEDs: They have a *cathode (-)* and an *anode (+)*, which means you have to learn which is which. There are 3 easy ways:



Your PumLantern lights the LEDs up in pairs LED1 & LED3, and LED2 & LED4, so if you want to colour-arrange your LEDs, here is an easy way to check them.



Step 1: Arrange LED so anode (+) matches solar cell's oval pad, and cathode (-) matches rectangular pad



Step 2: Pinch down the leads to the pads *hard* with your thumb and finger.



Step 3: Hold up to lamp. Look at the pretty colour!

With all this knowledge, now you won't have *any problem* installing the LEDs so the cathode side matches the flat-spot marked on the PCB in spots LED1-4, right?





Installation check: <u>ALL</u> the LED cups will look the same. Either they will be *all* right, or *all* wrong (we have confidence in you!)

#### Step 6: Preparing the large $1000\mu F$ capacitors

The  $1000\mu$ F capacitors actually store the extra "Pum" power in the circuit. Fold them like this. *Just* like this. One cap's leads to the right, the other cap's leads to the left.

See the stripe on the side? That's the cathode, which should be easy for you to identify because you're expert at identify-the-cathode-by-the-lead-length now.



#### STEP 7: INSTALLING THE 1000µF CAPACITORS

We had you fold over the capacitor leads before soldering them in so you are sure not to leave them standing straight up. If you do, they cast strange shadows on the inside of your Puml antern.

Make sure you install the capacitors correctly. The longer lead (anode +) is marked on the board with a "+", and is also the round pad. The cathode (-) is the square pad.

> Step 7: Install caps so long lead goes through "+" pad

#### STEP 8: INSTALL THE 74HCT240 CHIP

Remember the first step where we put in the chip carrier? Let's put it to work. We're almost ready to power-test your Pummer!

Find the chip, and put it in the carrier, so the notch matches the notch on the carrier. You might find it easier to put it in the carrier after bending in the leas a bit by laying the leas on a surface and gently bending it over.





Step 8: Install 74HCT240 into the carrier. Note the notch position on the chip and carrier, and make them match!

#### STEP 9: PUMMER TEST!

Time to see how good your soldering is!

Hopefully your batteries will have *some* charge. If not, charge'em up, or use a pair of AAA cells (borrowed from a remote control), and stick them into the AAA cell holder.

Insert the battery holder *from the underside* (opposite side to where you've done all your work so far), and give it a bit of a bend so the leads make a secure contact with the PCB. If all is well, you should see your 4 LEDs jumping to life in a pleasant, pummer-ish manner...



Step 9a: Put fresh batteries in the holder, and insert it from the *bottom*. These holes are labeled "Batt" on the top of the PCB.



If you don't see blinky lights, check:

- Batteries charged?
- Chip in right-way around?
- LEDs in right-way around?

There's not much else that can go wrong, so if nothing else, re-touch up your soldering!



#### STEP 10: ATTACHING THE SOLAR CELL

Pull the battery pack off, so it's easier to solder the solar cell wires to the PCB. This is pretty straightforward if you remember to solder red to "+" and black to "-".

Strip off a bit of insulation from the end of the wire by firmly pinching and pulling it off between your thumbnail and index finger. Or use a proper wire-stripping tool if you wish (but it's not as much fun). Solder the red wire to the PCB pad "Solar +", and the black to the square pad next to it.

Do the same on the solar-cell end of the wire, red to the oval pad, and black to the rectangle pad.



If all is well, when you hold the solar cell up to the light, the pummer will stop working (and start recharging). Cover it with your hand, and it should kick back to life!

#### STEP 11: SOLDER IN THE BATTERY HOLDER

If you are *sure* all is well with your pummer, then go ahead and snug the battery pack up to the back of the PCB. Solder it in and snip the leads.



You're ready to assemble the lantern, and install your pummer!

### ASSEMBLING THE LANTERN

We've done a lot of work to make assembly nice and tidy. Be gentle (especially with delicate art), and it'll turn out fine!

#### STEP 12: POP THE PIECES OUT OF YOUR SIDES

Except your liver - you need that part. Our laser-cut art should come out easily, but if not, use a sharp knife to gently pop it out of the frame.

#### STEP 13: THREAD THE SOLAR CELL THROUGH THE TOP

We've placed a little slit into the top of the lantern, so all you have to do is flex the board and slip the wire through the slot into the hole.

#### STEP 14: ASSEMBLE THREE SIDES AND THE TOP

We're not going to hold your hand and tell you about "Slot A"s and "Tab B"s. You're old enough to figure out what goes where. Just leave one side completely open.

#### STEP 15: LANTERN ORIGAMI

Fold the vellum paper in half, then fold each end in 1/4 again. Not clear? Here's some pictures:









Uniold until it holds a sarta bos-shape

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#### STEP 16: SLIDE THE VELLUM PAPER INTO THE LANTERN BODY

Place the vellum inside the lantern, so that each side sits flush with the lantern shell.

#### STEP 17: ATTACH THE FINAL LANTERN SIDE

Use some careful tweaking, and you should be able to mount the final side to the PumLantern without problem.

#### STEP 18: POP THE PUMMER CIRCUIT INTO PLACE

See those two notches on the bottom? You need to get the tabs on the end of your completed board in there. Push the PCB into one slot, then flex the other side until you can pop the other tab into place.

#### STEP 19: MOUNT THE SOLAR CELL

Before you mount your cell, you might want to think about where your Pumlantern will live. It may be best for the solar cell to be attached to one side instead of the top, so it better catches sunlight from a window.

Peel one side of your double-sided sticky tape, and press it onto the solar cell.

Then peel the other side and press it onto the top of the lantern. All done!







### CIRCUIT THEORY

There's two parts to the PumLantern. The "dark turn-on" circuit, and the actual Pum circuit. Let's start with the Pum circuit!

The Pummer is based around a very simple BEAM circuit called a "Bicore", which is simply an oscillator that has two outputs that change voltage. When one is "high" (3V), the other is "low" (0V). Every so often, they trade voltages.

We're using this "trade voltage" behavior to create a charge-pump, which is a fancy way of saying we're building something that makes more voltage than what it normally has access to. Here's how it works (showing only one pair of LEDs in operation):



The "dark turn-on" circuit is pretty simple. The chip has an "enable-low" line, which means when it sees zero volts, it turns on. We attach this line to the solar cell, and when it stops generating power (sun goes down), the 100kOhm resistor forces the chip on. That simple!

## SCHEMATIC

Here's the actual circuit diagram of the PumLantern's circuit. It's more useful for those of you who might want to modify your PumLantern, or build a second out of parts.



### Additional Enhancements

You might have noticed that there are little pads on the tabs that stick out of your PumLantern. Once side has a single square pad, which is the ground pad that connects to common grounds in the circuit.

The other tab has two pads: One labeled "S" and one "B".

The "S" pad lets you add an additional solar cell (connected between "S" (+) and the ground pad). This lets you use a *large* cell and have it power a whole string of lanterns at the same time.

The "B" pad lets you directly connect to the battery (with the ground tab) for easy recharging, or measuring voltage.

### Liked the PumLantern? Want more? There are several more kits Solarbotics offers for any skill level!



Find more neat kits, components, articles, resources and more at our official website: WWW.solarbotics.com

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