Auntie Spark's Guide to DC Voltage Regulators

Spring 2015

Many circuits and electronic devices are designed to work with standard power supply levels such as 12V, 5V and 3.3V. In many cases, different parts of the circuit may require different power levels. DC voltage regulators provide fixed and stable voltage levels, and they can be quite useful in power design and management. Most regulators come in compact IC package such as the 7805 in a TO-220 package shown in Fig.1, and they can be incorporated in PCB layouts.

Fig. 1 Basic 7805 voltage regulators in the TO-220 package

Choose the right DC voltage regulators:

There are two categories of voltage regulators, either linear regulators or switching regulators depending on whether the internal transistors operate at linear range or require switching on and off.

- Linear regulators provide cleaner output voltage and quick response time, but are generally much less efficient (<50%) than switching regulators (>95%). At low power levels, linear regulars are much cheaper and simpler to use, and they are more widely used. Because linear regulators simply dissipate the extra power through heat, proper thermal management (e.g. heat sink) should be considered if necessary. Most E80 circuits are low power circuits, and can use these simple linear regulators.
- In high power applications or in applications where power efficiency is more critical, switching regulators provide a better solution and an overall cheaper design when considering savings in battery lifetime and heat management. In addition, switching regulators can be used to generate higher output voltage levels than the supplied voltage, which is not possible with linear regulators. Switching regulators sometimes are referred to as Buck (step-down) or Boost (step-up) regulators. Switching regulators typically are much more complex, and the ICs include high speed switching signals and require more external components to set up.
- In addition to the voltages and efficiency considerations, load current is also important. The driving power of the regulator must be sufficient for the application. The operating voltage and current indicates the power and thermal management needs. These considerations also lead to proper choice of IC sizes and packages. For example, the TO-220 package shown is a relatively large package that handles a fair amount of power. It allows for through-hole mounting, and easier for breadboarding and attachment of a simple heat sink. If

space is an issue in the PCB design, then smaller surface mount packages should be chosen, and more careful thermal management should be designed.

- Some linear voltage regulators, such as LM 317 and LM350, allow for variable output voltage levels. Simple setup with external adjustable resistors can be used to control the output voltage.

  We list a few commonly used linear voltage regulators for your reference:

Part Number	LM7805	LM7812	LM317	LM337	LM350
Output voltage	Fixed 5V	Fixed 12V	Adjustable 1.2-37V	Adjustable –1.2 to –37V	Adjustable 1.2-33V
Output current	Up to 1A	Up to 1A	1.5A	1.5A	3A

Setting up DC linear voltage regulator:

The following circuit shows a typical set up for a linear regulator.

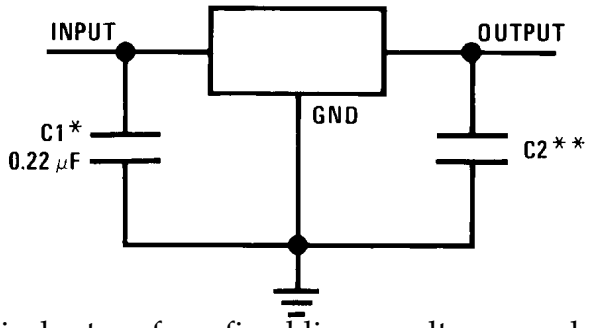

Fig.2 Typical set up for a fixed linear voltage regulator[7]

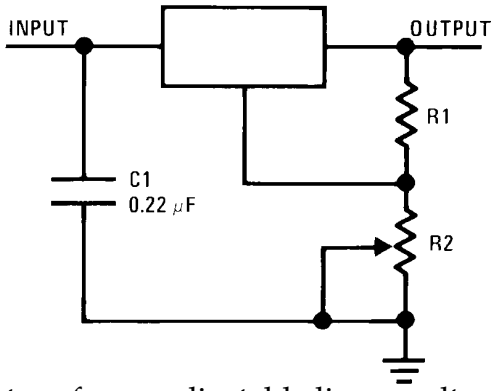

Fig.3 Typical set up for an adjustable linear voltage regulator [7]

- Check the pin layout and follow the recommendations in the data sheet.
- Make sure to add the 0.22μF or 0.33μF capacitor at the input and the 0.1μF capacitor at the output. Adding a larger (10μF) capacitor in parallel on the output also helps but is less critical. These capacitors are used to filter out noise on the power supply line. If you don't add them, your circuit will probably oscillate,

and unless you look at the power line on an oscilloscope, you won't be able to figure out what's going wrong.

- Evaluate the load current requirement, and make sure it is within the range. Estimate the power needs and see if a heat sink is necessary.

References:

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3. *LM317 data sheet:* www.fairchildsemi.com/ds/LM/**LM317**.pdf
4. Linear regulators in portal applications: http://www.maximintegrated.com/app-notes/index.mvp/id/751
5. *Thermal consideration in linear regulator:* www.ti.com/lit/an/slva118a/slva118a.pdf
6. An example of switching regulator: http://www.vicorpower.com/promotions/AC_to_PoL/Cool-Power/ZVS_Buck_Regulator/lp.php?utm_source=Google&utm_medium=AdWordsENU&utm_campaign=ZVSBuckRegulator&pi_ad_id=26562425667&gclid=CK6Tm9-P0bsCFWRk7AodYi8AUw
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