Maxim's Active-Emissions-Limiting Circuitry Demystified

Dec 22, 2006

Abstract: This application note describes the technology Maxim's 3rd-generation Class D audio power amplifiers utilize to enable their "filterless" operation in consumer electronics equipment. Specifically, this article explains how Maxim's new active-emissions-limiting circuitry minimizes radiated emissions without degrading audio performance.

Introduction

Maxim's 2nd-generation Class D audio power amplifiers feature a unique spread-spectrum-modulation mode that flattens wideband spectral components, improving EMI emissions that may be radiated by the speaker and cables. Maxim's 3rd-generation Class D audio power amplifiers employ the same spread-spectrum technology with a new active-emissions-limiting circuit that further reduces narrow-band spectral components without degrading audio performance. The combination of these two unique technologies allows Maxim's Class D audio power amplifiers, such as the MAX9705, to run 'filterless' with up to 24 inches of unshielded cable and still meet EN55022 electromagnetic-interference (EMI) regulation standards. This article explains the technology Maxim employs in active-emissions-limiting Class D amplifiers to minimize radiated emissions levels, while maintaining the high efficiency expected of Class D amplifiers.

Maxim's 3rd-Generation Class D Technology

Maxim's 3rd-generation Class D technology features Maxim's spread-spectrum-modulation technology with a new active-emissions-limiting circuit that further reduces narrow-band spectral components. Active-emissions-limiting circuitry greatly reduces EMI emissions by actively controlling the output-FET gate transitions under all possible transient output-voltage conditions. The edge rate of each gate transition is intelligently controlled such that the near rail-to-rail swing and the fast switching frequency contribution to emissions is reduced with as little impact on amplifier efficiency as possible.

Since the high efficiency of a Class D amplifier is due to its near rail-to-rail swing and the fast on/off transitions of its output FET (Figure 1), edge-rate control has the potential to negatively impact the Class D amplifier's efficiency.
Figure 1. Class D output waveform illustrating regions of loss due to its switching edge rate and transistor $R_{DS(ON)}$.

Fast transitions on the output contribute to high efficiency by minimizing loss in rise or fall time. If the on/off transition time is increased, then efficiency decreases. With active-emissions limiting, the output-FET gate transitions are intelligently controlled so as to maximize Class D efficiency while still achieving excellent emissions performance (Figure 2).
Figure 2. Active-emissions-limiting circuitry intelligently controls the edge rate of the Class D switching waveform and reduces radiated emissions with very little degradation in efficiency.
The MAX9705 Class D, Active-Emissions-Limiting Amplifier

The MAX9705 is an ultra-low EMI, mono, Class D amplifier featuring Maxim's 3rd-generation Class D technology. Offering efficiencies up to 90%, the MAX9705 boasts of 15.8dB quasi-peaked margin to the FCC limit with 12 inches of unshielded, twisted-pair speaker cable (Figure 3). More impressively, the MAX9705 can pass the FCC limit with up to 24 inches of unshielded, twisted-pair speaker cable (Figure 4).

![Figure 3. MAX9705 radiated emissions data (MAX9705EVKit, spread-spectrum-modulation mode, 12 inch, unshielded, twisted-pair speaker cable).](image)

![Figure 4. MAX9705 radiated emissions data (MAX9705EVKit, spread-spectrum-modulation mode, 24 inch, unshielded twisted-pair speaker cable).](image)

In addition to excellent EMI performance, the MAX9705 IC features a low 0.02% THD+N, a high 75dB PSRR, and a low-power 0.3µA shutdown mode. The MAX9705 is available in 10-pin TDFN (3mm x 3mm
Conclusion

The emissions performance of Maxim's 3rd-generation Class D amplifiers enables the truly 'filterless' operation of Class D amplifiers in consumer electronic equipment. In this way, spread-spectrum modulation and active-emissions-limiting circuitry reduce component count, extend battery life, and enable Maxim's 3rd-generation Class D amplifiers to provide Class AB performance without sacrificing efficiency. Consequently, this 'filterless' technology allows for smaller, more cost-effective solutions, making these amplifiers ideal for cellular-phone, MP3, PDA, and notebook applications.

¹For a detailed discussion of Maxim's spread-spectrum-modulation technology, refer to application note 3881, "Spread-Spectrum-Modulation Mode Minimizes Electromagnetic Interference in Class D Amplifiers."

<table>
<thead>
<tr>
<th>Related Parts</th>
<th>Free Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX9705</td>
<td></td>
</tr>
<tr>
<td>2.3W, Ultra-Low-EMI, Filterless, Class D Audio Amplifier</td>
<td></td>
</tr>
</tbody>
</table>

More Information
For Technical Support: http://www.maximintegrated.com/support
For Samples: http://www.maximintegrated.com/samples
Other Questions and Comments: http://www.maximintegrated.com/contact

Application Note 3973: http://www.maximintegrated.com/an3973
APPLICATION NOTE 3973, AN3973, AN 3973, APP3973, Appnote3973, Appnote 3973
Copyright © by Maxim Integrated Products
Additional Legal Notices: http://www.maximintegrated.com/legal