

Guide to Constant Current Power Supplies

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In the experiment conducted during the Hands-On session on turbulence, we used a constant current power supply. This is different from your usual DC power supply (e.g., cell phone or laptop AC adapters). Regular power supplies operate in such a way that they will supply whatever current is needed to maintain the voltage across the load at a fixed value. On the other hand, constant current supplies adjust their output voltage so that the output current is fixed independent of the load.

Our particular choice of constant current supply is based on the LM317 Adjustable Regulator from National Semiconductor Corporation. The LM317 has 3 terminals which are called the input terminal (V_{in}), the output voltage terminal (V_{out}) and the adjustment terminal (ADJ). On the TO-220 package (many other common electronics packages are also available) these are arranged as shown in **Figure 1**.

While the inner workings of the LM317 are fairly complicated, its basic operation is as follows: The chip is powered by a voltage applied to the input terminal (in our case, we used a 15V power supply from an old laptop). The chip then does whatever it takes to establish a voltage difference of 1.25 volts between the output terminal and the adjustment terminal. The adjustment terminal has high impedance so that very little current is allowed to flow into it, as long as there is an easier way for it to get to ground.

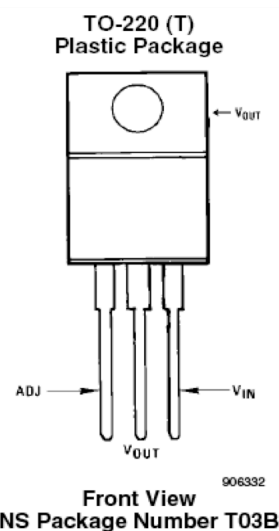


Figure 1. Pinout for LM317

We can use this to our advantage as shown in **Figure 2**. By placing a resistor between the output and adjustment terminals, we will drive a current through the resistor given by $I = 1.25V/R$, where R is the resistance of the resistor. If we now create a path for the current to flow to ground that has lower impedance than the adjustment terminal, the current will take this path. Notice that this current is independent of the load (at least as long as the impedance of the load is much smaller than the impedance of the adjustment terminal). If we now replace the resistor with a variable resistor or potentiometer (in our case we used a 200 Ohm variable resistor), we will have constructed a power supply where we can control the output current directly independent of the load.

50mA Constant Current Battery Charger

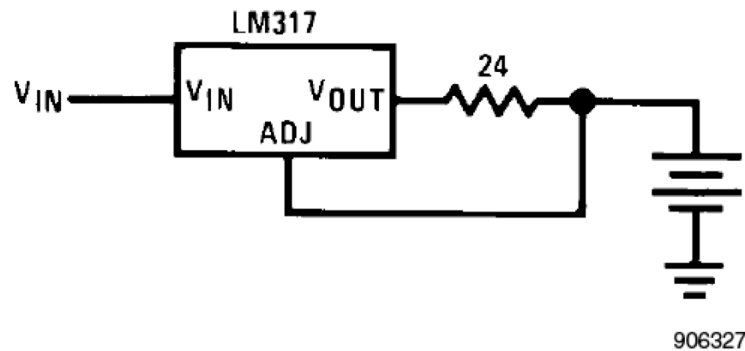


Figure 2. Constant Current Power Supply Schematic. In our session, we replaced the fixed resistor with an adjustable resistor and have replaced the battery with a generic load (e.g., our electrolyte or our LED arrays).

Using a constant current supply was convenient in our experiment because the forcing of the system is proportional to the current making this the natural choice of control parameter. If, on the other hand, we had used a constant voltage supply, the amount of current driven into the electrolyte would depend on the fine details of the electrolyte solution (e.g., salt concentration or temperature). The constant current supply lets us adjust the current independent of the details of our electrolyte.

Constant current supplies are useful for many other purposes. In our session, we also used them to power arrays of LEDs that we used for illumination. Powering the LEDs this way is useful for a couple of reasons. First, it makes it very simple to adjust the intensity of the light. Larger current, brighter lighting. Smaller current, dimmer lighting. Second, because they are being driven by DC, the LEDs will not flicker, a fact that is convenient when we are taking many images per second. If we had powered the LEDs with AC, the camera would detect variations in illumination as the current varied.

For more information on the LM317 and other application ideas, see the LM317 datasheet.