

The references for the two common-base regulator transistors ( $Q_1$  and  $Q_2$ ), which provide stable supply voltages for the op amps, are actually two pairs of standard NPN bipolar transistors (2N3904s) used as Zener diodes ( $Q_{1,4}$  through  $Q_{1,7}$ ). They are connected in series (with their collector leads clipped off) to obtain a net breakdown voltage of around 15 V for the pair. There really is a good reason for using such an arrangement since it would obviously be easier to use a 15 V "Zener" diode, as opposed to this seemingly more complicated approach. In reality, the connection of two bipolar transistors in this manner exhibits significantly less low frequency noise than the 15 V "avalanche" diodes, as they are more appropriately called, and is actually more cost effective. The composite Zeners are bypassed with 10  $\mu$ F 25 V tantalum capacitors, used mainly for reasons of economy and size, which filter out residual noise from the diodes as well as the power supply rails. Two resistors marked  $R_{BIAS}$  on the circuit diagram ( $R_1$  and  $R_2$ ), which are connected to each supply, serve to bias Zener connected transistors  $Q_{1,4}$  through  $Q_{1,7}$  and should be chosen such that with nominal power supply operating voltages (anywhere from 50 to 70 volts) about 1 mA of current will flow through them.