Class D Basics

What is a Class D Amplifier?

A class D amplifier is an efficient form of switching amplifier. It can be up to 90% power efficient, however, it generates more electrical interference than other configurations of amplifier. This kind of amplifier is widely used in all kinds of electronics, including hi-fi and PA (public announcement) systems. Increasingly companies are producing this kind of circuit but few have integrated with a high performance audio CODEC.

Different Classes of Amplifier

There are a number of different classes of amplifier categorised by the behaviour of the output devices when a sinusoidal test signal is applied:

Class A – Both output devices are continuously conducting as there is some bias current flowing in the output devices. This topology is the most linear (resulting in the lowest distortion) but also the least power efficient, around 20%

Class B – In this case there is no continuous bias current flowing in the output devices with one device conducting in the positive region and the other in the negative region. This improves the efficiency to around 50% but generates crossover distortion due to the time it takes to switch one device off and turn the other device on. This is particularly evident at low output levels where the non-linearity at crossover is a larger proportion of the output signal.

Class AB – This type of amplifier is a combination of the above two types which provides an acceptable level of performance (typically 0.1% to 1% distortion) at similar efficiency to class B. Here both output devices are allowed to conduct at the same time, but just a small amount near the crossover point (i.e. each device conducts for slightly more than half a cycle, but less than a whole cycle). Class AB is the most popular amplifier topology for portable audio.

Class C – Is not generally used for audio applications as it adds too much distortion to the audio signal

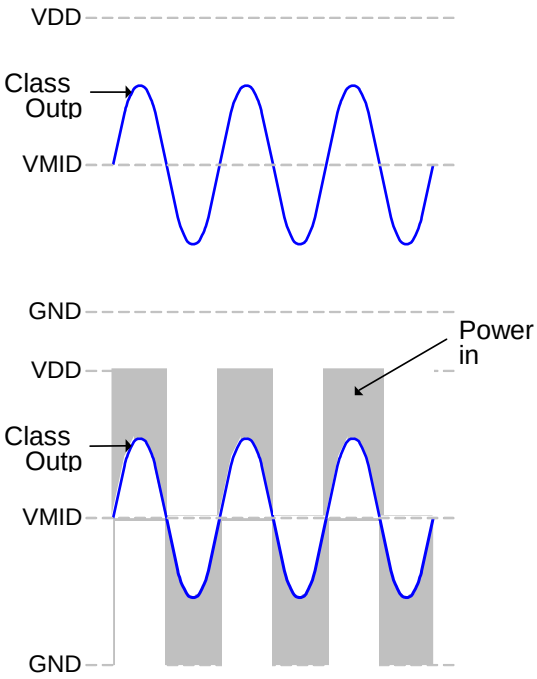
All the above are termed *linear* amplifier topologies as the output devices remain "non-saturated" (do not operate near the power supply rails).

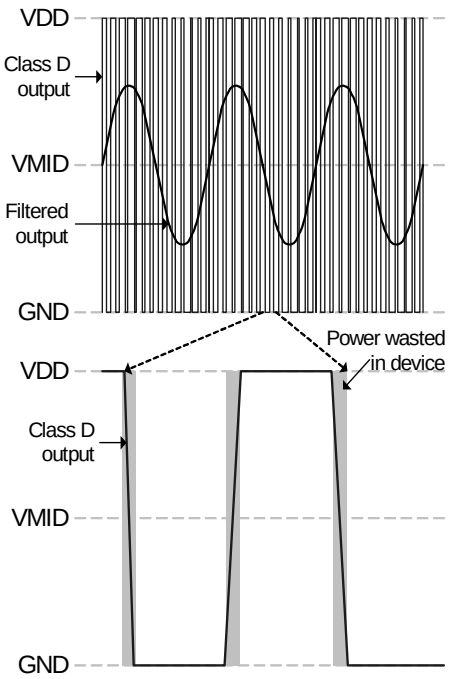
It should be noted that theoretical peak efficiency is higher but this is never reached in practice.

Indeed as real audio/speech signals are made up of many different sinusoidal components interspersed by periods of silence, the actual power efficiency is typically perhaps half the percentage values above (20-30% dependent on the signal).

Progressing to the topology of interest:

Class D – Both output devices operate as switches (either at the positive or negative supply rail) sometimes referred to as "saturated switching". When the output device is saturated it is not wasting power because either the voltage or the current is zero in this state. Heat is generated only during the switching transition but this can be minimised with careful design. The diagram below illustrates this:





Why Does a Mobile Phone Need an Amplifier?

All mobile phones require a headset/earpiece amplifier in order to comfortably listen to speech and this is usually integrated into the CODEC. Additionally, a more powerful amplifier may be required to drive a larger loudspeaker for ringtones, music playback or handsfree operation.

One increasing handset trend is for stereo loudspeaker drivers but this is not yet required for all phones so an external speaker amplifier is often employed.

Typically Class AB amplifiers are selected for the reasons stated above. Although the power efficiency with real signals may be as low as 20-30% one advantage of a linear amplifier is that, inherently, it does not generate high frequency interference. This is particularly a concern for wireless handsets which must pass “type approval” testing - one reason why Class D switching amplifiers have not readily been adopted for this application.

Why is Amplifier Efficiency an Issue?

Until now, phones were used mainly for voice calls, using a mono ear speaker and typically lasting 5-10 minutes. The power consumption of the amplifier circuit was not a major issue compared to other system components. However, with phones incorporating hands-free operation, MP3 music playback, and DMB reception, users may listen to phones for many hours. An inefficient amplifier could deplete the battery in this time.

What is Wolfson’s Solution?

Wolfson has launched an amplifier product that switches from Class AB to Class D mode transparently. This allows system designers to trade power efficiency for EMI (switching noise) and audio quality:

- Class D mode provides the benefit of power efficiency at the cost of slightly reduced performance and a level of switching noise which might, in some designs, interfere with RF functions such as mobile phone, GPS or FM radio reception.
- Class AB mode has the benefits of highest audio quality and not producing any switching noise, but its power efficiency is much lower.

A phone using this dual-mode amplifier can switch seamlessly from one mode to the other (under software control) depending on the use case.

Additionally, this also enables system designers to de-risk mobile phone designs – when designing for Class D operation, the option to switch back to Class AB in some or all use cases always remains open in case that EMI becomes a problem, without requiring any schematic or PCB layout changes.

We believe that Wolfson is currently the only company to produce this kind of dual-mode circuit.

Why are There Several Class-D Products from Wolfson?

Wolfson’s Class D products vary in many ways. For example, the WM8960 is a CODEC with an integrated Class D amplifier capable of delivering 1W per channel into two 8 Ohm output speakers. This is enough to drive the main speaker in a phone, or larger speakers in a cradle. The WM8985 is a CODEC with an integrated switchable Class D / Class AB headphone amplifier that produces much lower output powers, suitable for driving headphones rather than speakers. The WM8986 is a DAC with an integrated headphone amplifier. Additional Class D products may be released in future.

Does this Mean an Additional Chip in the Mobile Phone*?*

No, this technology has been integrated into audio CODEC chips eliminating the need for any external Class D or Class AB amplifiers

What About the Audio Performance of Class D?

Because Class D is a non-linear amplifier some early products launched many years ago suffered from low performance. Over the past 50 years this perception of inferiority has been eroded by advances in process technology and design techniques.

Today Class D amplifiers can be found in surround sound home theatre, LCD televisions, car sound systems and even battery powered hi-fi amplifiers.

Wolfson's integrated Class D amplifier technology is capable of producing a louder output for any given battery supply voltage, and performs nearly as well as its Class AB counterpart

CONTACT DETAILS:

HEADQUARTERS

Wolfson Microelectronics plc

26 Westfield Road
Edinburgh
EH11 2QB
United Kingdom
t: +44 (0)131 272 7000
f: +44 (0)131 272 7001
e:europe@wolfsonmicro.com

TAIWAN

Wolfson Microelectronics plc

2F, No.39, Alley 20, Lane 407,
Sec. 2 Tiding Boulevard,
NeiHu District, Taipei City 114,
Taiwan, R.O.C
t: +886 (0)8751 1600
f: +886 (0)8751 0201
e:asia@wolfsonmicro.com

KOREA

Wolfson Microelectronics plc

#502, Deokheung Building
1328-10, Seocho-Dong
Seocho Gu, Seoul 137-858
South Korea
t: +82 (0)2 584 3800
f: +82 (0)2 584 6336
e: korea@wolfsonmicro.com

JAPAN

Wolfson Microelectronics plc

6F Shinbashi
29 Mori Building
4-2-1 Shinbashi, Minato-ku
Tokyo 105-0004
Japan
t: +81 (0)3 5733 8677
f: +81 (0)3 3578 1488
e: japan@wolfsonmicro.com

CHINA

Wolfson Microelectronics plc

Room 1911
Cyber Times Tower A,
Tianan Cyber Park
Futian District,
Shenzhen, China
t: +86 (0)755 8347 6775
f: +86 (0)755 8347 6785
e: china@wolfsonmicro.com

USA

Wolfson Microelectronics Inc

16875 West Bernardo Drive
Suite 280, San Diego
CA 92127
USA
t: +1 (0)858 676 5090
f: +1 (0)858 676 0484
e: usa@wolfsonmicro.com

Wolfson Microelectronics plc

6F Honmachi Executive Office
3-5-3 Minami-Honmachi
Chuo-ku
Osaka 541-0054
Japan
t: +81 (0)6 6281 6140
f: +81 (0)6 6281 6141
e: japan@wolfsonmicro.com

Wolfson Microelectronics plc

Unit E2, 8F
Zhao Fong Universe Building
No.1800 Zhongshan West Road
Shanghai
China
t: +86 (0)21 6440 0358
f: +86 (0)21 6440 0388
e: china@wolfsonmicro.com

Wolfson Microelectronics Inc

245 First Street
Suite1800, Cambridge
MA 02142
USA
t: +1 (0)617 444 8492
f: +1 (0)617 444 8494
e: usa@wolfsonmicro.com

SINGAPORE

Wolfson Microelectronics Pte Ltd

101 Thomson Road
United Square
#05-02
Singapore 307591
t: +65 6356 6006
f: +65 6356 6116
e: singapore@wolfsonmicro.com

INDIA

Wolfson Microelectronics plc

Bangalore
t: +91 802 365 3406
e: india@wolfsonmicro.com