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Where did all that racket come from?

Since arriving in the market, CMOS single-supply amplifiers have been beneficial to single-supply-system designers worldwide. Key players affecting the THD+N (total-harmonic-distortion-plus-noise) characteristics of dual-supply amplifiers are input noise and output-stage crossover distortion. The THD+N performance of a single-supply amplifier also originates in the amplifier's input and output stages. However, the input stage's impact on THD+N complicates the nature of this specification with single-supply amplifiers.

Several types of single-supply amplifier topologies can accept input signals across the power supplies. In the complementary-differential-input-stage topology, when the amplifier's inputs are near the negative rail, the PMOS transistors are on, and the NMOS transistors are off. When the amplifier's inputs are closer to the positive rail, the NMOS transistors are on, and the PMOS transistors are off. For an illustration of this topology, see www.edn.com/090423bb.

This design topology has significant variations in the amplifier's offset voltage across the common-mode input range. In the input region near ground, the PMOS transistor's offset error is dominant. In the region near the positive power supply, the NMOS-transistor pair dominates the offset error. Both pairs are on as the amplifier's inputs pass between these two regions. The end result is that the input offset voltage changes between the stages. When the PMOS and NMOS transistors are both on, the common-mode voltage region is approximately 400 mV. This crossover-distortion phenomenon affects the amplifier's THD. If you configure the complementary-input amplifier in a noninverting configuration, the input crossover distortion can affect the amplifier's THD+N performance. For instance, in **Figure 1** the THD+N is 0.0006% if you avoid using the input transition. If the THD+N tests include the amplifier's input crossover distortion, the THD+N is 0.004%. You can avoid this type of amplifier crossover distortion by using an inverting configuration.

Another major THD+N contributor can be the operational amplifier's output stage. The output stage of a single-supply amplifier usually has an AB topology. As the output signal sweeps from rail to rail, the output stage displays a crossover distortion similar to the input-stage crossover distortion, in that the output stage switches from transistor to transistor. Generally, a higher level of quiescent current through the output stage reduces the amplifier's THD. The amplifier's input noise is another contributor to the THD+N specification. A high level of input noise, high closed-loop gains, or both can increase the amplifier's overall THD+N level.

To optimize a complementary-input-single-supply amplifier's THD+N performance, place the amplifier in an inverting-gain configuration and keep the closed-loop gain low. If the system requires the amplifier to be configured as a noninverting buffer, an amplifier with a single-differential input stage and charge pump is a more appropriate choice. EDN

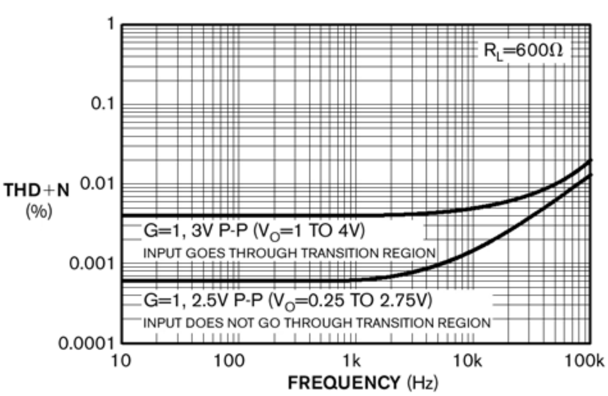

Figure 1 The THD+N is 0.0006% if you avoid using the input transition, or 0.004% if the THD+N tests include the amplifier's input crossover distortion.

REFERENCES

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