Cs Detector Circuit Updates - Draft

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Introduction

The cesium detector consists of three components: a tungsten filament, an ion repeller and an ion collector. The purpose of the detector's external circuitry is to heat the filament, to bias the filament and repeller, and to measure current from the collector.

This report details the current plan for external circuitry's layout. When the development of this circuitry is completed, the information in this paper will be incorporated into a more thorough report on the cesium detector.

External Circuitry

There are three key components to the external circuitry: a variac connected to a transformer, two small power supplies and an ammeter. The variac and transformer act as a voltage source in order to supply current to the filament. The power supplies control the voltages of the filament and repeller. The ammeter measures current readout and will be placed either at location X or location Y. A diagram of this setup is shown below. These three components are discussed in more detail later in this paper.

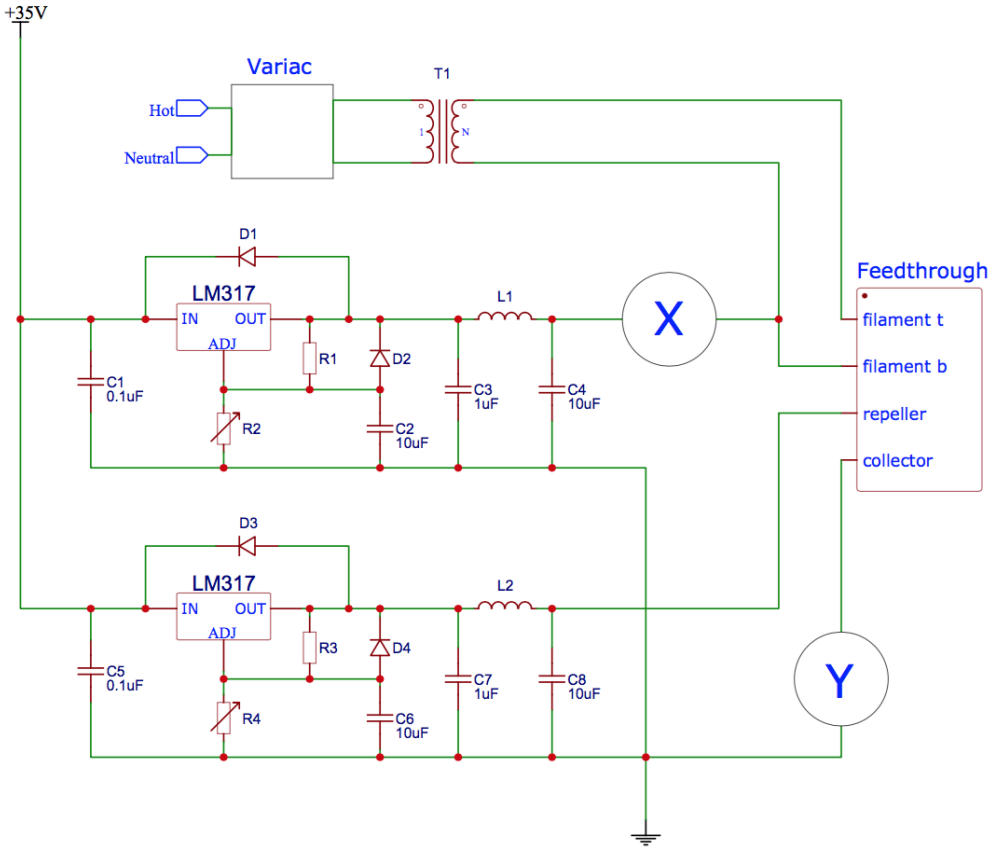


Figure 1: Proposed circuit for controlling the Cs detector. A Keithly multimeter can be placed at position X or position Y for current readout.

Variac and Transformer

A variac and step down transformer are used to control the current through the filament. Controlling the output voltage from the variac allows control over the filament's current. The variac is not galvanically isolated, and as such it can expose the circuitry make the circuitry vulnerable to unwanted stray currents. Attaching a transformer to the variac provides galvanic isolation to the rest of the circuit. This allows the circuit to carry signals without also carrying stray current. The variac controls the input voltage to the transformer's primary and a lower voltage is induced on the secondary.

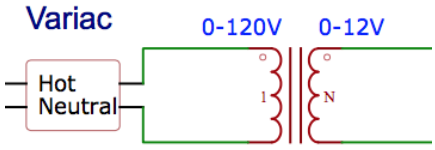
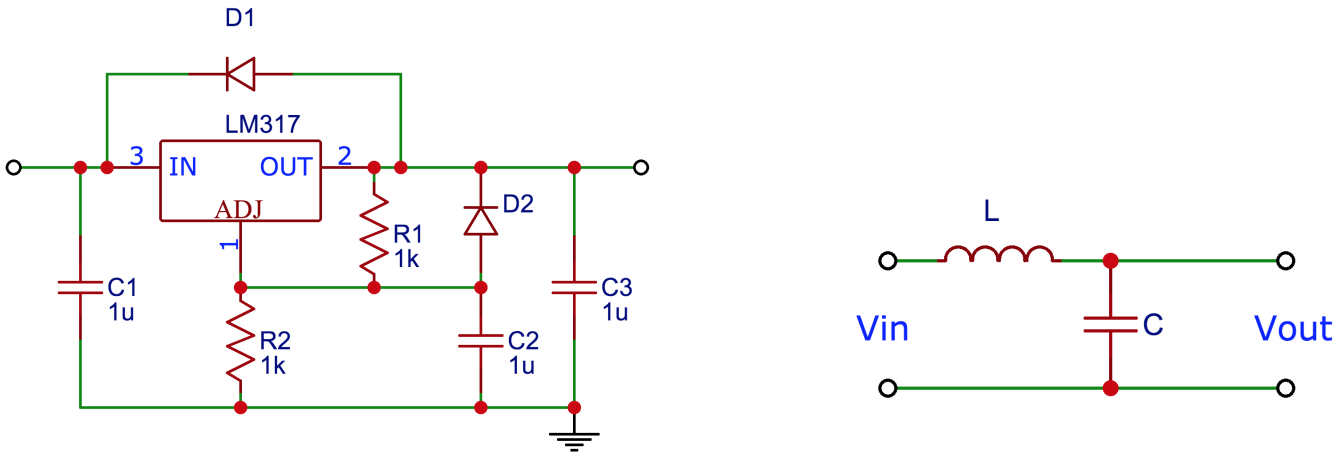


Figure 2: Variac and transformer

Biasing circuit

Figure 3a below shows an adjustable voltage regulator that uses the LM317 linear regulator. This circuit can be found on page 10 of the LM317 manual. The output voltage is given by $V_{out} = V_{ref} \times (\frac{R2}{R1}) + (I_{adj} \times R2)$ where $V_{ref} = 1.25$ V. Because I_{adj} is typically around 50 μA, the last term of the equation is negligible and we have $V_{out} = V_{ref} \times (\frac{R2}{R1})$. A low pass filter (like the one shown in figure 3b) is added to the voltage regulator. This filter only lets through frequencies below the cutoff frequency, $f_c = \frac{1}{2\pi\sqrt{LC}}$.



(a) Power supply / example biasing circuit from the LM317 manual

(b) Low pass filter

Figure 3: Power supply (biasing circuit) components***

The biasing circuit below is a combination of figures 3a and 3b. There are two biasing circuits; one that biases the filament at +10V and one that biases the repeller at +20V. These two circuits have a common input of +35V and they share a common ground. Each biasing circuit functions independently of the other.

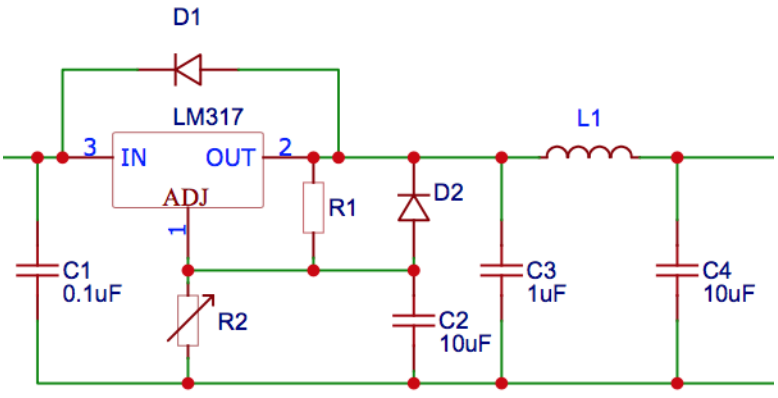
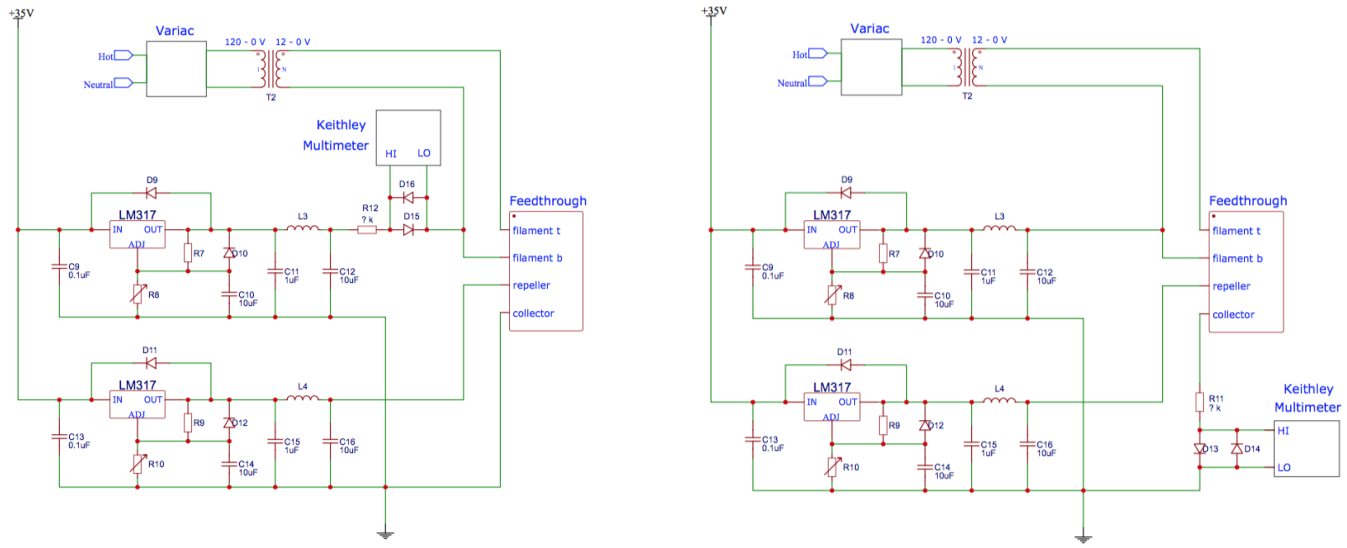


Figure 4: Biasing circuit

Keithley Ammeter

We will use a Keithley 195A Digital Multimeter to determine the current from the collector. Two options for placement of the Keithley are shown below. The Keithley may be protected by a series resister and two

diodes in parallel, although not extremely necessary as we will not be measuring currents large enough to damage the Keithley.



(a) Keithley at position X

(b) Keithley at position Y

Figure 5: Options for placement of Keithley

Moving Forward

The next steps for completing the circuitry are to purchase a suitable transformer and possibly purchase some low leakage diodes if we do decide to add protection to the Keithley.