Improved Vbe Doubler

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This circuit is an improved version of an old V_{BE} doubler. It is useful for class AB amplifiers which are of the topology as shown in Figure 1. This type of amplifier needs a bias circuit for Q_1 and Q_2 such that there is a constant voltage between their bases. Without a controlled bias voltage, the quiescent collector currents of Q_1 and Q_2 may be excessive, causing thermal failure, or insufficient, causing crossover distortion. It is desireable that this voltage have a similar temperature coefficient to the combined V_{BE} drop of Q_1 and Q_2. All four bias circuits shown in Figure 2 are temperature compensated, but only one of them has good regulation over current.

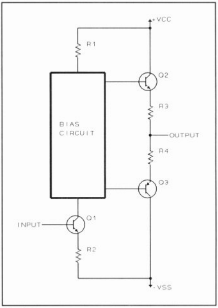

Figure 1.

Figure 2a is the simplest, just two series diodes. Figure 2b is the common V_{BE} multiplier set up as a doubler. Figure 2c is a two transitor approach, and finally Figure 2d is the improved circuit with better performance.

The voltage output of the circuit in Figure 2d, ignoring base currents, is given as

$$V_0 = V_{BE2} + V_{BE1} - I_o R_{14}$$

The current through Q_{13} does not change too much, so most of the change in output voltage comes from Q_{14}'s B-E junction. To calculate R_{14} in Figure 2d, find V_{BE} of the transistor at two points, minimum and maximum input currents. Set the voltage drop across R_{14} to be equal to the V_{BE} drop.

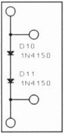

Figure 2a.

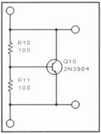

Figure 2b.

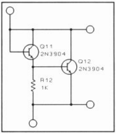

Figure 2c.

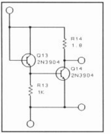

Figure 2d.

For example, the Motorola data sheet for a 2N3904 transistor gives a V_{BE} of 0.71V at 10mA and 0.87V at 100mA. This is a difference of 0.16V. The same drop across R_{14} for a change in current from 10mA to 100mA would require 1.8Ω.

All four bias circuits were simulated in SPICE to measure their dc performance. Figure 3 displays the results. Only the new improved circuit performed well over the input current range. From 10mA to 100mA, the change in output voltages were circuit A: 340mV, circuit B: 740mV, circuit C: 190mV, and circuit D: 30mV.

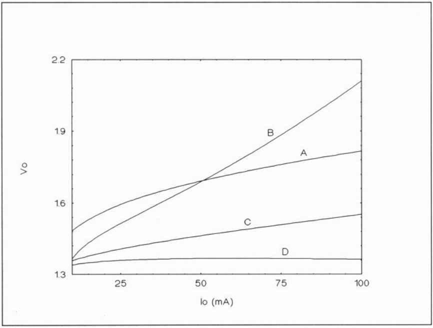

Figure 3.