IC references are popular with circuit designers because they are accurate and exhibit low drift. Some of my future columns will cover the three types of IC references: buried zener, bandgap, and XFET. You develop the reference-design procedure with a zener diode; the zener's simplicity illustrates the design procedure, and its problems make you appreciate IC references. The circuit specifications are $V_{CC}=30\,\text{V}\pm10\%$, $8.445\leq V_{REF}\leq 9.555$, $\Delta V_{REF}\leq 200\,\text{mV}$, $100\,\text{k}\Omega \leq R_{LOAD} \leq 200\,\text{k}\Omega$, and $0^\circ\text{C} \leq T_a \leq 80^\circ\text{C}$.

Select a 1N757 9.1V zener for the first try. Note that the maximum temperature coefficient is 6 mV/°C, and the zener-voltage tolerance is ±5%. The calculated reference voltage equals the maximum specification, $V_{REF}=(1.05)(9.1)=9.555\,\text{V}$, but the temperature-induced drift is $\Delta V_{REF}=(80–25)(6\,\text{mV})=0.330\,\text{V}$, thus exceeding the maximum-drift voltage specification.

Connect a signal diode in series with a 1N756 8.2V zener so that the diode's negative-temperature coefficient cancels part of the zener's positive-temperature coefficient (Figure 1). The diode's temperature coefficient ranges from -2.1 to -2.3 mV/°C, and the 8.2V zener's temperature coefficient is 5.4 mV/°C, so the combination's maximum temperature coefficient is 3.3 mV/°C. This scenario yields $\Delta V_{REF}=181.5\,\text{mV}$, which meets specifications, but the minimum reference voltage, $V_{REF}=(0.95)(8.2)+0.5=8.29\,\text{V}$, is less than the specified limit of 8.445V.

Calculate $R_{BIAS}$ as $R_{BIAS}=(V_{CC}-V_{REF})/I_z=(30–9)/7.5=2885\,\Omega$; select $R_{BIAS}=2800\,\Omega\pm2\%$. (The temperature-compensated zener includes the diode in Figure 1.) Because of power-supply and resistor tolerances, the change in $I_z$ ranges from $(30)(0.9)-9.53-0.11)/2.8(1.02)=6.07\,\text{mA}$ to $(30)(1.1)-8.62-0.05)/2.8(0.98)=8.86\,\text{mA}$. The load-resistance change causes about 90 µA of change in $I_z$, which is insignificant. This change in the temperature-compensated-zener current corresponds to a zener-impedance change of approximately ±5Ω (Reference 1), but $\Delta V_{REF}$ changes only about ±37.5 mV. You should also consider the zener-voltage change: Because of the $I_z$ shift, the zener-operating point changes when $V_{REF}$ varies by ±50 mV. Also, keep in mind that the maximum wideband semiconductor noise that the dc voltage contains is 20 µV.
The final voltage-reference change is $110 + 37.5 + 50 = 197.5$ mV. Some people say that this analysis is not the most rigorous, and they are right, but it gives you an idea of what using a zener reference involves. If $V_{CC}$ had been as low as 12V, a zener diode would fail to meet specifications. The load-resistance variation does not affect design calculations, because $R_{LOAD}$ is large. A smaller, 2-kΩ load resistance with a variation of 1 kΩ causes a great change in $I_z$, necessitating a zener-diode buffer. If the zener diode is part of an IC, then you can trim $R_{BIAS}$ with a laser, and adding a buffer is trivial. This buried-zener-voltage-reference method seems like a better way to build a voltage reference.

Reference