

How to decide, choose and make power supply for your project.

Purpose: This article is intended for beginners whose project has multilevel power supply for different purposes. It will cover DC to DC step down conversion. For better understanding, basic electricity knowledge is needed (such as what is resistor, capacitor and so on) At the end of this tutorial reader should be able to choose, design and adjust his power supply module.

What voltage levels do I need?

When choosing voltage level of power supply for any module of my project I am always thinking of safety of my module. I had some bad experience with powering up my AVR Butterfly with the maximum allowed voltage level 5V. Nothing to say, everything worked ok, until I did one mistake. During measurements with oscilloscope, by accident, I short-circuited two pins on PORTD, one of this pin was High and second was Low, so after this accident my Butterfly just started to behave unpredictable on IO pins. Since that I am always using power supply voltage level closer to the lowest allowed. In case of AVR Butterfly I keep it at 3,3V DC. So in case of eventual overloads it will resist longer. If you are using in your project different additional elements such as DC motors, servo motors, sensors, lights and so on controlled by your MCU, you will need different Voltage outputs on your power supply, of course you can use separate batteries for each module, but better to have one big battery and just step down voltage at the required level. Isn't it?

Let's see situation when we are building a robot with 1x MCU(3,3V), 2x proximity sensors(5V), 2x DC motors(12V), 1xRF modem (9V). Power supply in this case will be battery with relatively high voltage level(I am using 12,6V, 3 cells Li-Ion battery). How to divide 12 V into needed levels? We cannot use Voltage divider(potential divider) because of not linear resistance of the load. So we have two solutions left:

1. To buy Adjustable Step Down Switching Regulator for the price between 10 and 15\$, depending on the output power. For example superdroidrobots offers them in the link below:

<http://www.superdroidrobots.com/shop/item.aspx?itemid=824>

Advantages, ready to use, 3-pin module, with pretty big output power and big adjustable scale of Voltage levels.

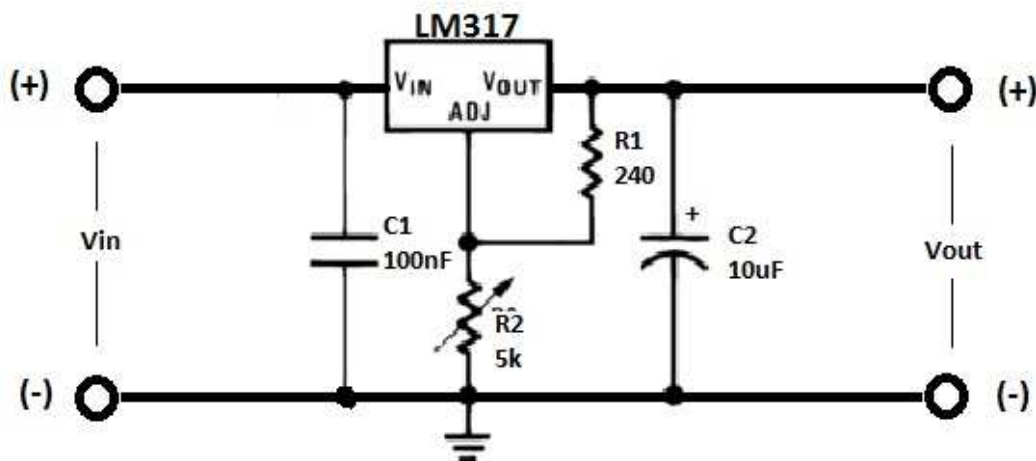
2. To make it by yourself with a budget not bigger then 3 \$. Advantages: first of all satisfaction, budget and the same features and parameters like ready module can offer.

Using 3-Terminal Adjustable Regulator LM117/LM317A/LM317

So you decided to take second solution. You will need following components:

1. LM317.....1piece(≈1.5\$)
2. 0.25W resistor 220-240 Ohm.....1piece(≈0.12\$)
3. Low power potentiometer 5kOhm.....1piece(≈0.20\$)
4. Ceramic capacitor 100nF.....1 piece(≈0.30\$)
5. Electrolytic capacitor $\geq 10\mu\text{F}$1 piece(≈0.30\$)

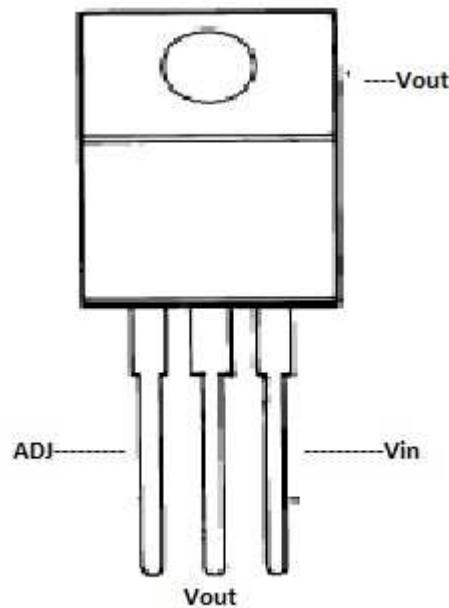
All those components for making the following scheme:



LM317 type can be with any ending(extension) depending on what output power you need.

LM317 extension differs depending on the body shape and materials, working temperature and maximum current which can resist element. I recommend

LM317AT from National Semiconductor with Plastic Package and place for heat sink. It has good temperature range $-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$ and output current of 1,5A(without heat sink). It allows regulation of output Voltage from 3V up to 40V.



Detailed description of parameters you will easily find in its datasheet.

Resistors. R1 240ohm resistor and R2 5kOhm potentiometer(adjustable resistor) can be at 0.25W or smallest because this two transistors are used to make Voltage Divider to give reference voltage to LM317. R2- is adjustable, so adjusting this resistor you will adjust reference voltage given on LM317 and in this way Output voltage is adjusted.

Capacitors. C1-100nF – ceramic capacitor. Is intended for filtering eventual high frequencies. This capacitor is not compulsory element for power supplies with small Output voltage. But when you project has high voltage output C1 is indispensable, because amplification features of LM317. C1- should be made of at least ceramic material or better. Electrolytic capacitor has much worse permeability for high frequencies. C2- it can be from 10uF and bigger, electrolytic capacitor with max voltage depending on maximum output voltage of our power supply.

Soldering. Assembling all elements in together can be done on the universal PCB soldering board. Just to follow upper mentioned scheme. Do not forget to mount R2 5kOhn resistor in the place where you will have easy access to adjust it.

Below is a picture of my amateur assembly of a power supply where I am using both, LM317 and ready solution from <http://superdroidrobots.com/>

