VOLUME MMXXVI • NO. 1 DECEMBER ISSUE 29¢

LO-FI BOOST

ORNAMENT KIT

THE MONTHLY JOURNAL OF FESTIVE CIRCUITRY



We here at Love My Switches hope you have a ton of fun building this MAS Effects ornament, and that it brings some extra holiday cheer to you and everyone around you.

If you have any questions or run into any problems, visit the MAS Effects forum:

masfx.info/forum

You can also email MAS Effects directly: (mark@mas-effects.com) or post to an online DIY pedal group (e.g. r/diypedals).

Merry Christmas

IN THIS ISSUE

A playable boost pedal you can hang on a tree! One dirt-inducing transistor, fifteen blinking lights, and an evening at the iron.



REQUIRED TOOLS:

- Soldering iron
- Flush cutters
- Holiday spirit

OVERVIEW

A boost pedal you can *hang on the tree*

This ornament is a playable boost "pedal" with a bit of overdrive or distortion when cranked, and blinking lights on the front.

AUDIO CIRCUIT

Nine Volt Nirvana Tape Measure

POWER

Comes on when a mono instrument cable is plugged into the input jack.

LIGHTS

Driven by a microcontroller, switched on and off by the toggle.

UNPLUG IT Leaving your guitar plugged in will drain the battery.

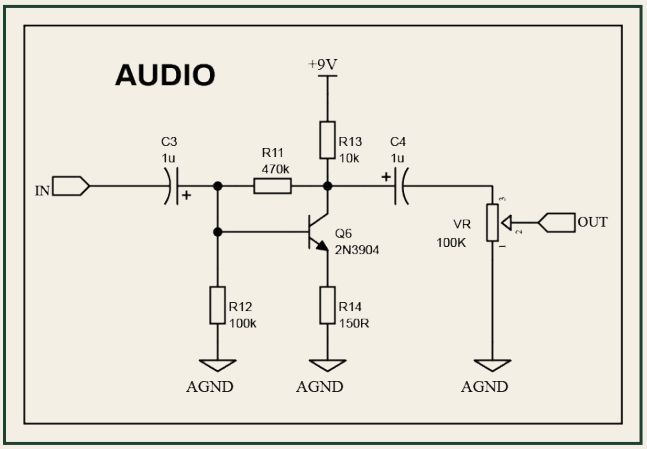
HACK IT The uC arrives pre-programmed, but you can write your own code: github.com/mstratman/xmas-pedal

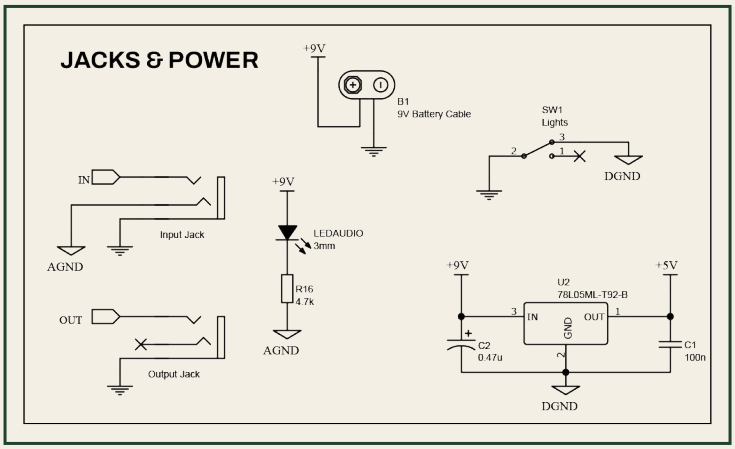
Bill of Materials

CHECK AGAINST THE LABELED BAGS

QTY	DESIG.	PART	NOTE
16	LED1–LED15	3mm	15 assorted for the tree, 1 audio indicator
1	LEDSTAR	5mm	Yellow, for the star
1	VR	100k	A100k 9mm pot, or 100k trimmer
6	Q1–Q6	2N3904	NPN transistor
1	SW1	SPDT micro toggle	Toggles power to the lights
1	C1	100n	
1	C2	0.47u	Electrolytic
2	C3, C4	1u	Electrolytic
1	U1	ATtiny13 or 85	Pre-programmed, included with PCB
1	U2	78L05	TO-92
5	R1–R5	8k2 (8.2k)	
5	R6–R10	1k	
1	R11	470k	
1	R12	100k	
1	R13	10k	
1	R14	150R	
2	R15, R16	4k7 (4.7k)	
1	—	9V battery cable connector	
1	—	8-pin DIP socket	Optional, for U1
2	—	Audio jack	
1	—	Wire	For hanger
1	—	Printed Circuit Board (PCB)	Green; shaped like a tree

Schematic

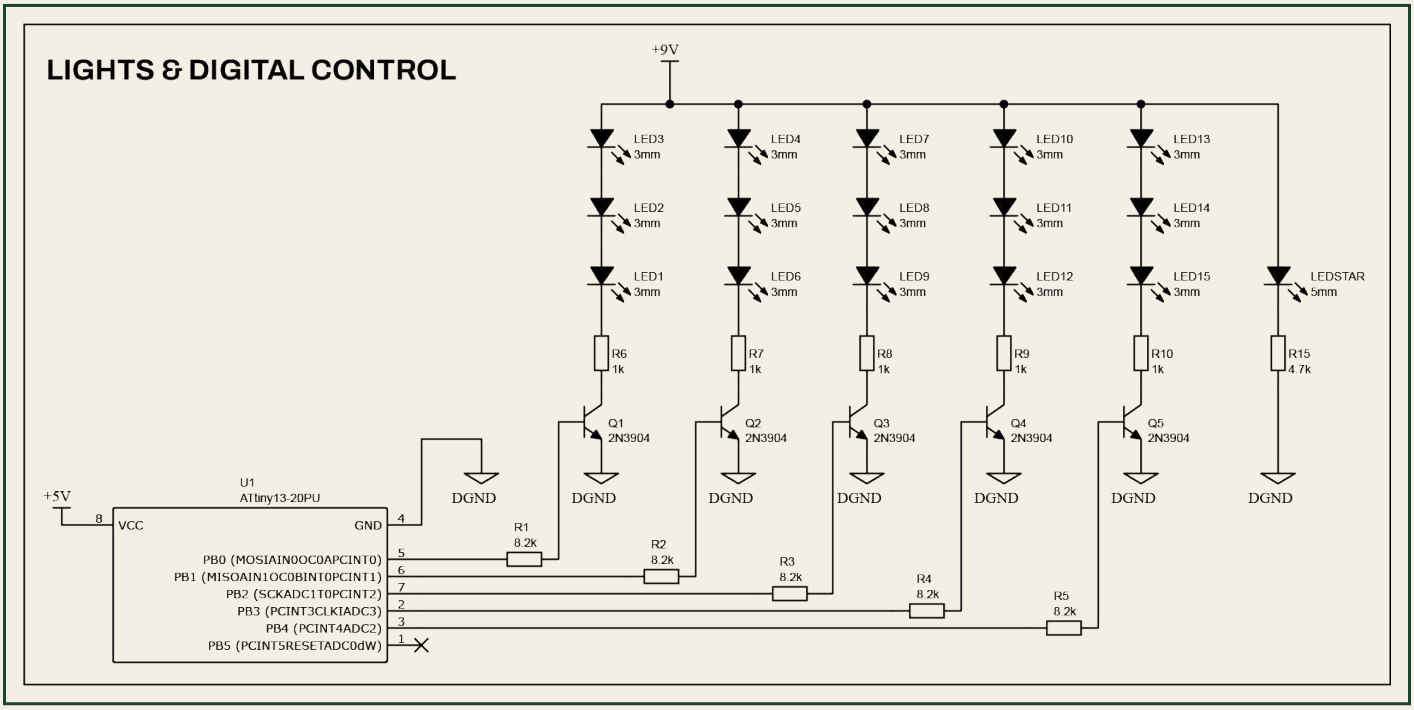




SWITCHING

A mono instrument cable bridges the sleeve and ring of the input jack, connecting the ground. i.e. plug in your guitar to turn it on.

The digital circuit uses a switch.



PREFACE: FOR BEGINNERS

Before you *heat the iron*

New to soldering components onto a printed circuit board? A few minutes here will save you hours later. Nearly every problem comes down to one of two things:

A Parts in the wrong spots, or wrong orientation	**B** Bad solder joints

A PLACING COMPONENTS CORRECTLY

KEEP THEM BAGGED

Leave components in their bags until you need them. Each bag is labeled, and look-alike parts are kept separate so they can't be mixed up.

READ THE NOTES

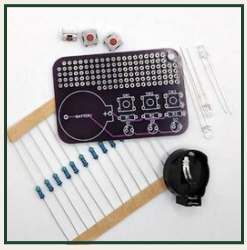
This document flags the polarity and orientation of the components, and provides useful tips. Those notes matter.

GO SLOWLY

Take your time. Enjoy the build!

B GETTING GOOD SOLDER JOINTS

- **Be confident in your technique first.** If you have any doubt, work through the *How To Solder* booklet and videos at masfx.io before starting.



Practice soldering wires onto a prototyping or vero board, or order this practice soldering kit we offer. It includes comprehensive instructions and a step-by-step video.

- **Learn what a good solder joint looks like.** Watch for the solder wicking up the component leg and spreading across the pad. That tells you both the leg and the pad got hot enough for the solder to bond.
- **If it isn't flowing, stop.** No wicking after a few seconds means the heat isn't transferring. Pause a moment, wipe the iron or rotate its tip against the joint, then try again.

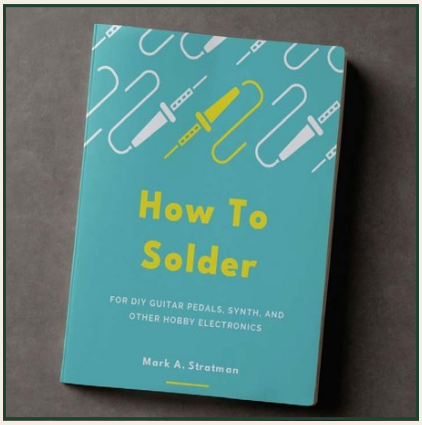


Figure 1. Free booklet and videos at masfx.io

STEP 1

Resistors

R1–R16 (SIXTEEN PIECES)

ORIENTATION DOESN'T MATTER

Resistor legs can go in either of the two holes, so this is a simple place to start. i.e. orientation does not matter.

Grab R1, find the "R1" spot on the board, and push its legs through. Bending the legs 90° first, i.e. to give the resistor a "U" shape, makes the job easier.

Once it's in place, bend the legs outward to hold the resistor to the board while you solder it.

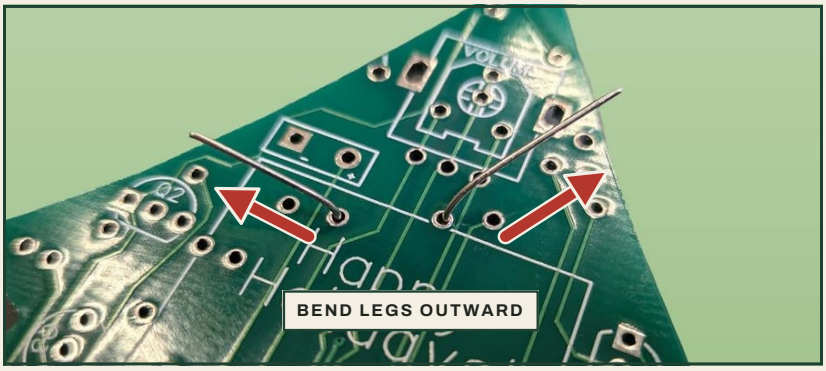


Figure 2. Bend the component legs to hold it onto the board

After the joint is fully cool, trim away the legs. Repeat for all the resistors.

VALUES ON THE BOARD

QTY	DESIG.	VALUE
5	R1–R5	8k2 (8.2k)
5	R6–R10	1k
1	R11	470k
1	R12	100k
1	R13	10k
1	R14	150R
2	R15, R16	4k7 (4.7k)

16 TOTAL



Figure 3. Finish adding all the resistors

PREVENT MIX-UPS Don't take the components out of the sealed bags until you are ready to solder them into place. We sorted them so you don't have to! Otherwise you'll need to decipher color-coded bands, or use a multimeter to measure.

WHICH SIZE?

Either 1/8 W or 1/4 W resistors will fit. The kit ships with the larger 1/4 W. The smaller ones drop onto the board more easily, but the bigger ones, I think, look better to make up the "garland".

STEP 2

The brain of the tree

U1 · ATTINY13 OR ATTINY85

ORIENTATION MATTERS

Flip the board over and solder the socket. There will be dots or a half-circle cutout, or both, to indicate orientation. The dots or half-circle should point toward the top of the tree. The dot on the microcontroller chip lines up with the dot on the PCB, and the cutout on the socket lines up with the one on the microcontroller.

Seat the microcontroller into the socket. You may have to slightly bend its legs inward.

The socket is optional. You can solder the microcontroller straight to the board, but the socket protects it from heat and lets you reprogram it later more easily.

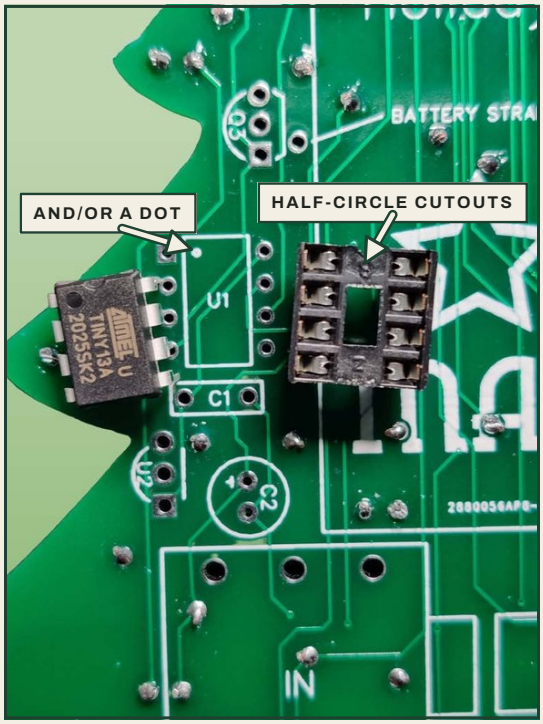


Figure 4. Microcontroller orientation

WHAT DOES IT DO?

This chip is the brain that controls the LEDs.

It toggles the voltage on several of its legs from low (0V) to high (5V). It's not capable of providing enough current (total flow of electricity) to power more than a single LED, though. Instead it turns transistors on and off, which act like switches for the full 9V power supply so it can handle banks of 3 LEDs at a time.

The microcontroller can be programmed with an AVR programmer and the Arduino IDE.

GOING FURTHER

To get the source code for this ATtiny13, visit:

github.com/mstratman/xmas-pedal

You can then use an AVR programmer to experiment and update the program on it. I recommend the SparkFun Pocket Programmer, but there are plenty of other options.

If you find the ATtiny13's 1K flash memory too limiting, an ATtiny85 can be used instead and has 8x more space for your program's code.

STEP 3

TO-92 components

Q1–Q6 · 2N3904 U2 · 78L05

Next, solder Q1, Q2, Q3, Q4, Q5, and Q6. These are common, general-purpose, silicon NPN transistors.

Solder U2, the 5V voltage regulator.

AVOID MIX-UPS Q1-Q6 are identical and can be interchanged. However, although they share the same TO-92 package (i.e. same physical body), U2 is quite different. If you get them mixed up, look carefully at the markings written on them.

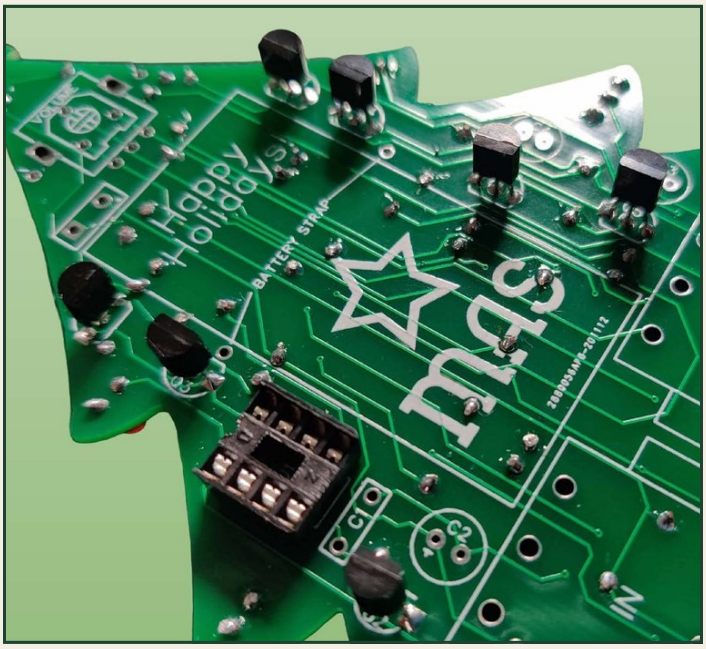


Figure 5. Placing transistors and regulator

ORIENTATION MATTERS Line up the flat side of each component with the flat side of the white silkscreen outline drawn on the PCB.

WHAT DO THEY DO?

U2

This voltage regulator (78L05) converts 9V, which is too much for our microcontroller, to a steady 5V.

Q1–Q5

These transistors (2N3904) act as switches, allowing the microcontroller to toggle the lights without powering them directly. The LEDs draw more current and voltage than it can supply.

Q6

Q6 (2N3904) is the heart of our boost circuit. It amplifies the audio signal. The transistor is configured as a common emitter amplifier.

STEP 4

Capacitors

C1 · 100NF C2 · 0.47UF C3, C4 · 1UF

Electrolytic capacitors (C2, C3, C4) need to be inserted with the correct orientation. Insert the longer leg into the hole marked with a “+” symbol on the silkscreen.

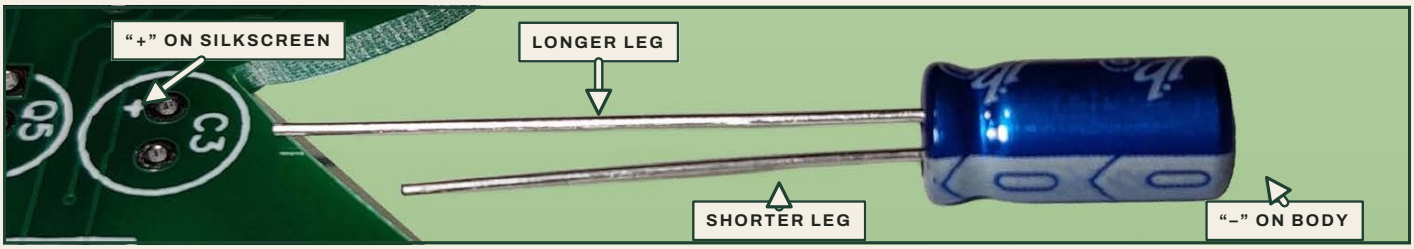


Figure 6. Orientation for electrolytic capacitors

C1, on the other hand, is a box film capacitor and can be inserted in either direction.

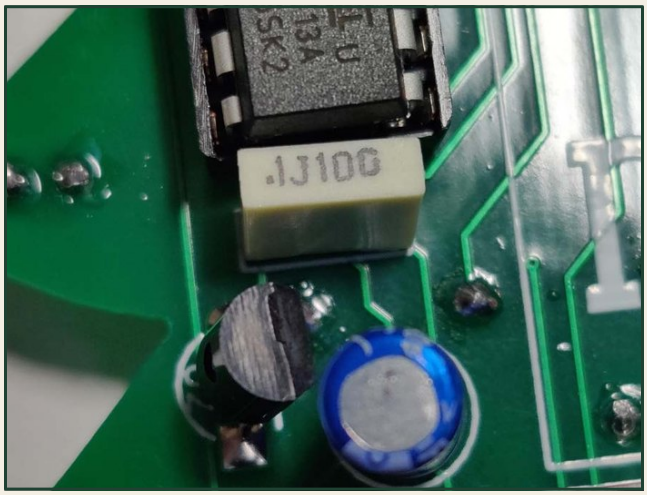


Figure 7. Box film capacitors go in either way

WHAT DOES IT DO?

C2

C2 helps to smooth out the 9V voltage going into the U2 regulator. It can help compensate for momentary drops.

C1

C1 works the same, but for the 5V coming out of the regulator. It is typically smaller than the capacitor on the input side.

C3, C4

C3 and C4 are the input and output capacitors for the audio circuit. They remove any DC bias from the signal and center the AC voltage around 0V. C3 and C4 also act in concert with R12 and VR to form high pass filters, blocking very low frequencies. In this circuit the cutoff is set extremely low.

STEP 5

LEDs

15 × 3 MM · 1 × 5 MM STAR · 1 AUDIO INDICATOR

ORIENTATION MATTERS

LEDs need to be inserted with the correct orientation. The longer leg is the positive side, or Anode. The shorter leg is the negative side, or Cathode.

The PCB has a small "+" printed on the side for the Anode.

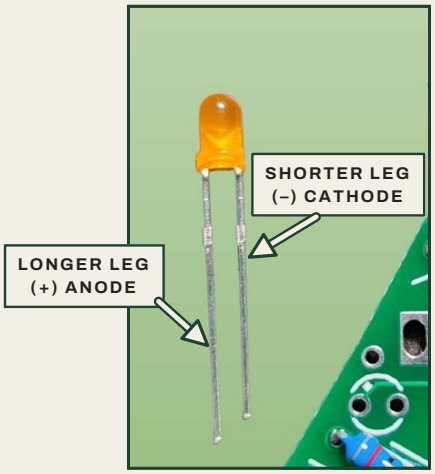


Figure 8. Long leg is "+"

5A THE STAR

Start by putting the large 5mm yellow LED at the top of the tree.

5B THE TREE LIGHTS

Populate the 3mm LEDs on the front of the tree. You can put the various colors anywhere you like. However be aware that LEDs are lit up in groups of 3, or sometimes multiple groups of 3.

For a nice, random mixture of colors when the groups of LEDs light up, follow the placement in Figure 10. If you'd like to arrange them differently, refer to Figure 9 and the schematic to see which groups of LEDs light up together.

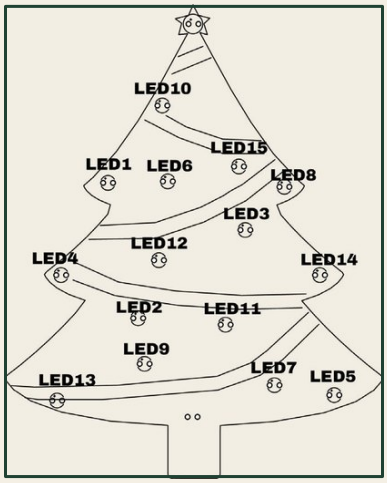


Figure 9. LED positions

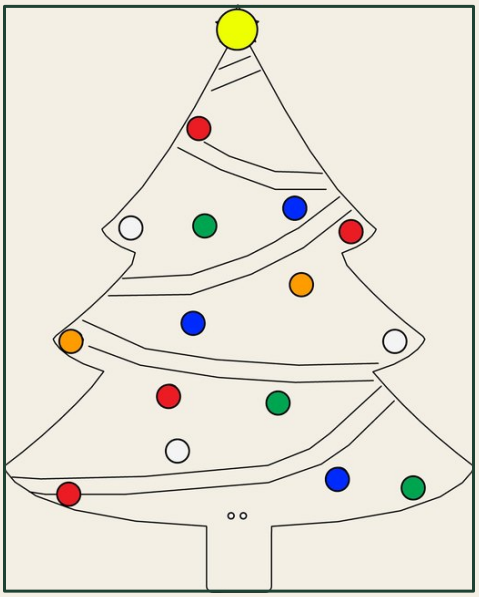


Figure 10. A good mix

5C THE AUDIO INDICATOR

One of the 3mm LEDs will go on the back of the PCB to act as a power indicator for the audio circuit. This will be yellow if you followed the color groupings suggested above, but you can use whatever color you'd like.

STEP 6

Jacks and switch

J1 · J2 · SW1

6A THE JACKS

Next, insert and solder each jack into place. Line up the lugs carefully with the holes on the PCB, then wiggle the jack slightly while gently pressing down.

DO NOT FORCE IT DO NOT FORCE it into the holes or you may damage the jack.

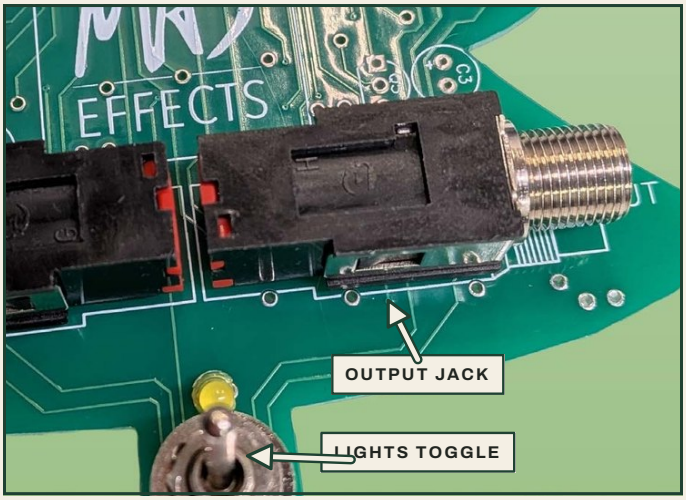


Figure 11. Jacks and the toggle switch in place

OPTIONAL, BUT RECOMMENDED

Put a piece of electrical tape over the pads of the two LEDs next to the input and output jacks. Some instrument cables will make contact with these and short them together.

FYI

To power on this circuit, a mono cable needs to be inserted into the input jack. The cable makes a connection between the sleeve, which connects to the circuit's ground, and the ring which connects to the battery's negative (–) terminal.

6B THE TOGGLE SWITCH

ORIENTATION DOESN'T MATTER

Solder the toggle switch for turning the lights on and off.

Orientation does not matter, and you can decide whether to place it on the front or the back of the ornament.

STEP 7

Volume

VR · 100K TRIMMER OR 9 MM POT

USE ONE
OR THE OTHER

You can use either a 100k trimmer, or a 100k 9mm pcb-mounted potentiometer for the volume.

You will find there are extra holes on the PCB to accommodate a couple styles of trimmers, as well as the regular potentiometer. Simply leave the extra holes unpopulated.

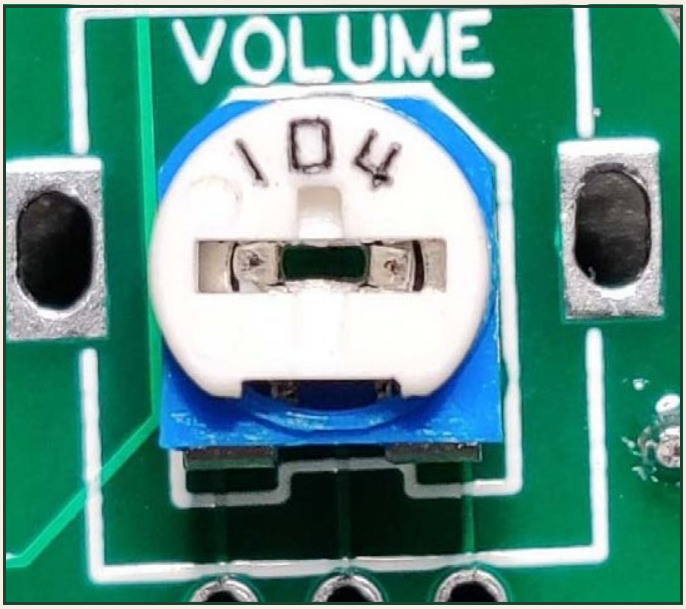


Figure 12. 100k trimmer

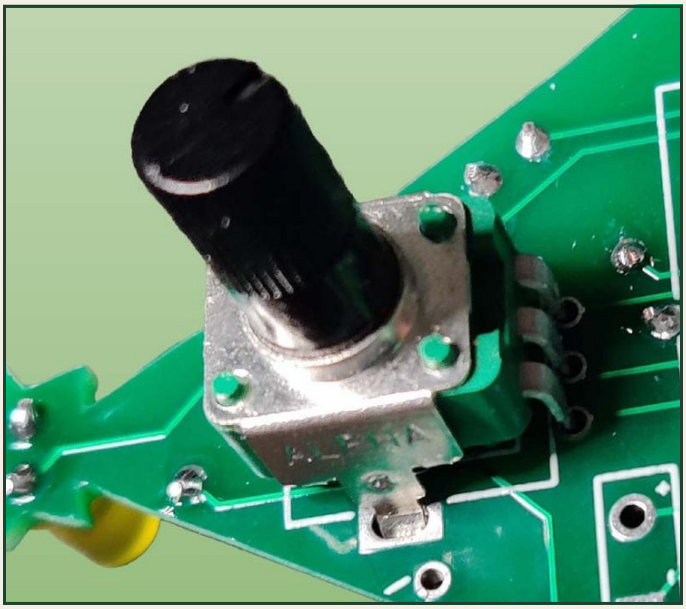


Figure 13. 100k 9mm potentiometer

GO GENTLY If you use a trimmer, be aware they are delicate and do not tolerate abuse. Turn it carefully and don't push it past its boundaries.

STEP 8

Battery

BATTERY CLIP · WIRE STRAP

The battery is secured to the board by 3 forces: the battery clip that it plugs into, the input and output jacks that it can rest upon, and a wire battery strap to hold it against the board.

8A THE CLIP

Trim the wires on the battery clip to about 1.5cm to 2cm. Solder the black wire to the pad labeled with a "–" and the red wire to the pad labeled "+".



Figure 14. Clip wires soldered to "–" and "+"

8B THE STRAP

- Scrap wire from the battery clip makes a great strap to hold the battery in place.
- Solder one end of the wire into one of the pads labeled "Battery Strap".
- Loosely pull the wire over the battery to the other "Battery Strap" pad, and trim it to length.
- Now solder the other side of the battery strap wire.

NOT TOO TIGHT You want it tight enough to hold the battery in place, but loose enough that you can slide the battery out when needed.



Figure 15. Battery held by the strap

STEP 9

Hanger

TWO PADS · BESIDE THE VOLUME KNOB

Finally solder a wire onto the two pads on either side of the volume knob.

This will be used to hang your ornament from a tree or wherever you decide to display it.

You can use the red wire trimmed from the battery snap along with the included green wire to make it extra festive.



Figure 16. The finished hanger

STEP 10

Clean OPTIONAL

TOOTHBRUSH · 91% ISOPROPYL

You can use an old toothbrush or cloth and rubbing alcohol to remove the soldering flux from the circuit board. Less diluted alcohol, e.g. 91%, will make the job easier.



Figure 17. The finished ornament

STEP 11

Share it

Be sure to take pics and post online to share your seriously sweet tree with everyone!

Tag us on Instagram and Facebook @lovemyswitches so that we can see your work and holiday spirit. Or, reach out to our inbox at contact@lovemyswitches.com and our website at lovemyswitches.com.



SUPPORT

Need a *hand?*

PROBLEMS WITH YOUR PURCHASE?

Problems with your purchase? Email MAS Effects at mark@mas-effects.com.

PROBLEMS WITH YOUR BUILD?

Visit the MAS Effects forum at masfx.info/forum, email MAS Effects directly (mark@mas-effects.com), or post to an online DIY pedal group (e.g. r/diypedals).



Happy Holidays