Precision voltage reference delivers 80 mA

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Large analog systems that present many loads to a voltage-reference source can often demand more current than a single reference IC can deliver. However, if the reference IC includes force and sense terminals, you can easily add a buffer to the circuit's feedback loop without affecting the reference's accuracy. For example, the circuit in **Figure 1** provides the same 0.04% initial accuracy and 7-ppm/°C temperature coefficient as IC_1, a standalone MAX6033. The buffer circuit delivers as much as 80 mA.

When you design a buffer stage for a force/sense-control loop, the buffer must provide unity-voltage gain with no phase inversion. In addition, the circuit's power supply must provide head-room voltage to accommodate the reference voltage plus voltage drop across the buffer stage. The simplest buffer circuit comprises an NPN transistor that connects as an emitter follower, which requires a drive voltage that exceeds the reference's output voltage by one transistor base-emitter voltage drop. If you add the required minimum power-supply voltage plus the maximum allowable base-emitter voltage, the configuration runs out of head room. Using a PNP stage to drive the emitter drive stage solves the head-room problem but inverts the output voltage and prevents the force/sense loop from functioning. Adding a second PNP stage cancels the phase inversion but destabilizes the force/sense loop by adding excessive gain.

The modified complementary Darlington, or Sziklai, connection (**Reference 1**) in **Figure 1** solves both problems by providing an emitter follower's unity-voltage gain with no inversion. The output PNP stage provides plenty of head room, but the NPN stage does not. You can easily overcome this drawback by adding diode D_1 to shift the NPN transistor's emitter voltage downward by a diode drop. Thus, to a first approximation, the diode's voltage drop and the transistor's base-emitter voltage cancel one another, leaving plenty of voltage head room.

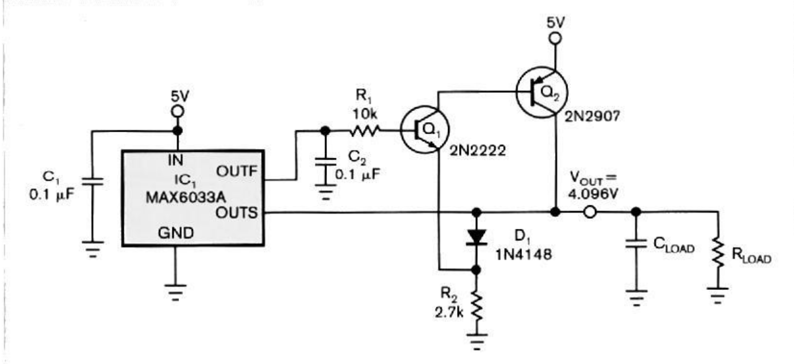

Figure 1 Add a two-transistor output buffer to a 4.096V, 15-mA reference IC to boost its output current to 80 mA or higher.

Transistor Q_2, a 2N2907, provides limited current gain, which in turn limits the circuit's maximum output current to 80 mA. Substituting a higher gain transistor can increase the output current to any reasonable level.

For stability, the MAX6033 requires 0.1-μF ceramic bypass capacitors on its In and OutF pins. Capacitor C_2 determines the circuit's response speed, but the buffer circuit exerts no significant effect on transient response. Most dc-reference-voltage ICs cannot accommodate a fast-changing load-current step; thus, the circuit's transient response and its ability to supply fast current spikes depend on the output capacitor, C_{LOAD}. Values of C_{LOAD} as high as 10 μF do not affect the circuit's stability.EDN

REFERENCE

1 "Sziklai Pair," Wikipedia, http://en.wikipedia.org/wiki/Sziklai_pair.