Ornament Kit: Lo-Fi Boost

mas-effects.com/holiday/

I hope you a have a ton of fun building this 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 our MAS Effects subreddit:

reddit.com/r/maseffects

This is where you'll get the quickest help. You can also email me directly (mark@mas-effects.com) or post to various DIY pedal groups online (visit mas-effects.com/holiday-instructions/ for a list), but these may take a bit longer.

Happy Holidays!

Overview

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

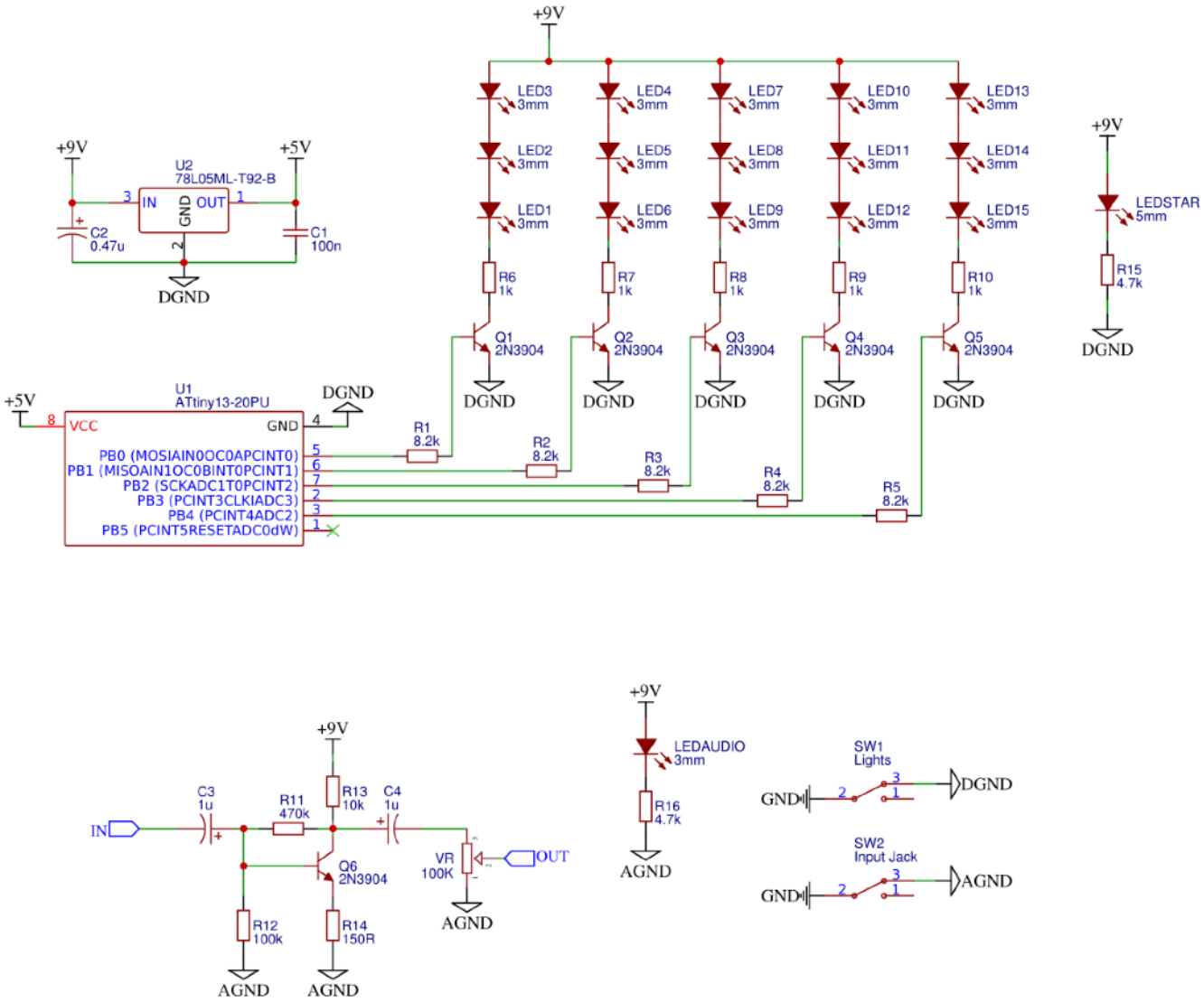
The audio circuit is the Nine Volt Nirvana Tape Measure. It is supplied power when a mono instrument cable is plugged into the input jack. **Leaving your guitar plugged into this will drain the battery!**

The lights on the front of the ornament are controlled by a microcontroller (uC), with power toggled by a switch. I've pre-programmed the uC for you, but feel free to experiment and write your own programs to it. You can find the code on the github project page (github.com/mstratman/xmas-pedal) so it should be straightforward to restore it to its original settings.

Bill of Materials

QTY	Designator	Part	Note
16	LED1-LED15	3mm	15 Assorted LEDs for tree, 1 for Audio indicator
1	LEDSTAR	5mm	5mm yellow LED for star
1	VR	100K	A100k 9mm pot, or 100k trimmer
6	Q1,Q2,Q3,Q4,Q5,Q6	2N3904	2N3904
1	SW1	SPDT Micro Toggle	Toggles power to lights
1	C1	100n	
1	C2	0.47u	Electrolytic
2	C3,C4	1u	Electrolytic
1	U1	ATtiny13 or ATtiny85	Pre-programmed uC, included with PCB
1	U2	78L05	TO-92
5	R1,R2,R3,R4,R5	8.2k	
5	R6,R7,R8,R9,R10	1k	
1	R11	470k	
1	R12	100k	
1	R13	10k	
1	R14	150R	
2	R15, R16	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


+9V
LED3 3mm
LED4 3mm
LED7 3mm
LED10 3mm
LED13 3mm
LED2 3mm
LED5 3mm
LED8 3mm
LED11 3mm
LED14 3mm
LED1 3mm
LED6 3mm
LED9 3mm
LED12 3mm
LED15 3mm
R6 1k
R7 1k
R8 1k
R9 1k
R10 1k
Q1 2N3904
Q2 2N3904
Q3 2N3904
Q4 2N3904
Q5 2N3904
DGND
+5V
U2
78L05ML-T92-B
IN
GND
OUT
C2 0.47u
C1 100n
LEDSTAR 5mm
R15 4.7k
U1
ATtiny13-20PU
VCC
PB0 (MOSIAIN0OC0APCINT0)
PB1 (MISOAIN1OC0BINT0PCINT1)
PB2 (SCKADC1T0PCINT2)
PB3 (PCINT3CLKIADC3)
PB4 (PCINT4ADC2)
PB5 (PCINT5RESETADC0dW)
R1 8.2k
R2 8.2k
R3 8.2k
R4 8.2k
R5 8.2k
C3 1u
R11 470k
R13 10k
C4 1u
IN
Q6 2N3904
VR 100K
OUT
R12 100k
R14 150R
AGND
LEDAUDIO 3mm
R16 4.7k
SW1 Lights
SW2 Input Jack

Instructions

PREFACE: For Beginners

If you haven't spent much time soldering components to a PCB (printed circuit board) then here are a couple tips to help you ensure success with this project.

Nearly all problems people face when building kits such as this come from either

A. Placing **components in the wrong spots**, or with the wrong orientation, or
B. **Bad solder joints**

Placing components correctly:

- **Leave the components in the bags** until you are ready to use them. I labeled each bag and kept similar-looking components in separate bags to help ensure you don't mix them up
- Read this build instructions document. I will make notes about **polarity and orientation** of LEDs, electrolytic capacitors, and the IC. These are very important to follow.
- Take your time

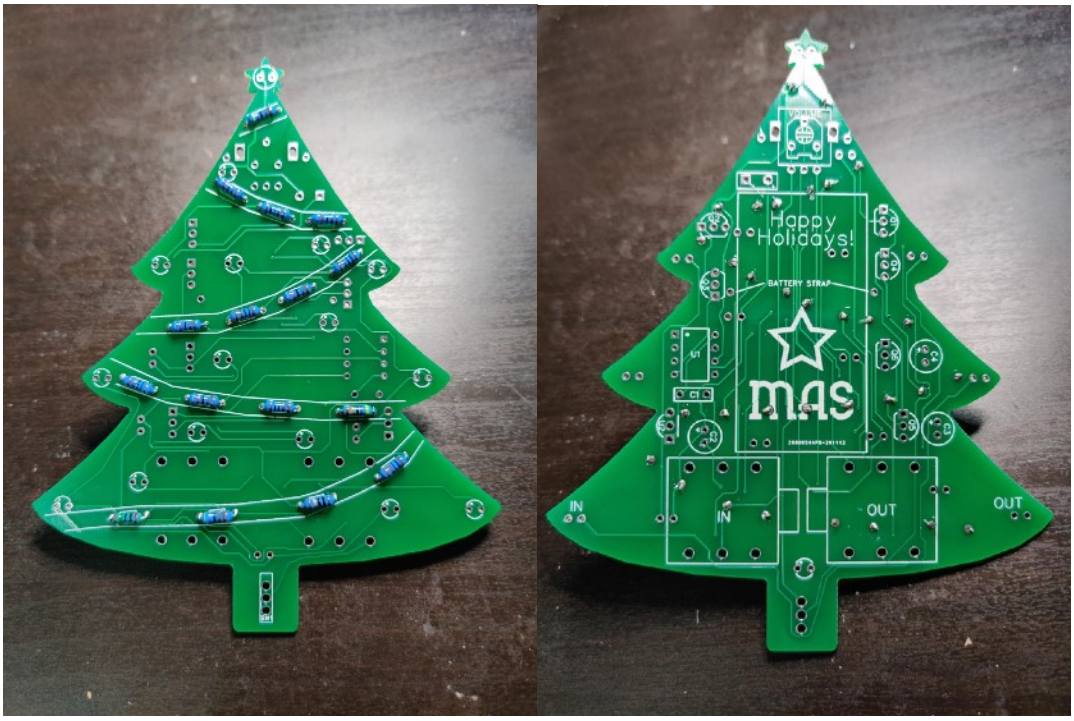
Getting good solder joints:

- First and foremost make sure you're confident in your soldering techniques. If in doubt, check out our "How To Solder" booklet and videos at masfx.io.
- If possible **practice soldering wires** onto a prototyping or vero board (fiberglass board with holes, and copper pads), or this **practice soldering kit** we offer. The practice kit includes detailed and comprehensive **instructions and step-by-step video to help you learn to solder**.
- Watch carefully to recognize when the solder has been pulled up onto the component legs, and spread across the pad of the board. This indicates both the component and the pad were sufficiently heated, and the solder bonded with them.
- If the solder isn't wicking up against the pad and component within a few seconds: Stop. Wait a few moments. Then try again. Wipe your soldering iron or rotate it against the joint if necessary to get good heat transfer.

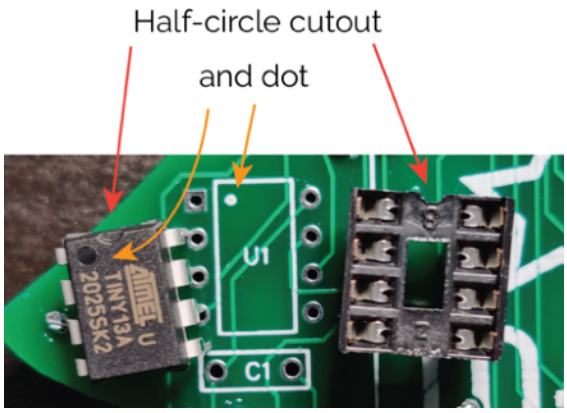
STEP 1: Resistors (R1 - R16)

You can use either small 1/8W resistors or the larger 1/4W resistors. 1/4W were included with the kits. The smaller ones are easier to fit onto the board, but I think the bigger ones look nicer.

You may find it easier to bend the legs 90 degrees from body of the resistor before trying to place them. Orientation does not matter. Resistors can be inserted in either direction.



STEP 2: Microcontroller (U1)



Solder the socket to the PCB.

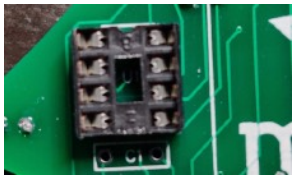
The **dots and half-circle cutouts should be toward the top** of the tree. i.e. The dot on the microcontroller (uC) should line up with the dot on the PCB, and the semicircular cutout on the socket should line up with the one on the uC.

The socket is optional; You can simply solder the uC to the board if you prefer, but the socket will help protect the uC from heat damage while soldering as well as give you the flexibility to reprogram it later if you'd like.

What does it do?

This uC is the brains that controls lighting up the LEDs. It can be programmed with an AVR programmer and the Arduino IDE

Here's the socket soldered to the PCB.

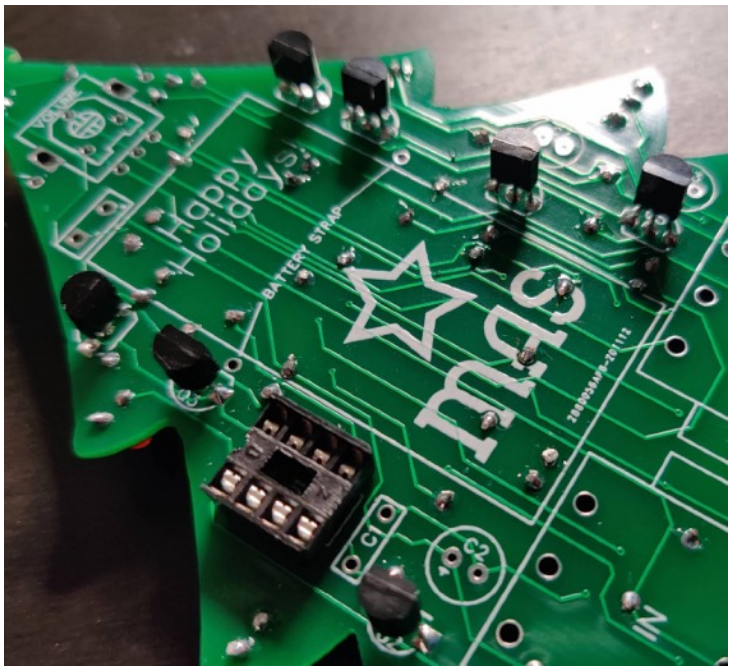


ADVANCED PROJECT:

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, U2)



Next solder in place the 6 transistors: Q1 through Q6. These are common NPN general-purpose silicon transistors.

Orientation matters, so line up the flat side of the component with the flat side of the white silkscreen outline.

Solder U2, the 78L05 5V voltage regulator.

What does it do?

U2 converts 9V, which is too much for our IC, to a steady 5V suitable for powering it.

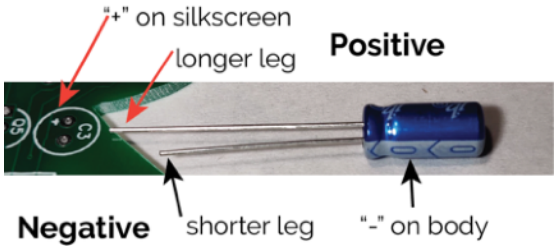
Q1-Q5 allow the IC to switch on and off the LEDs without directly powering them. They consume a fair amount of current and require more voltage than the IC operates on.

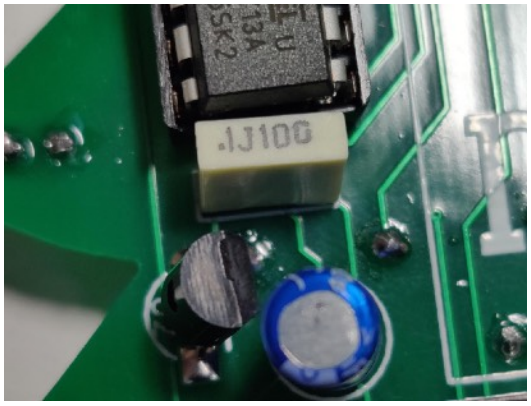
Q6 is the heart of our boost circuit. It is used to amplify the input signal.

STEP 4: Capacitors (C1, C2, C3, C4)

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.

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





What does it do?

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

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 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

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.

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

5B: 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.

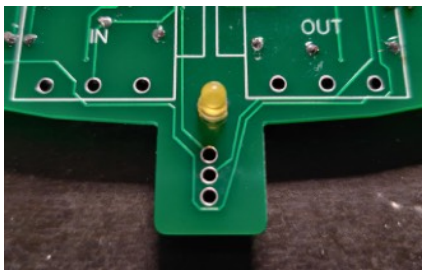
DON'T group your LEDs like this photo. This indicates which ones light simultaneously

Avoid placing too many of the same color within the same group to achieve a more random appearance.

The groups are color-coded in the image to the left. This is EXACTLY THE OPPOSITE of how you want to group your colors (unless of course you want a less random appearance).

Placing the LEDs like the photo in the lower right will yield a good, random appearance.

5C: One of the 3mm LEDs will go on the back of the PCB to act as a power indicator for the audio circuit. Again, this can be whichever color you like.



STEP 6: Jacks and Switch

6A: 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.

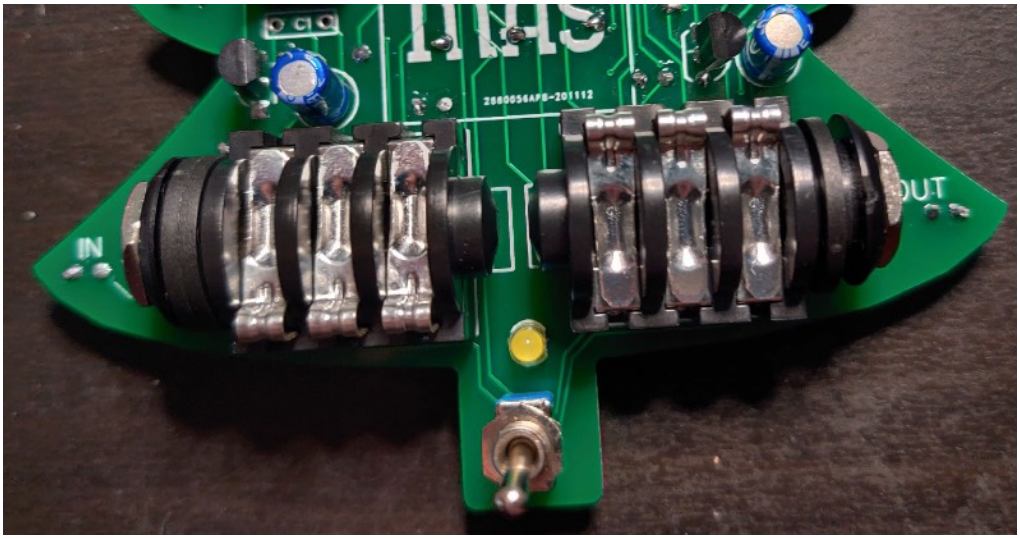
DO NOT FORCE it into the holes or you may damage the jack.

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: 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.

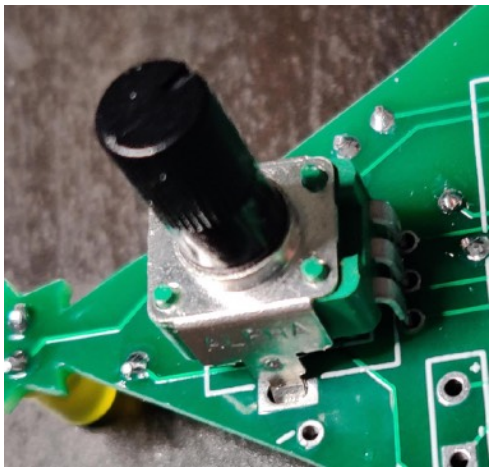


STEP 7: Volume (VR)

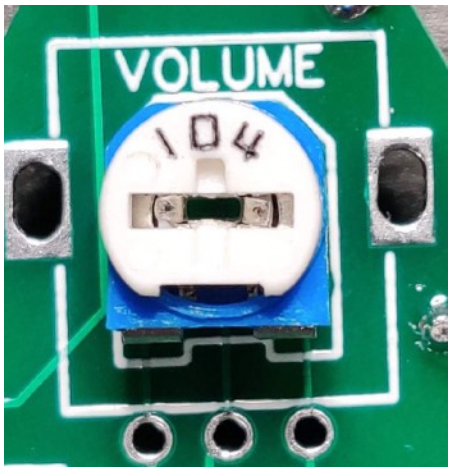
You can use either a 100k trimmer, or a 100k 9mm pcb-mounted potentiometer for the volume.

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.

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.



use one or the other



STEP 8: Battery

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: 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 "+".

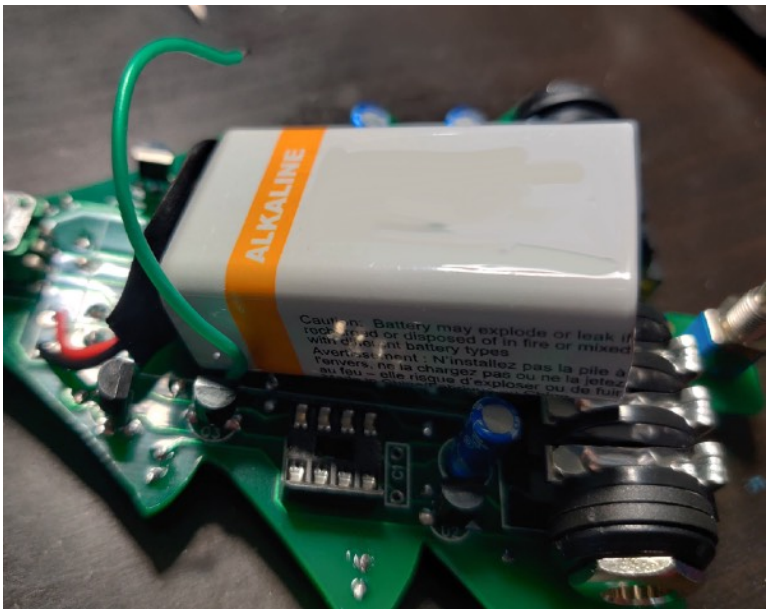
8B: Scrap wire from the battery clip makes a great strap to hold the battery in place.

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.

You want it tight enough to hold the battery in place, but loose enough that you can slide the battery out when needed.

Now solder the other side of the battery strap wire.



Step 9: Hanger

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.

STEP 10: (Optional) Clean

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.

STEP 11: Share with friends, family, bandmates

Be sure to take pics and **post online** to share with everyone. And if you know anyone who might appreciate either a kit or a pre-assembled ornament, **send them to mas-effects.com/holiday** .

Happy Holidays!