

If one chooses to use a 2-transistor or 4-transistor current mirror, and does not want to do matching, then PMP5201 would be a good choice. Alternatively, for even lower noise, one can also use matched 2SA1312 instead.

When using 2SK332 or 2SK209, degeneration (R5,6, P1) can be reduced to 10R to recover the loss in open loop gain due to the lower Y_{fs} (12mS at 2mA). The much reduced source degeneration of the LTP also reduces sensitivity of input pair to CM noise (Groner ^[14]). The closed loop performance of the modified circuit, on the other hand, is still essentially identical to the original even under different loading conditions.

A 4-BJT Wilson mirror with matched h_{fe} should actually give lower distortion and also lower DC offset. With 150mA bias, it will still be capable of +/- 3.5V at 30 ohm 200mW, +/-7V at 65R 370mW, +/-11V above 100R 600mW. Note that most high-end headphones are specified at 200mW, so this fits well. The emitter resistors in the current mirror R3, 4 are not absolutely necessary in a full Wilson mirror, so they may be replaced by 0R jumpers or reduced in value, should one wish to further minimise voltage headroom required.

If one happens to have a 100R headphone, and wants to be able to swing +/-10V (500mW rms) with low distortion, then one can consider swapping R10 with an Osram power TOPLED (LS G6SP). The LED adds another 1.8V to the voltage headroom for the current mirror, even at no current, thus ensuring that even a full Wilson mirror will always function. However the LED is rated at 200mA maximum, so it is wise to reduce the bias to 100mA as described in the original article (R13 = 6.8R).

Further Prototypes

Two more prototypes were built, using matched 2SK209GR for the LTP as well as for the CCS, 4x matched 2SA1312BL for the Wilson mirror, with R3, 4 reduced to 250R. The rest was the same as the original version. A slightly heavier Zobel network of 9R--22n was used also.

The same set of measurements were performed, and the results were essentially identical, with a slightly lower bandwidth of 700kHz due to the heavy Zobel. Even with 27R load, the -3dB bandwidth is still 550kHz. But if you know for sure that you shall only use the amplifier with <50R load, you may well use the original values as specified by Borbely.

DC offsets were also around -20mV without trimming, even with slightly worse matching of the LTP (6 μ A I_{dss}) and much less degeneration. The clipping behaviour with 27R load was also identical with the original version. So there is no measureable disadvantage with the 4-transistor current mirror, except perhaps for slightly increased noise.

For those who do not wish to do any matching at all, a Plug & Play version can then be built on the same PCB, using 2SK332 (or LSK389 in TO-71) and PMP5201.

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