Design of a Single-Supply Circuit for EIC DIRC Photodiode Readout

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EIC DIRC photodiode readout will use a transimpedance amplifier circuit combined with a low-pass filter to convert the photodiode current response to a measurable voltage. Previously, design and simulation efforts used an ideal op-amp in the circuit for ease of simulation. However, real op-amps require power supplies for the device that also acts as references for the op-amp's output. Typically, a positive and negative power supply, ±12 V DC for instance, is used for the device, but for applications where only positive output signals are expected (like EIC DIRC photodiode readout), the circuit can be modified to use only one positive supply.

Changing the circuit to use only one +12 V DC power supply has the main benefits of reducing the peripheral components needed for the circuit and allow the circuit to be powered by one wall wart power supply. This reduces the hazard class of the circuit's enclosure to class 1 since typically, the positive and negative voltage come from a single 120 V AC to ± V DC, which makes the circuit enclosure a class 2 hazard.

When a positive and negative reference voltages are used, the non-inverting input of the op-amp is connected to ground. This allows the amp-amp output to be at 0 V and stable if there is no current input from the photodiode. If this is done when a single power supply is used, with no current input, the output will settle close to 0 V, never actually reaching zero, and become saturated because the negative voltage reference is at 0 V (or ground). When this happens, the op-amp's response to a change in the input current will be delayed, causing the output voltage to behave similar to a capacitor charging.

This undesirable behavior can be prevented by using a potentiometer as a voltage divider to bias the non-inverting input of the op-amp, holding the input at a low, millivolt level voltage. The minor downside to this is that when there is no current input to the op-amp, the output will not be 0 V, but will be at whatever voltage is at the non-inverting amplifier. Fortunately, this offset is easily accounted since the offset can be measured and precisely tuned using the potentiometer, making the offset a non-issue.

- **Op-amp circuit used for the EIC DIRC photodiode readout circuit modified to use a single +12 V DC power supply**
  - **Gives benefits of reducing circuit's enclosure to a class 1 hazard class since one single wall wart power supply can be used**
- **Modification biases the non-inverting input to the op-amp to prevent output's saturation when there is no current from the photodiode**
  - **Output's saturation would delay any output response to the current input changes**

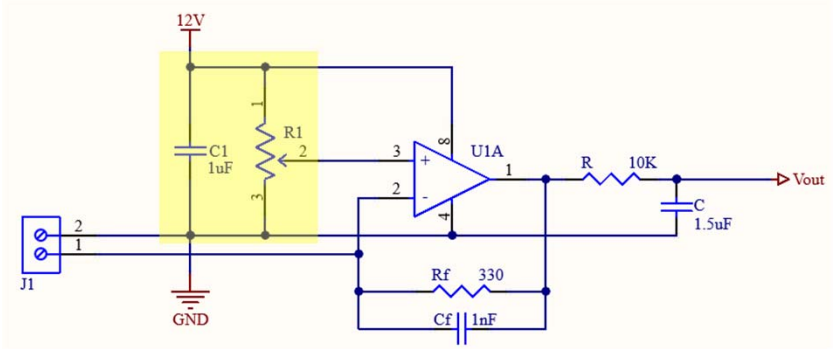

Fig 1: Single-power supply op-amp circuit. New portion added to bias the op-amp's non-inverting input is highlighted in yellow. R1 is a potentiometer acting as a voltage divider with the output connected to the op-amp. C1 is a power-decoupling capacitor for stabilizing the op-amp's power in the event that the 12-V supply has any oscillations or glitches.