What is PWM? PWM stands for pulse-width modulation. A circuit is turned on and off rapidly to create a lower average voltage at an output. This is the basis for almost every regulator we use in mods. All our Murata, GE, Delta, Emerson, Evolv and YiHi regulators use it. These are all referred to as switch mode power supplies. Here's a really good explanation of how they work:

https://www.youtube.com/watch?v=wJU7AJgERG8

https://www.youtube.com/watch?v=CEhBN5_fO5o

If you need further information about about any of the aforementioned regulator brands, either use the other documents in this collection or, you know, Google it.

How is this PWM setup different than a switching regulator? As you saw in the video (because you wouldn't just skip the video like a douchebag) there can be a lot to making a switching regulator. Feedback, filtering, and all kinds of stuff like that makes those regulators very complex. They produce a flat output with very little ripple. Grab any buck regulator datasheet, like the one for the NSR020 20A Raptor from GE and have a look at all the features and specs. The PWM described here outputs a square wave, fully on and fully off over and over, and sends that waveform to a MOSFET. This makes the whole thing less complex, which leads to the next part...

Why PWM? People in the group kept asking "how can I adjust the voltage on my MOSFET mod?" Some folks ask if connecting a potentiometer to a MOSFET is the way to go. Well it isn't, unless you want to make a very large mod that is mostly a hand warmer. So PWM is the answer to those questions, and Derek Jones suggested it. By pulsing from 0V to nearly battery voltage, the MOSFET is either totally on or totally off. It doesn't sit in that grey area where it acts like a resistor. This makes PWM ideal for a drop-in modification to existing MOSFET mods. It is adjustable from around 10% battery voltage to 99% battery voltage.

Not only does it make a great MOSFET mod conversion, but it provides the part of a buck converter that you really care about - the voltage adjustment - without the stuff you can maybe do without. Also, this is something you can build from parts, making it much more of a DIY project than slapping a DNA in a box and calling yourself a modder.

Why does it whine/buzz/beep/make a noise? Electronic switching is noisy in all applications, but especially when it isn't filtered. This PWM runs at about 1.5kHz, which is squarely within audible range. If it bothers you that much, use a much higher resistance pot (200kΩ for example) and it'll be a barely audible hum because lower frequencies do not propagate as well in that medium. No other components have to be changed.

Can I use a different pot value? Yes, you can use any value higher than 10k ***WITHOUT ANY ADVERSE EFFECTS AT ALL.*** You will have 100% the same PWM mod, except the frequency will be lower, which does not affect performance. If you use a lower pot than 10k, you will increase the frequency, likely overrunning the MOSFET's ability to switch. The mod might work, but the MOSFET may get hot very easily, especially under heavier loads, and your efficiency will be shit. Lots of energy will be wasted as the MOSFET tries to keep up with the 555 timer. In other words, ***DO NOT FUCKING USE A 200Ω POT IN YOUR PWM MODS.*** That is, unless you know how to adjust the frequency otherwise, which you don't. But that is beyond the scope of this document.

Why does my voltmeter [insert odd behavior here]? Let's think about this for a moment. You have a device that pulses from zero to battery voltage over and over. An LED voltmeter wants to see a flat input. Even if a meter works, it'll be inaccurate because it's going to try to average the output, and that is not a true picture of the output. Even if you filter the output to the meter, it'll only show you an arithmetic mean, not an RMS value. Sorry, folks. You'd need a digital oscilloscope with RMS (NOT a Fluke RMS meter) to read the true output. Stop being obsessed with the number on the screen and simply enjoy a vape.

Why are there other diagrams? Under certain conditions (see below), 555 timers are known to fail by being stressed too hard by switching a MOSFET under heavy load. The standard diagram was modified to address that by adding P-FET buffering.

What is buffering? In this instance, a secondary MOSFET is being used to handle the switching current drawn by the primary MOSFET, so the 555 timer doesn't have to. Think of it as MOSFET inception. The reason a P-FET is used is because the primary MOSFET is an N-FET. An N-FET is fed a positive signal to activate it. a P-FET switches a positive signal, so that's what must be used to feed an N-FET. Clear as mud? Sweet. Moving on.

Why didn't you use a proper MOSFET driver or gate resistor instead of a P-FET? A gate resistor changes the R/C time constant, which ultimately affects switching speed. Also, it does not guarantee an overcurrent won't be passed to the N-FET anyway. As for a driver, I wanted a simpler option for DIYers. A P-FET does the same thing more simply. If anyone tells you their board is better because it has a MOSFET driver, you're being lied to. *cough* Venom *cough*

Which diagram do I use? If you're making a 2S PWM, the standard diagram with a standard 555 (see below) is fine. You can use the P-FET buffered version, but it's unnecessary. If you are making a 3S or 4S PWM, I highly recommend you use the P-FET buffered version with a standard 555. Timer failure is known to happen with very low resistances otherwise. How low? I'm not going to tell you a number, because you'll quote me like it's gospel. **THAT DOES NOT MEAN IT WILL DEFINITELY FAIL.** Some of you feel the need to tell me about every time you ran a 3S or higher PWM without buffering successfully. Yes, I know it can work under many

circumstances. It can also fail under many other circumstances. Use it or do not, but don't come crying if the shit fails when I told you it would. If you plan on making a 1S (single/parallel) PWM, you must use the P-FET buffered diagram with a CMOS timer (see below). The 1S setup requires the CMOS timer's lower minimum input voltage and the CMOS timer requires P-FET buffering. Also, if you ever do make a 1S PWM, please show it off, because it's probably 1 of 1 in the ecosystem.

Which 555 do I use? Look guys, 555 timers have been around longer than most of you, so there are a lot of variants. Use one that does not say "CMOS" anywhere in the datasheet unless you want a single or parallel PWM. If you want a single or parallel PWM, use one that does say "CMOS" in the datasheet and make sure it has a minimum input voltage low enough for the application.

Can I use a different N-FET? This PWM circuit is designed to have a slow enough frequency to accept any MOSFET acceptable for any unregulated MOSFET mod. Refer to the "How To Choose a MOSFET…" PDF guide in this collection at bit.ly/googleBOX if you want to use a different one.

Can I get a parts list? No. Fuck yourself. However, I'll give you some basics that'll help: 1. Use ceramic caps. 2. The P-FET just needs to handle a couple amps or so (aside from the voltage ratings you should already be familiar with). 3. The resistors need to be the correct ohm value. Unless otherwise mentioned, no other resistor specs are relevant. That's literally all you need to know to select parts compatible with this setup.

How does it all work? If you want to see the basic circuit explained in obnoxious detail, skip to about 7:00 in this video:

https://www.youtube.com/watch?v=OXsu29K_Ap4

Also check out my YouTube channel, Relayer1974. I have a few videos on PWM mod stuff there. There's also an unrelated video featuring a sock puppet. So with all that out of the way...

This setup allows you to vary the average output voltage to the atomizer without the use of a complex regulator. The 555 gets wonky below 3V, so single or parallel setups are out of the question. It'll work with up to 18V in, so a 3S or even 4S power supply is possible.

Like I said, this is a series-only variable voltage MOSFET diagram using the 555 timer IC. A 555 spec sheet can be found here:

http://www.ti.com/lit/ds/symlink/ne555.pdf

I wanna solder a PWM setup right meow. BUY A BREADBOARD AND BUILD THIS WITHOUT SOLDERING ANYTHING BEFORE ATTEMPTING A FINAL PRODUCT. These

things are nearly impossible to troubleshoot online, so do me a favor and try to make one on your own without solder before asking me why your finished PWM box doesn't work.

http://www.ebay.com/…/Electrical-Test-Equipme…/92074/i.html…

For those of you worried about fucking up your 555, use a socket!! It'll let you pull the 555 right out and swap it if you do something foolish.

http://www.digikey.com/pro…/…/4808-3004-CP/3M5473-ND/1133626

When you're ready to make one, use some strip board if you want a very easy way to keep up with your electrical connections.

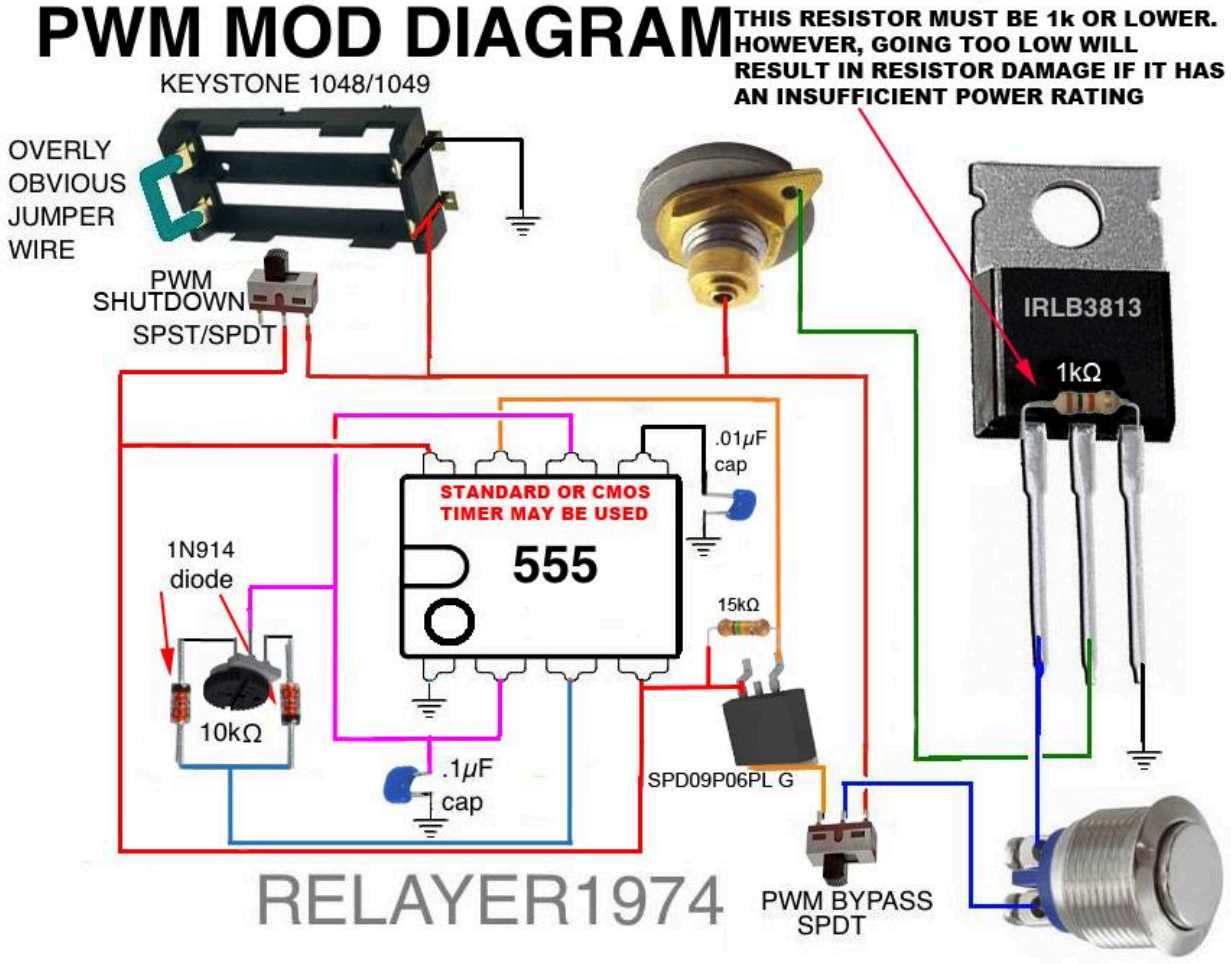
http://www.digikey.com/product-detail/…/8022/V2018-ND/565947

Can’t I just buy a PCB from [company name here] and not worry about all this shit? A PCB holds the components. It does not make things work any differently. Thus, you’ll still need to understand PWM fully if you want to be successful. Using a PCB to skip the learning process not only makes life harder on you, but on the people who have to support your lazy ass.

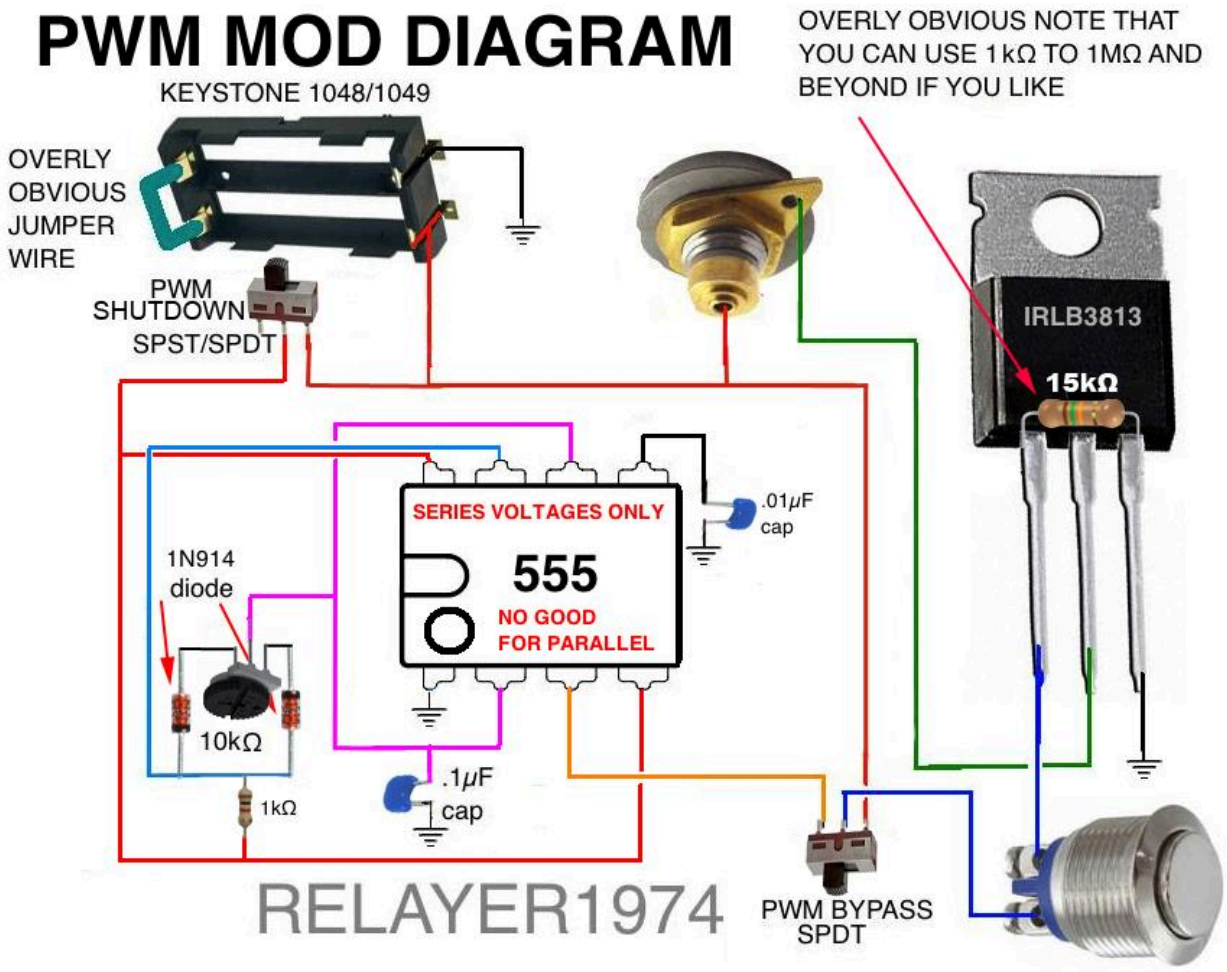
What is with the slide switches? Bypass and shutdown modes are fully optional, but shutdown is nice as a master off switch and to prevent draining the cells when not using the mod for long periods. If you can’t figure out how to remove them from the diagram, you aren’t ready to do so :)

SCROLL DOWN FOR DIAGRAMS

THIS DIAGRAM CAN BE USED WITH CMOS OR TTL (STANDARD) 555

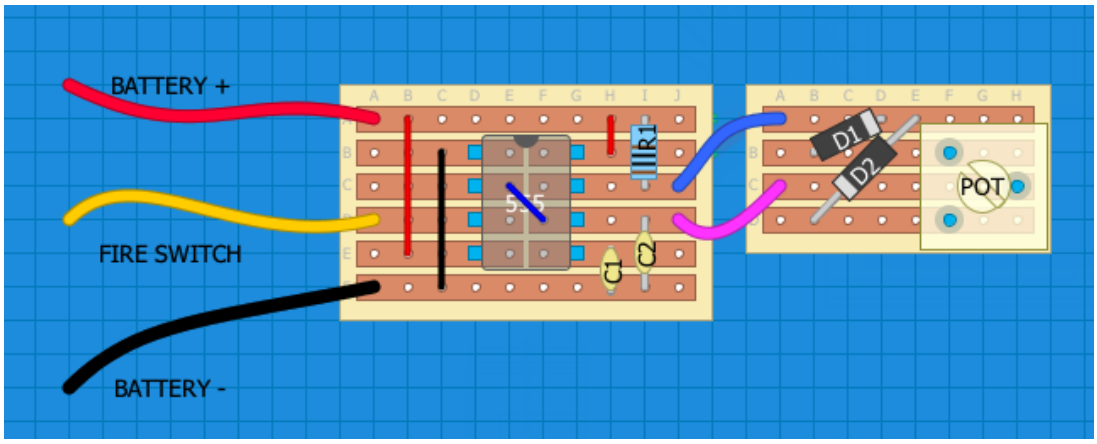


THIS DIAGRAM CAN ONLY BE USED WITH THE TTL 555

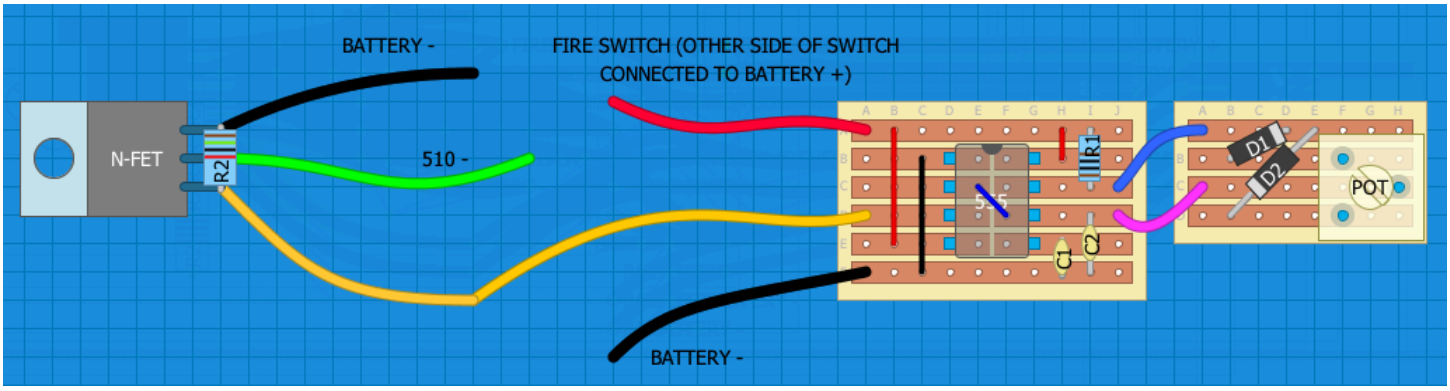


VARIOUS STRIPBOARD DIAGRAMS:

STANDARD PWM AS A DROP-IN MODIFICATION TO AN EXISTING MOSFET MOD



"NO IDLE DRAIN" CONFIGURATION STANDARD PWM



STRIPBOARD P-FET BUFFERED PWM WITHOUT SLIDE SWITCHES