Lab 10: Op-amps and detectors

This week's lab focuses on using op-amps and detectors together for high-quality measurements. In particular, we will focus on using op-amps with photodiode detectors and thermistor temperature sensors.

1. Construct an LED pulsing light source from a red LED (Light Emitting Diode) and the the function generator. Set the function generator to 5 V pk-pk with the low voltage set to 0 V. Attach the LED directly to the function generator and see if it flashes when the function generator frequency is set to 10 Hz. Determine the PN junction voltage of the LED.

2. Use an FDS100 Thorlabs photodiode to construct the circuit of figure 10 such that the current-to-voltage conversion is 10 mV/μA. Install the photodiode and the red LED in front of each other to maximize the amount of emitted light incident on the photodiode – fasten the photodiode and the LED so that they will not move. Measure the rise time and fall time of the photo-current signal.

Assuming that the LED turn-on and turn-off is instantaneous (I measured about 100 ns with a high-speed detector), determine the capacitance of the photodiode.

3. In the same manner as part 2, construct the circuit of figure 12 such that the current-to-voltage conversion is 10 mV/ μA and the bias voltage is + 15 V. Measure the rise time and fall time of the photo-current signal. Estimate the capacitance of the photodiode.

4a. In the same manner as part 2, construct the circuit of figure 11 with an LM741CN op-amp. Measure the rise time and fall time of the photo-current signal, and estimate the effective capacitance of the photodiode.

4b. Replace the LM741CN op-amp with an OP27 op-amp. Do you see any difference? Does the output oscillate? If it does, can you reduce it? Measure the rise time and fall time, and estimate the capacitance of the photodiode.

5. In the same manner as part 3, construct the circuit of figure 13 using the OP27 op-amp. Does the output oscillate? If it does, can you reduce it? Measure the rise time and fall time, and estimate the capacitance of the photodiode.

6. Construct the circuit you designed for Design Exercise 10-4. Measure the load current for R_{LOAD}=0 Ω, 100 Ω, 1 kΩ,, 10 kΩ, 100 kΩ, and 1 MΩ. How well does your current constant current source work? Replace the load resistor with a TH10K thermistor, and verify that the current does not change.

7. Construct the circuit you designed for Design Exercise 10-5 and roughly estimate the temperature-to-voltage conversion ratio (V/°C) for the entire circuit.