

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 desirable 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 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 transistor approach, and finally Figure 2d is the improved circuit with better performance.

The voltage output of the circuit in Figure 1, Figure 2d, ignoring base currents, is given as

$$V_O = V_{BE2} + V_{BE1} - I_E R_{14}$$

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.

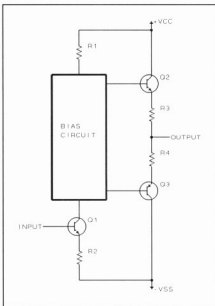


Figure 1.

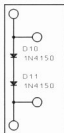


Figure 2a.

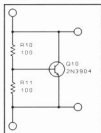


Figure 2b.

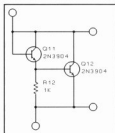


Figure 2c.

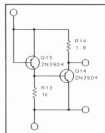


Figure 2d.

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 1.8 Ω .

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.

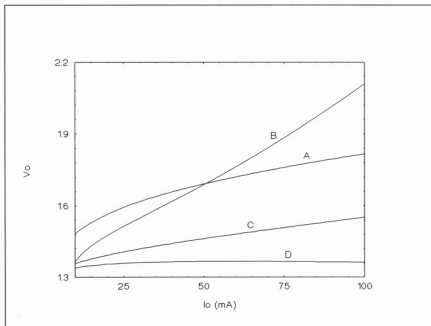


Figure 3.