

Current source enables op amp's output to go to ground

Frank Chan, Vancouver, BC, Canada

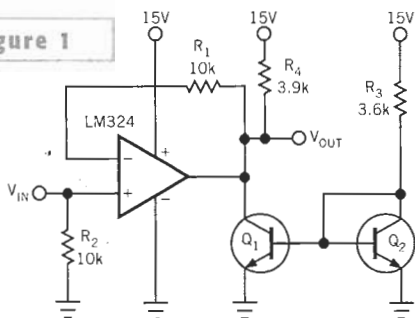
THE LM324 is a cost-effective choice for an op amp, especially when you need to apply ground-level inputs. Although its output purportedly includes ground, its poor current-sinking capability limits the applications. At output voltages lower than 0.5V, the op amp's sinking current ranges only from 2 to 100 μ A. You can add an external current-sinking circuit to bring the usable output

voltage down to the millivolt level. In **Figure 1**, Q_1 , Q_2 , and R_3 form a 4-mA current source that drains the output of the LM324. R_4 is the load, demanding a sink current of 4 mA. This design uses a 2N2222 transistor for its low saturation voltage. The output characteristic becomes the saturation characteristic of the added transistors, Q_1 and Q_2 . Using this current source, the output voltage is linear down to 22 mV above ground. **Figures 2** and **3** show the output characteristics. The lowest usable output voltage depends on the load (sink) current. When the load current is 0.5 mA ($R_4=30$ k Ω), the output

With 0.5-mA load current, the output voltage is linear down to 4 mV.

voltage is linear down to 4 mV. **Figure 4** is the original output characteristic of the LM324 driving R_4 (3.9 k Ω) without the added sinking current source. The current source presents a constant load to the LM324. You can configure a leftover op amp as a voltage comparator to cut off the current source when the output voltage is higher than 1V. □

Figure 1



An external current source can bring the usable output level of an LM324 down to the millivolt level.

Figure 3

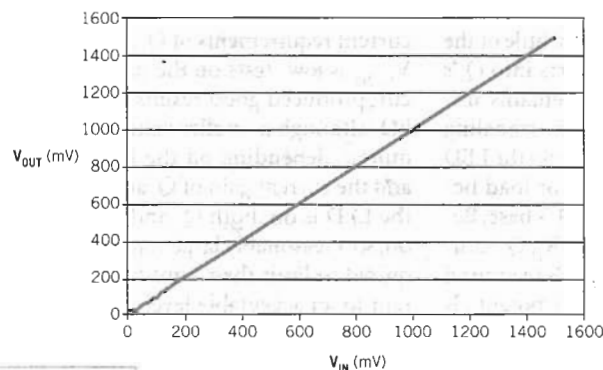
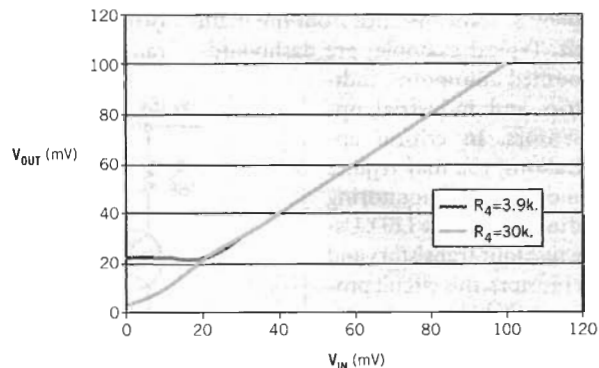
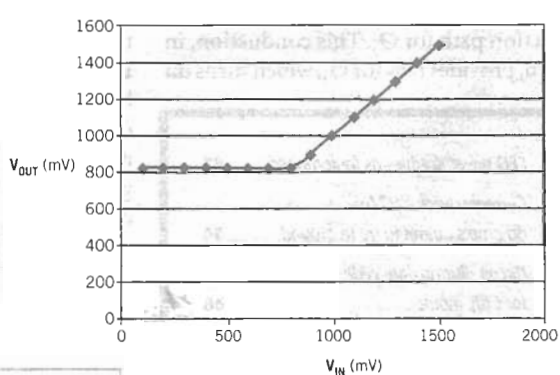


Figure 2

The transfer function of Figure 1's circuit is linear down to the low-millivolt level.

Figure 4



This graphic shows the LM324 transfer function without the added current source.