

Class D Audio Power Amplifier - iPod Dock

Version 1.0



Publication Date: 2010/02/22

Copyright © 2010 XMOS Ltd. All Rights Reserved.

1 Overview

Class D power amplifiers (PA) offer excellent power efficiency when compared to other classes of PA. The output stage switches at high frequency between fully on and fully off and can be controlled by a pulse width modulation (PWM) signal. The audio signal is kept in the digital domain right up until the final PA stage. This avoids degradation of the audio through analog stages, and also eliminates the additional bill of materials cost of a high quality DAC.

The XS1-L1 provides an excellent platform for an *all digital* iPod dock solution. Digital audio samples are acquired from the iPod across its USB interface and then used to drive a class D audio PA. A single XS1-L1 device provides all of the processing and interfacing requirements of the system: implementing the USB host to obtain the audio samples; performing digital signal processing (DSP) on the samples; driving the PWM to control the class D PA.

A general description of class D PAs is contained within a separate application note *Class D Audio Power Amplifier Overview*. This document describes a specific implementation of a class D PA integrated with the XMOS iPod Dock Reference Design.

2 iPod Class D Demonstration Hardware

The iPod class D PA demonstration was implemented on an iPod Dock Reference Design board (V1.0) connected to a class D prototype PCB. Four 1-bit ports are required to drive the stereo class D PA board, so wire modifications were made to the iPod Dock board to route these signals to the class D board (see Figure.1). The PA also needs a 12V power supply.

The class D PA is a stereo single ended implementation. The major components used on this PCB are listed in Table 1.

Manufacturer	Description	Part No	Qty	Cost(\$)*	Total Cost(\$)
Fairchild	Dual N-type and Ptype MOSFET	FDS4897C	2	0.21	0.42
Fairchild	MOSFET driver	FAN3227T	2	0.44	0.88
Panasonic	470uF DC Blocking Cap	EEU-FM1A471	2	0.08	0.16
Panasonic	220uF Reservoir Cap	EEU-FM1E2211	1	0.08	0.08
					1.54

* 1000 off prices obtained from Digikey.com on 2009/12/18

Table 1: Class D PA Bill Of Material



Figure 1: Photo of the iPod Dock Class D PA Hardware

The XS1-L1 operating at an XCore frequency of 400MHz has eight 50MHz threads.

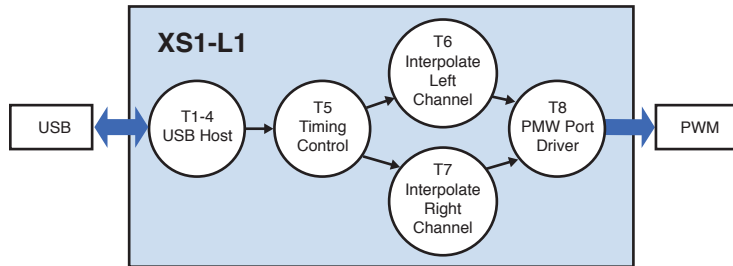


Figure 2: iPod Dock Class D PA Thread Diagram

Table 2 shows how the threads are allocated to the software tasks.

Thread	Thread Name	Description
1–4	USB Host	iPod Dock reference design
5	Timing Control	Generates 1ms timing packets to the iPod. Splits the left and right samples and buffers them.
6	Interpolate Left Channel	Upsamples and filters the audio input samples to the PWM frequency (for example 48kHz to 384kHz).
7	Interpolate Right Channel	Upsamples and filters the audio input samples to the PWM frequency (for example 48kHz to 384kHz).
8	PWM Port Driver	Drives the PWM ports for both channels using the PWM frequency samples.

Table 2: Class D iPod Implementaton: 50MHz Thread Requirements

Table 3 lists the performance figures for the Class D iPod Implementaton:

Power per Channel into 4R load	3W _{RMS}
Signal to Noise Ratio	-90.3 dB
Dynamic Range	85.4 dB
Total Harmonic Distortion + Noise (at maximum power -3dB)	0.345%

Table 3: iPod Dock Class D Audio Performance

3 Related Documents

Information about XMOS technology is primarily available from the XMOS web site; please see <http://xmos.com/documentation> for the latest documents or click on one of the links below to find out more information.

Document title
Class D Audio Power Amplifier Overview_amp

4 Document History

Date	Release	Comment
2010-02-22	1.0	First release

Disclaimer

XMOS Ltd. is the owner or licensee of this design, code, or Information (collectively, the "Information") and is providing it to you "AS IS" with no warranty of any kind, express or implied and shall have no liability in relation to its use. XMOS Ltd. makes no representation that the Information, or any particular implementation thereof, is or will be free from any claims of infringement and again, shall have no liability in relation to any such claims.

Copyright ©2009-10 XMOS Ltd. All Rights Reserved. XMOS and the XMOS logo are registered trademarks of XMOS Ltd in the United Kingdom and other countries, and may not be used without written permission. Company and product names mentioned in this document are the trademarks or registered trademarks of their respective owners. Where those designations appear in this document, and XMOS was aware of a trademark claim, the designations have been printed with initial capital letters or in all capitals.