Application Brief

Benefits of Op-Amps with High Output Current

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While op amps are used across many analog circuits, some can require higher output currents to meet system goals.

Most traditional amplifiers do not support high output current, leading to the need for additional components. This document discusses the benefits of using the OPAx310, an op amp designed for high current applications.

LED Driver

Traditionally, op amps require an external transistor to drive LEDs, as shown in Figure 1 with the OPA2374. However, a few op amps, such as the OPAx310, (shown in Figure 2) can use a simplified design that removes the external transistor and directly drive the LED.

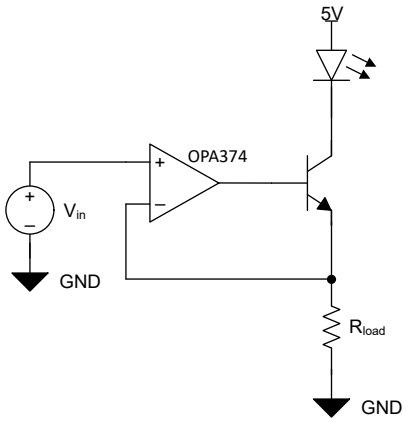

Figure 1. Traditional Op Amp LED Driver Circuit

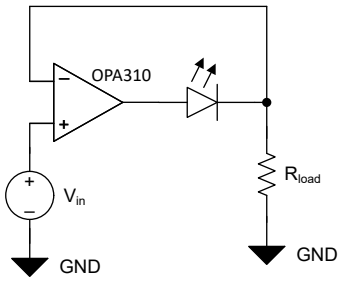

Figure 2. OPAx310 Direct LED Driver Circuit

With many LEDs requiring only 10 mA to operate, why does the OPA2374 require an external FET or BJT? An important op amp characteristic to understand when determining whether an external transistor is required is the output voltage swing versus output current. While most low voltage op amp outputs can source enough current through an LED to power it, the output voltage at these higher currents is not enough to overcome the diode voltage drop if designed to, as Figure 2 shows. By including the external transistor, the op amp no longer directly drives as much current and voltage to the LED. The trade-off with this design (as Figure 1 shows), is that the design becomes more costly and requires more board space.

As Figure 3 shows, the OPA2374 can supply 11 mA of current, but the output voltage is 2.7 V, which is lower than the required voltage drop of many LEDs . This also does not take process variation across units and change in performance across temperature into consideration. Compare that to the OPA2310 that has very minimal voltage drop even at high current levels, and it is clear why the OPA2310 does not require an external transistor to drive the LED, which saves cost and board area.

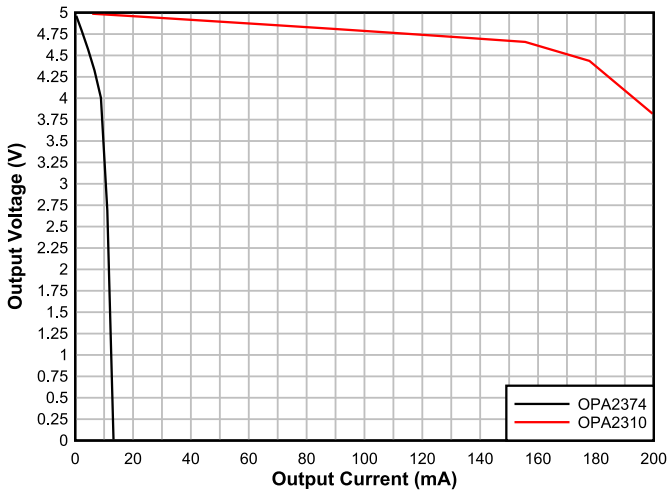

Figure 3. Output Voltage Swing versus Output Current (Sourcing)

Howland Current Pump

Howland current pump is a common design used to create current sources using op amps. A higher output current amplifiers helps reduce the need for higher channel counts to drive the same load.

In this example, a 50-Ω load requires 75 mA of output current. Most amplifiers (such as the TLV2772 shown in Figure 4) require two or more channels in parallel due to the op amps limited output current capabilities. For the TLV2772, it can only output 50 mA at 25°C. In contrast, a single channel OPA310 (shown in Figure 5) can meet the systems requirements. The OPA310 is a benefit to this design by reducing components, design complexity, and board space.

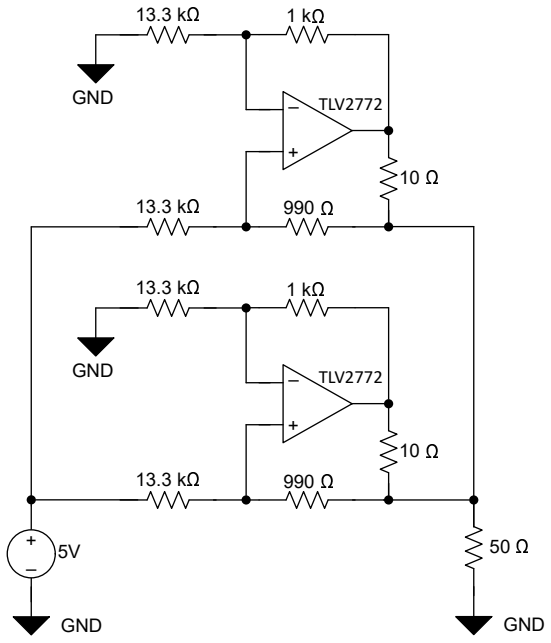

Figure 4. TLV2772 Howland Current Pump Circuit

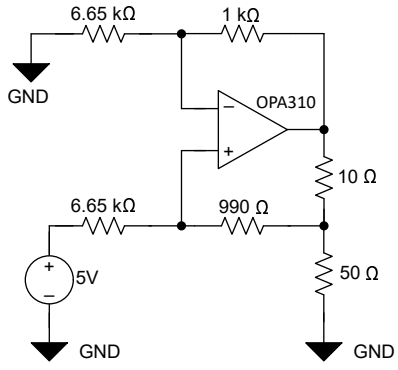

Figure 5. OPA310 Howland Current Pump Circuit

Reference Buffer

Op amps are commonly used in reference buffer designs where affordability is a higher priority than accuracy. Because of this, op amps commonly struggle with driving a large value output capacitor, even in DC applications, due to needing a large amount of current to initially charge the capacitor. Depending on the value of the output capacitor, additional passives can be required for stability.

In the example shown in Figure 6, a reference buffer circuit is designed to output a 2.5-V and drive a 100-nF capacitor. The results seen in Figure 7 and Figure 8 illustrate that while both OPA310 and OPA313 can reach a steady voltage on the output, the OPA310 can do so in less than 100 µs and with a lower overshoot voltage. Lower overshoot is important for sensitive devices that are designed for 2.5-V supplies.*

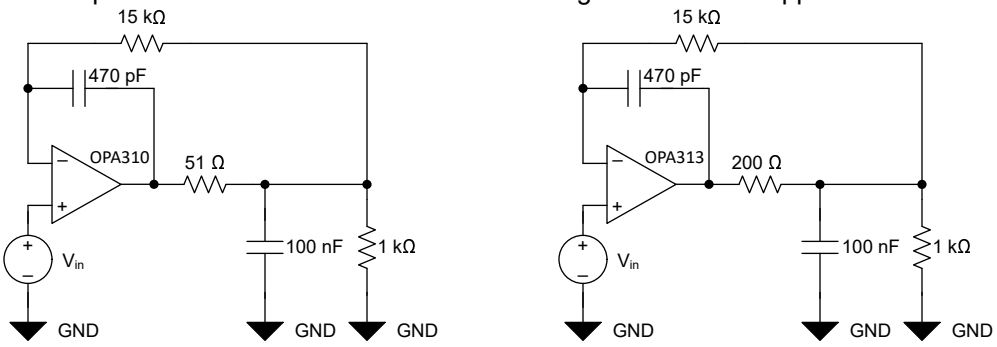

Figure 6. Reference Buffer Circuit

Note

*The difference in the Riso resistor between the OPA310 circuit and OPA313 was done to optimize the stability of both circuits. The phase margins of the OPA310 and OPA313 are 94.01° and 84.75° respectfully.

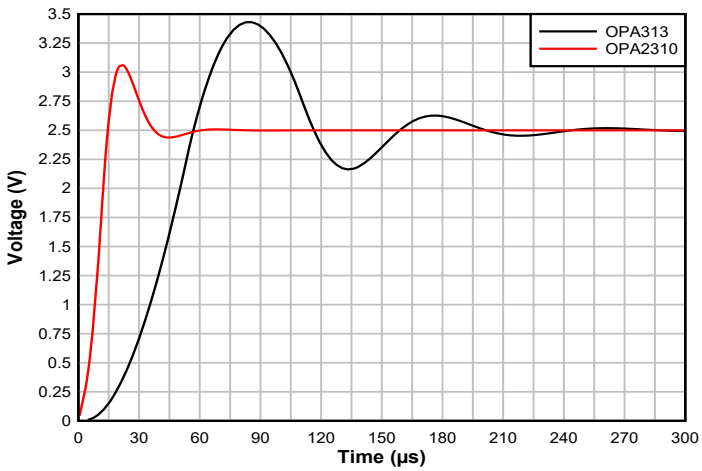

Figure 7. OPA310 versus OPA313 Simulated Voltage Transient Results

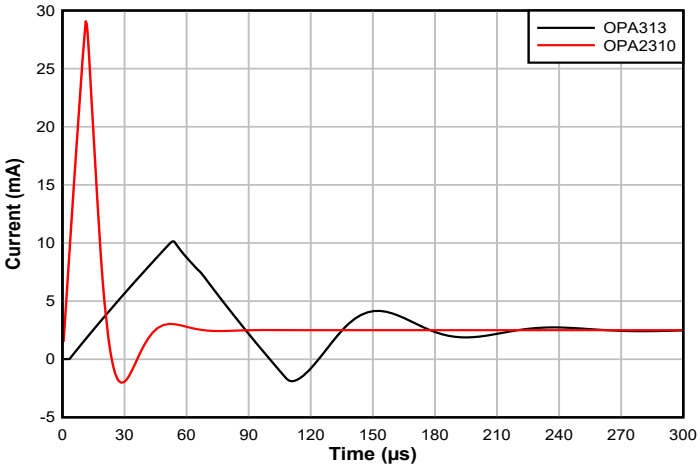

Figure 8. OPA310 versus OPA313 Simulated Current Transient Results

Conclusion

While most op amps can be used in the high current applications discussed here, this usually comes with trade-offs in terms of component count, complexity, or start-up time. Using an op amp designed with higher output operation can simplify design, reduce cost and shrink board space.

References

Texas Instruments, *Voltage-to-current (V-I) converter circuit with MOSFET*, analog engineer's circuit

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Texas Instruments, *Analysis of Improved Howland Current Pump Configurations*, application note

Texas Instruments, *“Improved” Howland current pump circuit*, analog engineer's circuit

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