RoeTest – Computer Tube Tester / Tube Measuring System

(c) - Helmut Weigl   www.roehrentest.de

Voltage Regulators: - revised 30.09.2014

The construction manual requires precision voltage regulators LT 1086-x. In the following there is an explanation why these expensive precision voltage regulators are used.

The A/D converters within the PIC18F4523 controller have a resolution of 12 bit. This corresponds to 4096 steps. At 5V reference voltage this relates to a resolution of circa 0.0012V/per step. The reference voltage must be very stable, otherwise the measured values from the A/D converter would change if the reference voltage varies.

The PIC controller has 8 A/D converter inputs. These inputs can only be fully used when resigning the external reference. So the supply has to be chosen as reference voltage (the D/A converter I^2C-components also use the 5V supply as reference).

For this reason the 5V power supply must be highly stable. The exact absolute value does not matter but solely the stability of the supply. Simple 7805 voltage regulators do not meet the requirements. As input voltage and load current are about constant there is also no concern about the regulation characteristics. Relevant is the temperature drift. That must be kept as low as possible.

There are 2 starting points:
1. Keep temperature changes low:

As the RoeTest normally operates at room temperature (15-25°C) the ambient temperature has only a small effect on the temperature stability.

But after switching on the voltage regulator will warm up and the output voltage will change over time. The degree of warming depends on the power dissipation and the cooling. To keep warming up small a heat sink is needed as well as a low difference between input and output voltage (so called drop out voltage). The latter can only be achieved using a Lo-Drop voltage regulator. One has to take into account that a reserve is needed for fluctuations of the mains voltage.

2. Use a voltage regulator with low temperature coefficient:
Standard 78xx-voltage regulators have a TC of 100ppm (=0.01% per °C). Assume a lowest ambient temperature of 10°C and a highest chip temperature of – lets say 40°C – (the heat sink temperature will be lower) there is a temperature difference of 30°C.
30° x 0.01% = 0.3% voltage change (at 5V: 0.015V). This is too inaccurate. The measured values would change too much when the device is warming up. Many will object that 0.3% is far below the tolerance limits of the tubes. But the following has to be taken into account:
When the reference voltage changes, all other voltages (Anode-, G1-, G2-,G3-,Heater voltage) change, also all measurements change. The error can be additive or in case of the G1-voltage (control of the tube) be multiplicative.

For this reason a precision voltage regulator, the LT 1086, is used. The output voltage is much more stable and more independent of temperature changes. The data sheet states 0.5%.
But that would be much too much and is specified over the full temperature range from 0-150°C.

The graphics for 'temperature stability' in the data sheet shows a change of only circa 0.2% in the range from 10-40°C. Still a relative large value.

I did not solely rely on the data sheets but also did practical testing. For that purpose I built a regulated voltage supply with the standard 7805 as well as with the LT 1086. Then I measured the voltages over time after switching on. Further more I warmed up the voltage regulators using a hair dryer and let them cool down again. The LT1086 did not show significant variations (only minimal output voltage change) but with the 7805 there were remarkable changes of the output voltage. The practical behavior of the voltage regulators was much more different than one would guess from the data sheets!

I strongly recommend using the precision voltage regulators (additional note: 78xx are not pin compatible with the LT1086x!).

A stable power supply is also necessary for the operation of the simple high voltage OP-Amps. For this reason I also used this precision regulator for the +/-12V power supply.

Nevertheless a small drift will always be there (other components also have drift, resistors, OP-Amps...). Therefore as with all other measuring devices the following applies:

a) The highest accuracy is reached after achievement of the working temperature
b) Calibrate regularly (at working temperature)