Better Accuracy from the LM317

Based on idea from
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Voltage regulators have been indispensable in modern electronic circuits for several decades. They are available in many types and sizes, with either fixed or adjustable output voltages.
One of the oldest voltage regulators still in production is the LM317, which was introduced back in 1971 by National Semiconductor. While the present-day implementations of the LM317 are likely to have a modified version of the original chip design, the characteristics, pin-out and physical dimensions continue to remain the same.
The output voltage of the LM317 is easily set with the aid of two resistors connected to the Adjust pin (**Figure 1**). The input voltage may go up to a maximum of 40 V and the IC can deliver more than 2 amps, provided that the difference between the input and output voltages is less than 15 V.

With the LM317 it is possible to set the output voltage very accurately, provided you first take the effort to measure the internal reference voltage of the IC. This will be, depending on the manufacturer, between 1.2 and 1.3 V. To measure the actual reference voltage the LM317 to be used has to be plugged into a breadboard first, according the schematic of **Figure 2**. R1 may have a value between 240 and 470 Ω. Connect a voltage between 3 and 10 V to the input (in any case more than 3 V, the minimal voltage differential between input and output to ensure that the LM317 operates properly). Now measure the voltage at the output of the regulator using a multimeter. This is the internal reference voltage. The author has measured, among others, the following values with types from various manufacturers: ST317: 1.249 V, UA317: 1.275 V, SSS317: 1.231 V.

In addition, you have to take into account that a current of about 50 µA will be sourced from the Adjust pin and this will therefore also flow through resistor R2 of the voltage divider in **Figure 1**. This value too can differ from one manufacturer to another, so check the datasheet of the relevant manufacturer.

When we take all this into account, we can calculate the component values for the desired output voltage using the following formulas:

$$R2_{theoretical} = (U_{out} / U_{ref} - 1) \times R1$$
$$R2_{adjust} = (U_{out} - U_{ref}) / I_{adjust}$$
$$R2_{tot} = R2_{theoretical} \times R2_{adjust} / (R2_{theoretical} + R2_{adjust})$$

Of course, you could use a trimpot for R2 and adjust it until the desired output voltage has been obtained, but using this calculation you can mount the correct fixed resistor on the circuit board right away. This same calculation can also be used with the negative version, the LM337.

All the calculations here assume that the operating temperature of the IC is reasonably constant. Both U_{ref} and I_{adjust} drift somewhat with large changes in temperature, while the output voltage also varies a little with different load currents.

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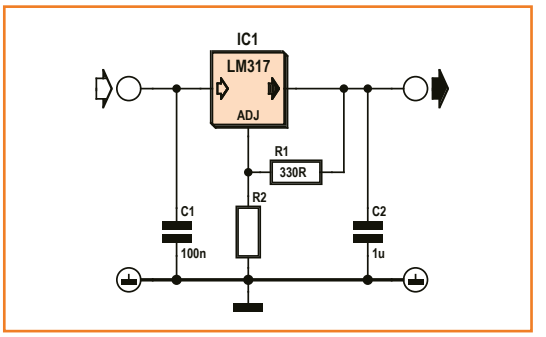

Figure 1.
The standard application circuit for the LM317 voltage regulator.

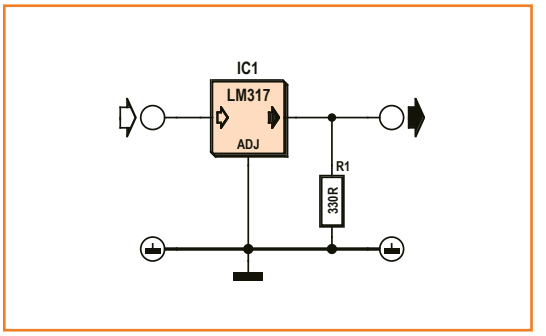

Figure 2.
By connecting the Adjust pin to ground we can measure the internal reference voltage at the output.