Demand-switched supply boosts amplifier efficiency

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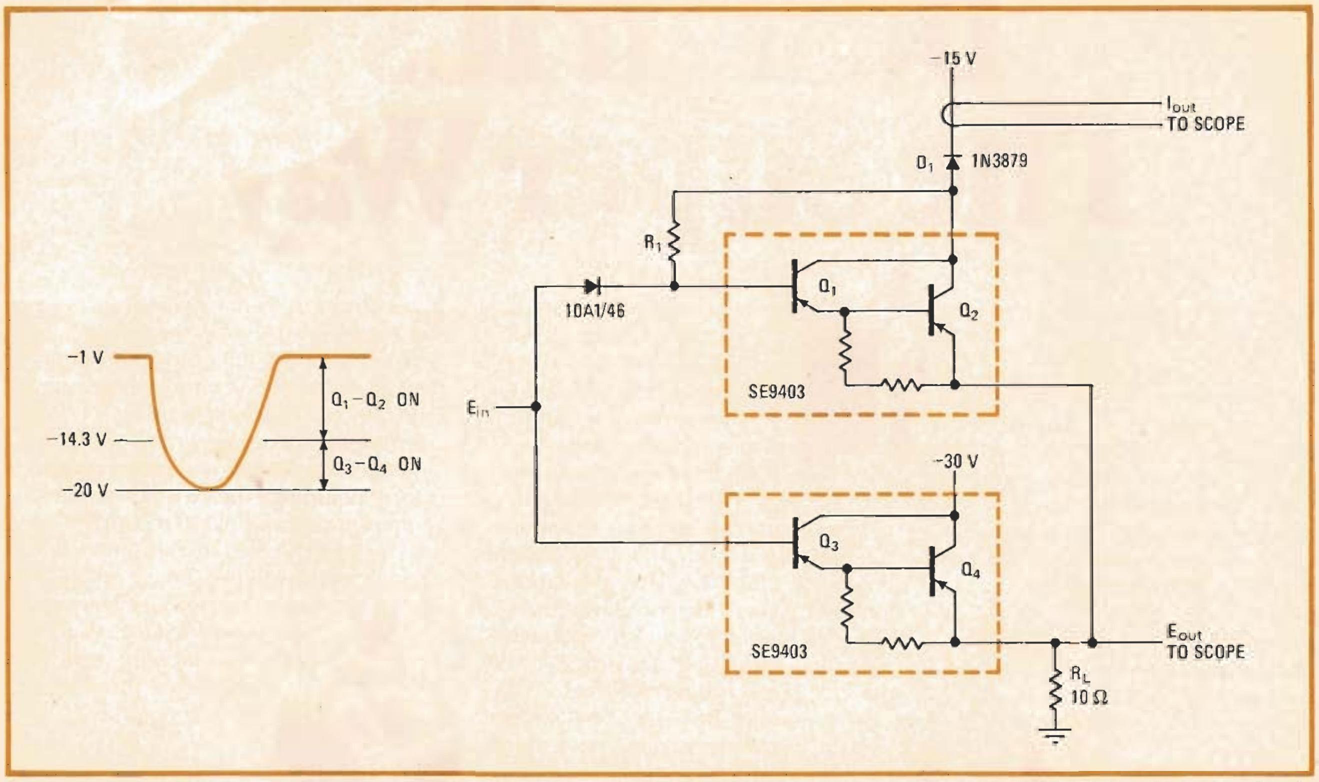
The efficiency of high-power audio amplifiers operating in class B will be improved by up to 80% at low power levels if the supply voltage can be switched from a low to a high value as the power demands on the amplifier increase. Using the automatic-switching circuit described here ensures a lower heat dissipation than would be possible with an amplifier that delivers a low-power output from a single high-voltage supply, which is the



High efficiency. Audio power amplifier switches from Darlington pair Q_1–Q_2 and low-voltage supply to Q_3–Q_4 and high-voltage supply only when power output demands increase. Circuit thereby eliminates the need for amplifier to dissipate excessive heat, a condition that occurs when an amp with a single high-voltage supply is used to process a low-amplitude input signal.

most common situation. The increased efficiency of this power amplifier can produce considerable savings in its weight and size and also reduces the amplifier's heat sink requirements.

The amplifier is designed to switch from the low- to the high-voltage supply as the audio signal level passes up through the low-voltage supply level. The switchover is made with virtually no perturbation in the output current up to as high as 25 kilohertz. At higher speeds, any waveshape distortion can be reduced by implementing negative feedback around the amplifier. Both supply voltages can be derived from one source, with the low voltage taken from a selected tap on the power transformer.

Several circuit configurations were tried, among them a cascaded emitter follower, a series transistor configuration, and the parallel transistor arrangement shown in the figure. The cascaded emitter follower and the series configuration performed adequately below 10 kHz. At higher frequencies, however, the effects of carrier storage produced by the first two arrangements caused large perturbations in the output current. The parallel arrangement finally adopted has virtually no storage problem and appears to be the most useful at higher frequencies.

For simplicity, the operation of one half of a complementary-output stage (see figure) is described. A half-sine wave that swings from −1 to −20 volts is the input-signal source in this case.

When the input level is at −1 V, current flows through D_2, R_1, and D_1. Thus the input base of Darlington pair Q_1–Q_2 is one diode drop lower than the base of Q_3–Q_4. As a result, Q_1–Q_2, which uses the −15-V supply, is on and Q_3–Q_4 is off.

When the input signal reaches within one diode drop of the low-voltage power supply, D_2 begins to turn off and Q_3–Q_4, which uses the −30-V supply, starts to turn on. As Q_3–Q_4 moves into the linear region, Q_1–Q_2 begins to turn off, so there is a smooth transition of current in the load. Q_3–Q_4 stays on until the signal polarity reverses; when the signal passes through the low-voltage supply level, Q_1–Q_2 goes on and Q_3–Q_4 goes off. □