



instructables

DIY Boost Converter || How to Step Up DC Voltage Efficiently



by GreatScottLab

In this project I will show you an efficient and common way how to step up DC voltages. I will also demonstrate how easy it can be to build a boost converter with the help of an ATtiny85. **Let's get started!**



Step 1: Watch the Video!

The video gives you all the information you need to create your own boost converter. The next steps just contain additional information for your convenience.

<https://youtu.be/QnUhjnbZ0T8>

Step 2: Order Your Components!

Here is a list of all the parts that you need with example sellers (affiliate links):

1x IRLZ44N MOSFET:

https://s.click.aliexpress.com/e/_dWhSrDI

1x 100μH Coil:

https://s.click.aliexpress.com/e/_dU3eskP

2x 47μF Capacitor:

https://s.click.aliexpress.com/e/_d7dOwRz

1x 100k■ Potentiometer:

https://s.click.aliexpress.com/e/_dX83GAF

1x 1N5819 Schottky Diode:

https://s.click.aliexpress.com/e/_dYR45Bh

2x 10k■, 1x 1k■, 1x 2.2k■, 1x 100■ Resistor:

https://s.click.aliexpress.com/e/_dTPpXjt

2x PCB Terminal:

https://s.click.aliexpress.com/e/_dYbstfZ

Perfboard: https://s.click.aliexpress.com/e/_dXx2Zv5

Ebay:

1x ATtiny85: <http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

1x IRLZ44N MOSFET:

<http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

1x 100μH Coil: <http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

2x 47μF Capacitor: <http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

Aliexpress:

1x ATtiny85: https://s.click.aliexpress.com/e/_dValID1

1x 100k■ Potentiometer:

<http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

1x 1N5819 Schottky Diode:

<http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

2x 10k■, 1x 1k■, 1x 2.2k■, 1x 100■ Resistor:

<http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

2x PCB Terminal: <http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

Perfboard: <http://rover.ebay.com/rover/1/711-53200-19255-0/1?...>

Amazon.de:

1x ATtiny85: <http://amzn.to/1E9ubfB>

1x IRLZ44N MOSFET: <http://amzn.to/1Osfnxn>

1x 100μH Coil: <http://amzn.to/1OsfxVz>

2x 47μF Capacitor: <http://amzn.to/1OsfIjE>

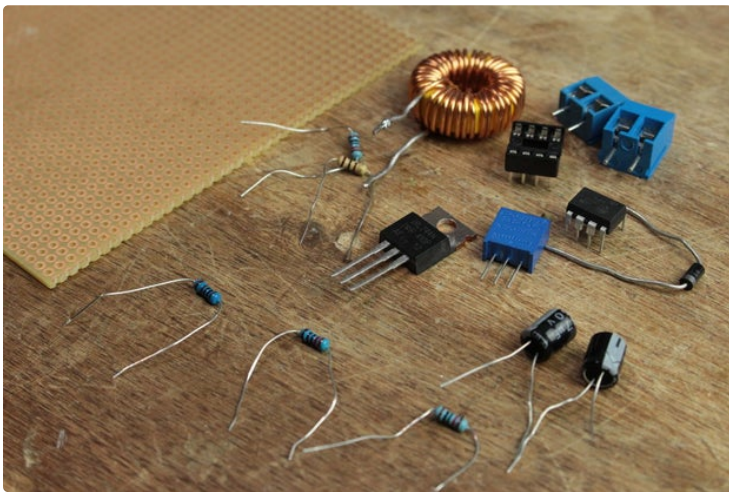
1x 100k■ Potentiometer: <http://amzn.to/1OsfBEN>

1x 1N5819 Schottky Diode: <http://amzn.to/1OsfwBc>

2x 10k■, 1x 1k■, 1x 2.2k■, 1x 100■ Resistor: <http://amzn.to/1E9uEhN>

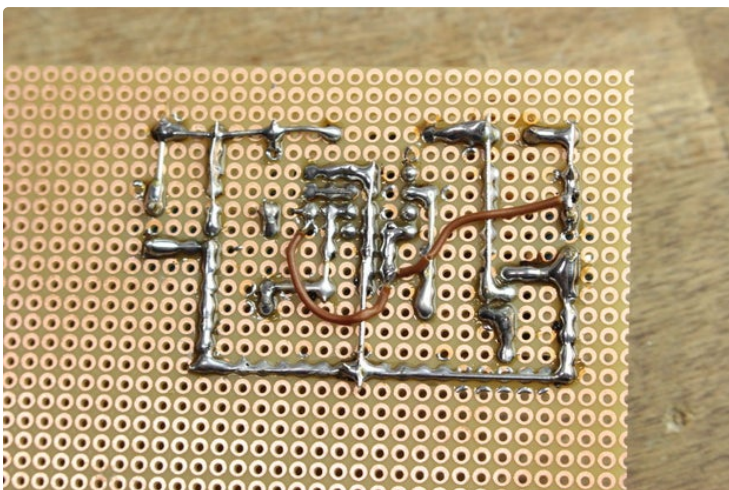
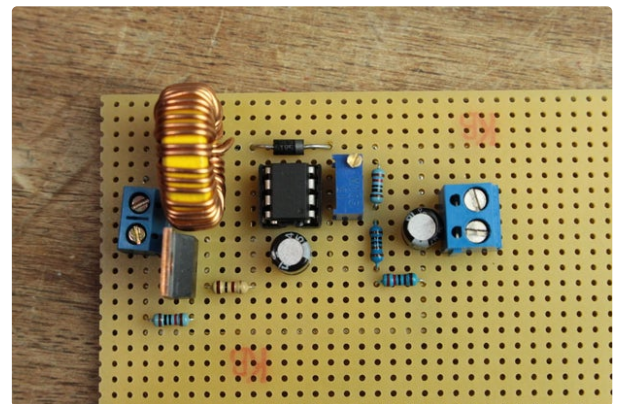
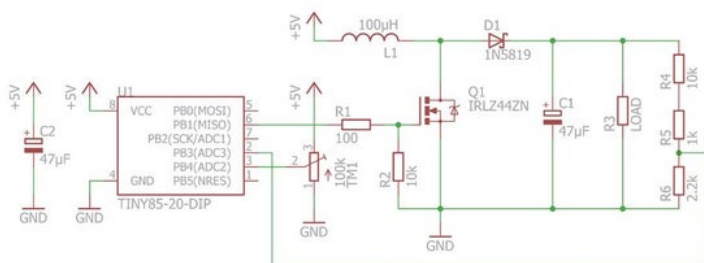
2x PCB Terminal: <http://amzn.to/1GzZAZw>

Perfboard: <http://amzn.to/1YAqPI8>



Step 3: Build the Circuit!

Here you can find the schematic for the project and reference pictures. The soldering process takes around 45 minutes if you know what you are doing.



Step 4: Upload the Code!

In order to upload the code to the ATtiny85 you can use an Arduino Uno. Here is an older video of mine in which I demonstrated how to do that:

//www.youtube.com/embed/9LjfkjwMqXI



<https://www.instructabl...>

Download

Step 5: Success!

You did it! You just created your own Boost Converter!

Google+ for news about upcoming projects and behind the scenes information:

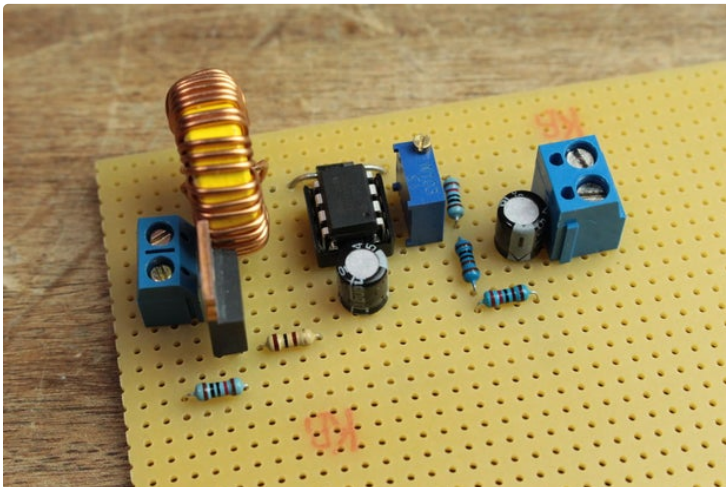
Feel free to check out my YouTube channel for more awesome projects:

<https://twitter.com/GreatScottLab>

<http://www.youtube.com/user/greatscottlab>

<https://www.facebook.com/greatscottlab>

You can also follow me on Facebook, Twitter and



I really enjoyed this project, It gave me such a great insight into the world of electronics because of all the videos Great Scott has made about this project. I was able to get my first experience with perf boards and PCB design thanks to this project!



Why on Earth would anyone want to go to the trouble and expense of building this boost converter (whose parts cannot be obtained for less than \$20) when a better quality module can be purchased for around \$3 ??? I can get SIX (6) ready-made modules for less than the cost of the parts!!!



This site is called "Instructables". Not "Just buy a premade board"



XD yeah. Thanks for giving us *Instructions!* :D



Well said - this project like most projects on Instructables are to inspire and relay how items are made. So on behalf of some of these negative comments a BIG THANK YOU from me :)



Where can I get as this alternative with the circuit diagram and component list



You can buy any Boost Converter for less than 3\$, but you won't understand how it works. This Boost Converter is build as a tutorial to understand it.



Diud you do shopping around? Here in RSA the one supplier's was for an I.C. so high that I could get the same make and type of I.C. and all the components from another plus a box and vero board !!!



The title of this website is "Instructables" which tends to suggest there ought to be some "instructions" ... that was my main quibble about this project ... the DEARTH of "instruction" (along with the lack of any clearly-stated purpose or introduction). Cost is a completely secondary issue (unless it's the cost of my time that's being wasted ... and I consider that always a primary concern).



so you really take more of your o so precious time to type out a comment like this? You are a confusing person. Why not just move on and leave the comments section for information or questions



I ALWAYS shop-around (I have been an inveterate shopper-arounder for over a half-century). That's how I know that there's NO WAY (no matter how much they claim it) that you can acquire the parts to built this boost converter for less-than the \$3 a ready-made module would cost (even if you have devices you can scavenge for parts ... and I have a warehouse full of them ... which I regularly scavenge for parts to build my projects) ... AND, that's not considering the outrageous cost you will pay in your time expended ... in actually finding/extracting the right parts, but also in the time spent fiddling-around trying to adjust the circuit to work with a part that's not an identical match to those specified. You may not consider your time as very valuable, but being an old codger with one-foot-in-the-grave-already, I find that every hour of my time grows in value day-by-day ... so, I'm not into wasting any of it needlessly. Besides, there are much easier (and cheaper) ways to "learn" this circuit ... worlds of online instructional materials about boost-converter circuits. And, yes, as I've already acknowledged, for me, the "thrill" of building a successful project is what has always been my primary motivation-and-reward for building electronic projects and kits ... and I agree with the point-of-view presented by many that there is no substitute for the efficacy of learning through actual "hands-on" building and experimentation ... BUT, I still hold to the opinion that trying to build such a project as the one described here (without any but the most scatter-brained and unclear directions) is a waste-of-time (even more so for a novice than for an old-hand like me) and MONEY ...

@ MickeyPop ... if you ACTUALLY believe your cost estimates are accurate (and I don't think you or anyone else here is that dumb), then you probably also believe that the Pentagon can buy a hammer for less than \$400, or Trump's whole line of BS ... ha ha ha ah ah aha ha ha!



mine can drive 4 amps almost all under \$20 drive around 80-300 miliAmps. - a few drive near 1 Amp - have not found any cheap that can drive that much

1 scrap toroid \$0
10 ft bell wire about 10 cents
1 salvage FET -- \$0
2 schotky diodes 87 cents/ each - \$1.74
3 junk caps -- \$0

a few spare resistors about 15 cents
vector board 54 cents worth
NET COST out of pocket -- \$2.53 - that's why



99-cents (FREE shipping) ... I bought 10 of them:

<http://www.ebay.com/itm/381544971857>

Much better, more capabilities/range = \$2.97 (plus modest shipping) ... I got 7 at this great price:

<http://www.ebay.com/itm/331727051544>



But using an 8 bit computer to regulate voltage ? Hard for anyone to maintain in your absence if and when it fails. You would need to supply spares. I don't mind people using op-amps instead of transistors, but I am against using Arduinos instead of 555 timers, say. Yes it is fun, but why drive in thumbtacks with sledgehammers ? Good effort though, people will replicate to see what tweaking can be done. Not enough younger people doing this anymore. My wife has a Masters, and has *never* used a soldering iron. Many people are no longer comfortable buying discrete components any more either. I was so happy to see Nixies in Tomorrowland ! Please do something with Nixies...



ya don't value education , and 'hands-on' learning?

Sad.



BuffS1; you miss the point.

this is to learn how they work. also not all of the \$3 modules meet any application and home made may sometimes be needed. -- only recently i needed an "isolated" supply to boost 8v to 14v.

no board could be found so i made mine. the point of instructables is teaching.

i say job well done.



a side note;

if you mount the filter cap (c1) the FET and Micro so ground paths between them are as short as possible you can often increase the efficiency by as much as 8-12 percent, though 6 percent is more likely on this simple circuit.

If your coil is a dumbbell type instead of toroid you will also reduce the EMI.

EE 50 years in electronics



>> If your coil is a dumbbell type instead of toroid you will also reduce the EMI.

Why?... Toroid is closed! Dumbbell (drum) is open...



dumbbell by their shape create a partial *Faraday* shield because of the way the ends couple back on each other in all directions, the best ones are the short wider relieving the ends closer together.

They do radiate some but less than the toroid. Toroids radiate 90 degrees to their center.

Dumbbells couple on themselves.

Because the iron is in the center on the dumbbell the field shape is different than with the hole in the toroid. The iron in the center acts kind of like an absorber or like the "Keeper bar" on a horseshoe magnet.

ie; When you take the Keeper off a magnet it feels far stronger than when the Keeper is on the magnet. The magnetic field acts similarly here.



EXACTLY!!!

The point of this entire site, is to learn by application!

It's not about "what is cheaper"

It's about knowledge.

And knowledge, is something no one can take from you...



Great project, I am tremendously fascinated by the DC-DC converter circuit. I've seen journal papers on extracting energy from voltages as low as 0.006V to an unloaded output of 1V [i.e. the one found here <http://cap.ee.ic.ac.uk/~pdm97/powermems/2009/pdfs/...>

not very practical but I still love the idea!]. I have been working on how to make a circuit to collect energy [generally solar] gradually and store it in a large container to power a much larger circuit for a few moments every so often as an art project.

This looks like it only uses 3 of the 6 pins from the ATiny85 one or two to sense and the other as a pulse driver. This puts it in the control pin count range of the ATiny10 (\$0.45 at the time I bought it) and if you happen to find programming in assembly in a 1Kbyte environment fun. I find it perversely fun to program something that can fit comfortably on an air-gun BB but has similar processing specs to the Atari2600's 6502.



We build things to learn, to improve on our existing skills (and pick up new ones), to get ideas for new projects. I have been enjoying electronics this way for fifty years.

I don't care what your level of expertise may be, with a 'buy-it-don't-build-it' attitude you will never approach the depth of knowledge of a veteran maker in this or any other craft.

You 'Do-It-Yourself' - for yourself!



For the fun of making something, maybe?



Learning exercise? Flexibility? Also, you could make this for about \$3 if you shop around instead of amazon/ebay. The inductor is the most expensive part, and you have to supply your own for 90% of boost converters out there. You can scrounge them from dead PSUs. Attiny is ~\$1, mosfet is about the same, and I have the rest of the stuff lying at my makerspace. It would cost me about \$3, total.

Since I have all of these components in my stock, I could whip this up if I needed a boost controller on short notice, without having to order anything.



Because we are on a site for makers, not buyers. I have these components sitting around, mostly salvaged for free. The only thing I'm missing is the ATtiny85. I could put this together for the cost of a "quality module" and have the satisfaction that I did it myself.

By your logic, there would be next to no need to make anything because the economics of volume make things cheaper than what you can make. I make things because I enjoy the process, not because I can make it cheaper.



I actually made this project three times, first on a breadboard then a perf board, and finally, on a PCB I designed and ordered from JLCpcb. My boost converter has the same components as listed in the project mats list with a few exceptions: I have a 220 uH inductor, and Arduino nano to replace the tiny, and a 1uF capacitor on the 5v/gnd of the Arduino. This project was great at expanding my view of circuit design as this project was my first experience with perf and PCB boards. Thanks to Great Scott for publishing this awesome project for us!
:D



What is the switching frequency supposed to be? I'm measuring about 32khz driving the gate of the mosfet. That seems a little slow?



Maximum amp? I just want build a 5 amp boost buck dc-dc converter using ur circuit and lm317 (added some thing for 5amps.....) Thx

(Worry for bad English because I am from Taiwan)



Out of TOPIC. Scott,(or anyone else) can you able to help me? I just want to control 5v relay with D1 mini (esp8266) so when I press the button I need to relay turn off after 1-2 seconds.(I am using Blynk app to control my D1 mini) Sometimes when I constantly press the button D1 mini disconnects from internet and relay stays ON until resets and connects back. How I can solve this problem thank you in advance.



What is the maximum output current (I_{out} max) of this project thanks.



Hello! You can control the output voltage with the potentiometer, my question is: can you use a digital potentiometer instead so that you're always working on a constant voltage? If so, how can you program it?

I'm building a MPPT charge controller using a boost converter but I need the charge controller to controll itself, can the attiny85 or arduino UNO do that?

I'm sorry but I'm really a beginner in electronics.



Thanks for sharing your idea. I use it to charge my 12V lead-acid battery from a (beefy) 5V power supply.

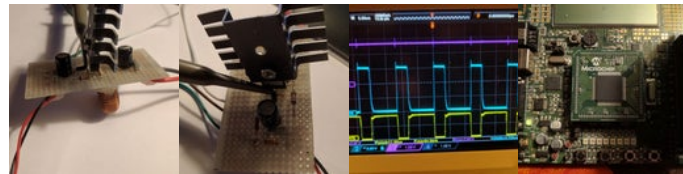
I didn't have an ATtiny lying around, but there was a PIC24F at hand.

It seemed that the IRLZ44 mosfet did not switch nicely at 200+kHz, so I lowered the frequency to about 80~120kHz and used a big coil from an old PC power supply. I guess the coil is around 1mH.

The switching speed problem with the mosfet could be due to that no driver circuit was used, the gate was driven directly from the PIC (at 3.3V only).

A switching frequency of around 100kHz works fine now.

So, now I can charge and top up my battery to keep it in top shape:-)



Those capacitors looks like they're at the end of their life, I think you should change them, just to be safe.



Did you build this on a solderless breadboard first?



Hello friend,I don't get the ATtiny85, can I do the converter using only Arduino UNO?

Reponse me please



Yes you can. He used the Tiny85 is because you only need 3 I/O pins, so the Uno is huge overkill. Plus the uno can cost anywhere from 3x to 6x more than a Tiny85.



Excuse me, I am sorry guys, I need a favor..

I would like to ask u something about the circuit above. I have a power supply dc voltage with 0,3 volt as an output, and I want to step up it become 12 volt dc, can I use u'r circuit above?

thanks u so much for u'r answer :)



Yes, if correctly fine tuned. But when you raise the voltage, the current drops.



Can't download the pdf



What changes would need to be made in order to boost 12V rather than 5V?

Put a 7805 regulator in series with the ATTINY



Here's the code for Arduino UNO or any other Arduino with ATmega328 chip:

```
int pwm = 1;
int potinput = A2;
int feedbackinput = A3;
int potinputval;
int feedbackinputval;
int pwmval;
void setup() {
  TCCR0B = TCCR0B & 0b11111000 | 0x01;
  pinMode(pwm, OUTPUT);
  pinMode(potinput, INPUT);
  pinMode(feedbackinput, INPUT);
  digitalWrite(pwm, LOW);
  pwmval = 0;
}
void loop() {
  potinputval = analogRead(potinput);
  potinputval = map(potinputval, 1023, 0, 255, 0);
  feedbackinputval = analogRead(feedbackinput);
  feedbackinputval = map(feedbackinputval, 1023, 0, 255, 0);
  while (potinputval > feedbackinputval) {
    if (pwmval == 230) {
      potinputval = analogRead(potinput);
      potinputval = map(potinputval, 1023, 0, 255, 0);
      feedbackinputval = analogRead(feedbackinput);
      feedbackinputval = map(feedbackinputval, 1023, 0, 255, 0);
    }
    else {
      pwmval = pwmval + 1;
      analogWrite(pwm, pwmval);
      potinputval = analogRead(potinput);
      potinputval = map(potinputval, 1023, 0, 255, 0);
      feedbackinputval = analogRead(feedbackinput);
      feedbackinputval = map(feedbackinputval, 1023, 0, 255, 0);
    }
  }
  while (potinputval < feedbackinputval) {
```

```

if (pwmval == 0) {
  potinputval = analogRead(potinput);
  potinputval = map(potinputval, 1023, 0, 255, 0);
  feedbackinputval = analogRead(feedbackinput);
  feedbackinputval = map(feedbackinputval, 1023, 0, 255, 0);
}
else {
  pwmval = pwmval - 1;
  analogWrite(pwm, pwmval);
  potinputval = analogRead(potinput);
  potinputval = map(potinputval, 1023, 0, 255, 0);
  feedbackinputval = analogRead(feedbackinput);
  feedbackinputval = map(feedbackinputval, 1023, 0, 255, 0);
}
}
}
}

```



did u performed using this code..?



One question tho. Which pin is the pwm output in ur code ? Pin1 of the arduino ?



Oh, sorry. Pin 1 isn't a PWM pin. Please change it to 5/6. (Pin 5 and 6 can provide higher PWM frequency)



Yeah i was wondering about that... thx for the correction



Why do you say "if (pwmval == 230)" ? What's so special about number 230?



Sorry, this code is not mine. It's written by GreatScott. I just changed it a little bit to make it compatible with ATmega328P.



Its too big for my attiny 13 :(



This code is for ATmega328, not ATtiny13. If you want to use it on ATtiny13, you'll have to study its datasheet.