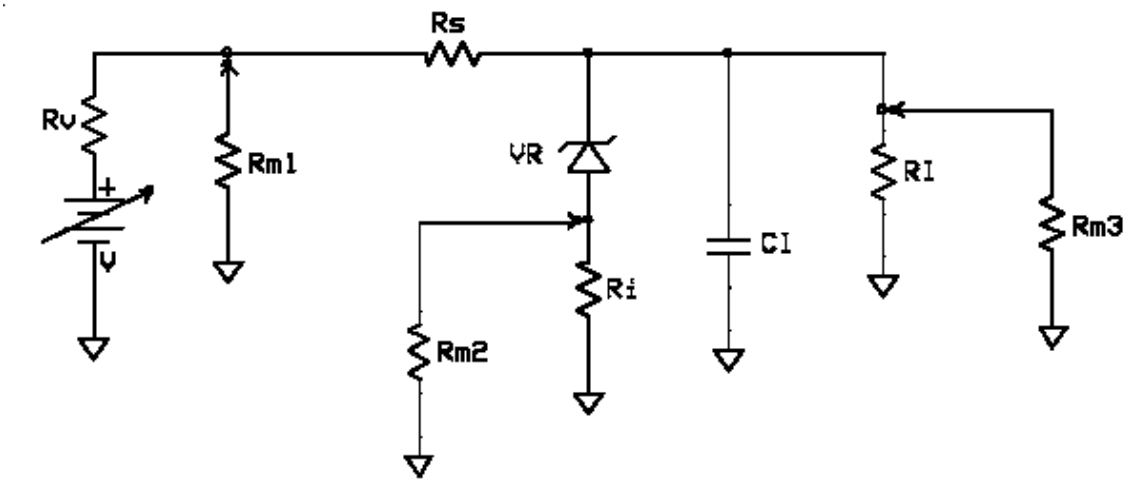
Testing and using the Codatron II ä shunt regulator



In testing any device, always draw a complete schematic of the test circuit and assume as little as possible.

Note that all resistors have a voltage rating and a power rating, are not linear and have a temperature coefficient that is also not linear. In most cases, these non-linearities can be ignored, and temperature coefficients are nominally low enough to also be ignored. Just make sure that these non-ideal characteristics are not forgotten.

Refer to the schematic above and note that the supply voltage V can be adjusted and has its own internal resistance Rv which may depend on the voltage setting and current load.

For testing and operation of a shunt regulator, a series dropping resistor Rs and a load resistor Rl must be used. Note that the total series resistance is Rv + Rs.

It is good practice to use test values that are the same as in a final circuit.

Note that the use of a meter to measure V will not measure the exact value of V due to the voltage drop inside the supply due to Rv. Also note that the meter will draw current depending on its internal resistance. Most Digital Volt Meters (DVMs) have an internal resistance of 10 megohms and their rating makes them unsuitable for the direct measurement of voltages greater than 1000 volts.

Normally, a current monitoring resistor Ri is added in series to the shunt regulator VR. This has the disadvantage of decreased regulation, so a low value of 10K (ten kilo ohms) is used which will develop 600 millivolts at a nominal regulating current of 60 microamperes.

Use of a DVM (Rm2) to measure that voltage will have very little effect on the actual voltage, as 10 megohms put in parallel with 10K will change the resistance only 0.1% which can be safely ignored.

Use of capacitor Cl is optional and should be used in a test fixture if the final circuit uses one. Again, values should be the same.

Measuring the load voltage with a meter Rm3 will increase the total load; again a DVM is unsuitable for direct measurement of voltages over 1000V.

For testing purposes, Rm1 and Rm3 should not be changed during any measurements such as line regulation (changes in V), load regulation (changes in Rl) or temperature regulation (changes in the temperature environment).

For temperature testing, it is a good practice to start with only the shut regulator in the temperature chamber; that way any temperature sensitivities of the resistors is not a part of what one measures.

Furthermore, it is good practice to change only one variable at a time. For example, change only temperature, then change only the line voltage V, then change only the load Rl.

Take as many data points as you need for each setting; say change temperature for a given voltage and load setting and then change the voltage setting and take measurements for the same temperatures, and so on. Even time can be a variable: say one subjects the regulator to a step in voltage or a step in temperature, making measurements of the output voltage at regular intervals.

Use a good spreadsheet program and enter the data, and use the graphing capabilities for two dimensional or three dimensional graphing.

Measuring high voltages means that one must use a special high voltage resistor in series with either a DVM or a VOM. That resistor must be at least as accurate as the measurement requires, and the meter inaccuracy will always add to the total inaccuracy.

One percent high voltage resistors rated to 20KV and 5,000 megohms are available via DigiKey or Mouser (Ohmite Mini-Mox, Maxi-Mox and Slim-Mox).

For better accuracy, one must make their own using 0.05 percent resistors, but hundreds may be needed as 470K is the maximum value available (DigiKey: Susumu 0805 SMD chip resistors rated at 100V each). Alternately, one could use 0.1 percent resistors where Susumu 0805 SMD chip resistors are available to 1 megohm at 100V or use IRC RC55 0.1 percent leaded resistors from Mouser which go to 1 megohm and apparently are rated at 100V each.