CLARIDY Amps™

Clear Audio Reproduction / Intelligent class-D

by

InterSource
OEM, Inc.

Introduction

Class B amplification

Operating a pair of power devices in a linear state (constantly varying resistance, similar to a volume control or light dimmer), between off and full on, so that the output corresponds to the input signal. One device is used for the positive half of the waveform & transitions to the second device for amplification of the negative portion of the waveform.

Introduction

Class H amplification

Signal tracking power supply (typically switch mode) with class B output stage.

A performance mix between class D and class B.

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Introduction

Class D amplification

Operating the power devices in 2 states only (either on or off) at a frequency much higher than the input signal, with the average of the generated output volt-time-product corresponding to the input signal.

Introduction

There are no digital amplifiers, but some amplifiers are more digital than others.

Some refer to class D amplifiers as ”digital”, however, this is not technically accurate. Class D amps utilize pulse width modulation to generate their analog output signal (i.e. their net average output voltage varies directly with input voltage change).

True digital products (i.e. CD players), use pulse code modulation to sample the analog signal and generate a digital (binary 0’s and 1’s) representation.

Advantages of class D vs class B

- Higher efficiency: class D > 90% vs class B < 66%
  (1/3 heat generated)
- Idle losses for 100W are ~2.5W for our class D, compared to ~9W+ for a typical class B
- Smaller PCB area, overall size & weight
- Reduced heat sink & ventilation requirements
- Smaller power supply requirements
- Triple the power capability for a given size and weight
- Longer life expectancy due to less heat generation
- No idle current calibration reduces mfg. complexity
- No thermal drift (steady state or transient, see example on following graphs)
- Reduced $$ cost per Watt

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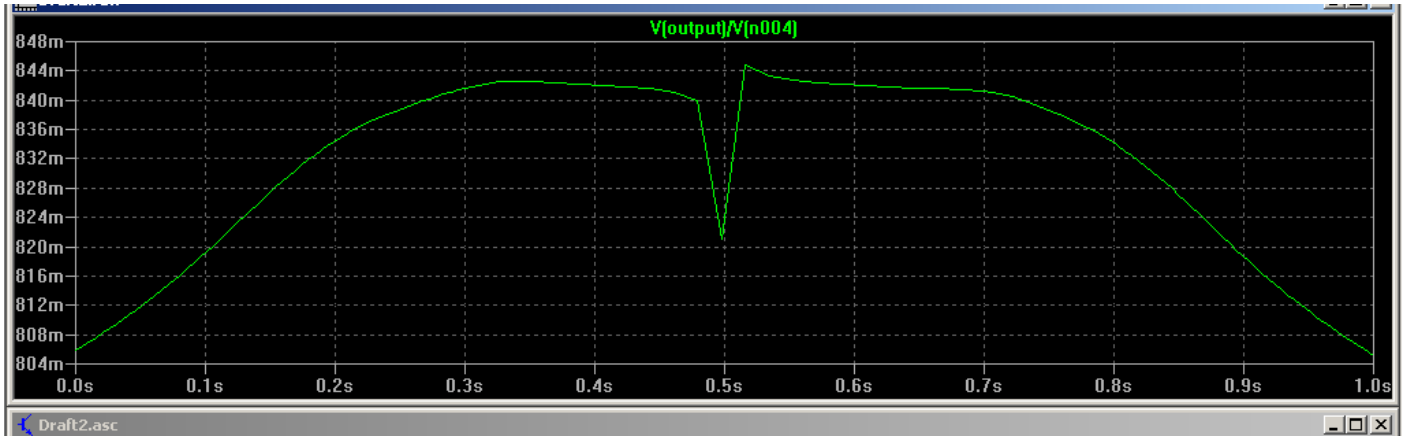
Introduction

Transfer function of class B idle current 50% of the signal swing



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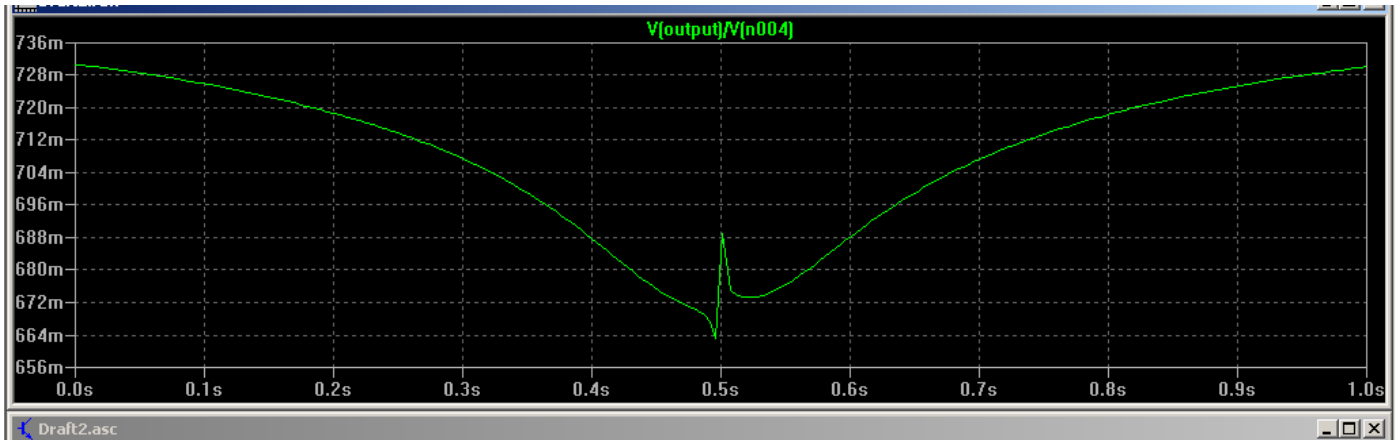
Introduction

Transfer function of class B idle current 5% of the signal swing



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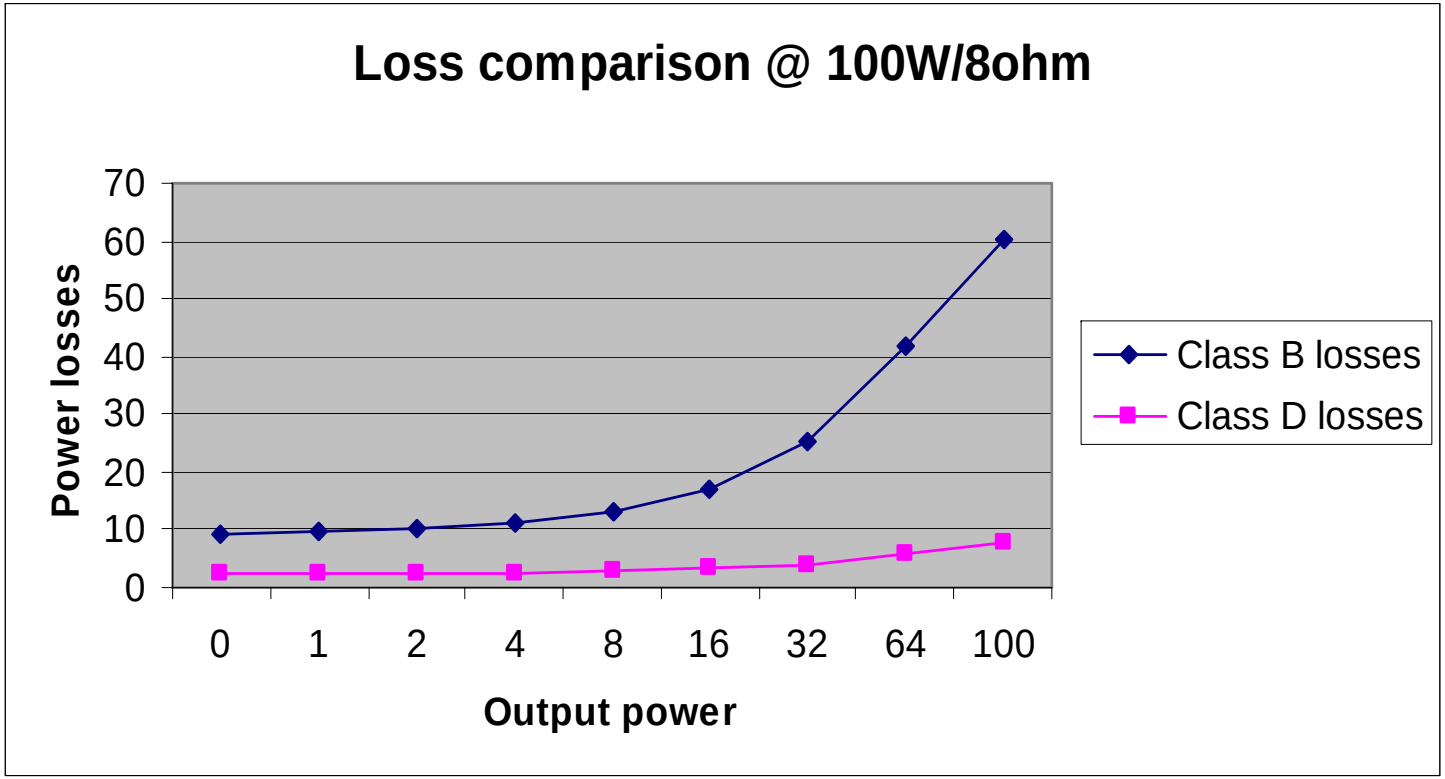
Introduction

Efficiency Comparison of class D vs class B

- A typical 100W x 1 channel class B amplifier played near max output wastes enough energy to power a 60W+ lighbulb
- A typical 1000W x 1 channel class B amplifier played near max output wastes enough energy to power a plasma TV and preamp
- Multiply the above by the number of channels channels in a modern home theater system or multi-room audio system
- The wasted energy is dumped back into the room in the form of heat, shortening the life of components & forcing home A/C's to run more frequently to maintain temperature
- In a "best case" scenario, home power outlets can supply ~15A @ 120V for ~1800W max of power. A class B amp could provide ~1kW max from this, where a class D amp could achieve 1500W
- See the following 2 graphs for illustration of efficiency

Introduction



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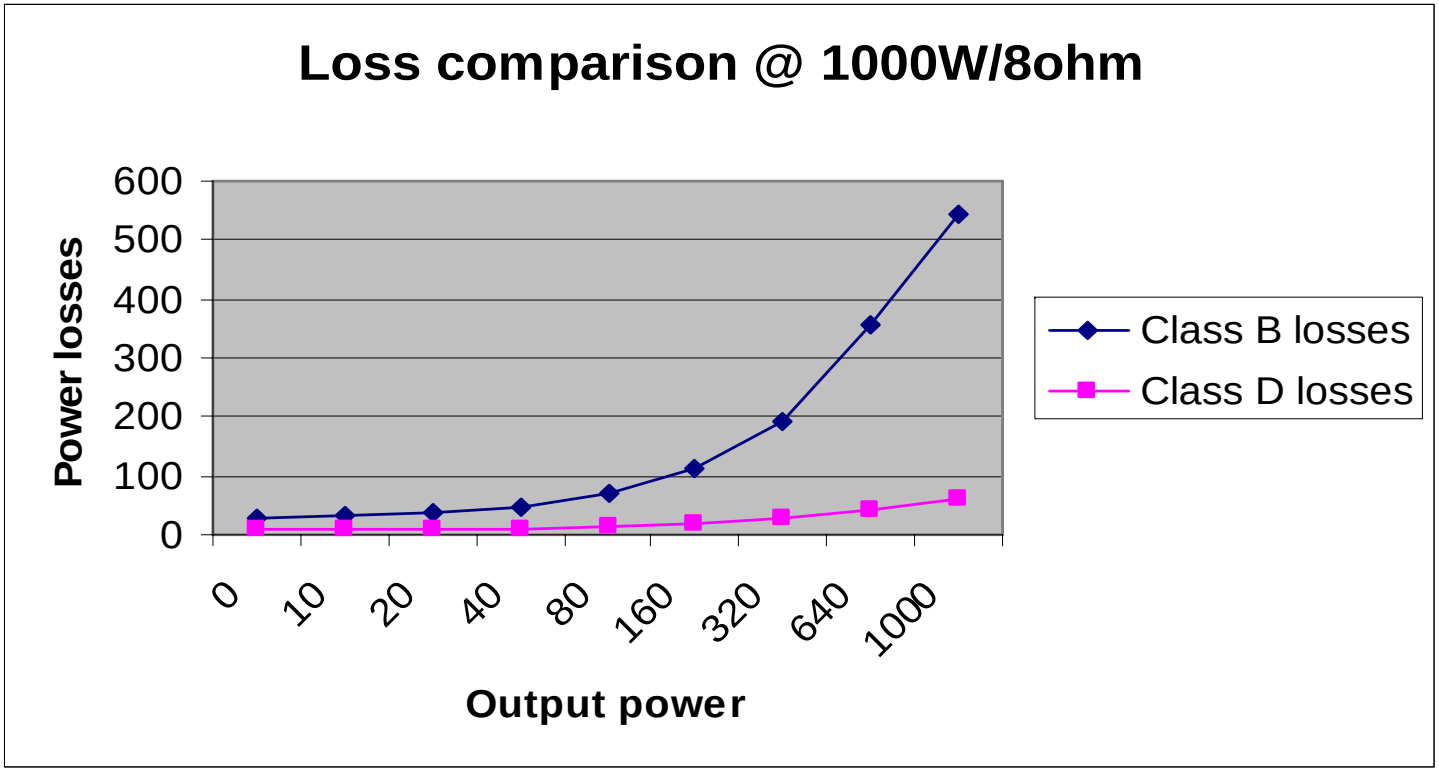
Introduction



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Introduction

Distortion categories

Linear distortion – does not change the harmonic content of the signal, for example gain variations & phase variations, which are much less noticeable to the human ear

Non linear distortion – changes the harmonic content of the signal and is very audible to the average listener

Introduction

Basic distortion sources in class D amplifiers

Modulation errors – odd order harmonics
(non linear)

Switching waveform errors – even and/or odd order harmonics (non linear)

Output filter problems – odd order harmonics (non linear)

Multiple feedback loops – (non linear)

High output impedance – frequency response and phase deviations (linear)

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Class D topologies

Class D Topology #1:
Triwave modulation

The original switching topology developed for class D amplifiers and still the most common.

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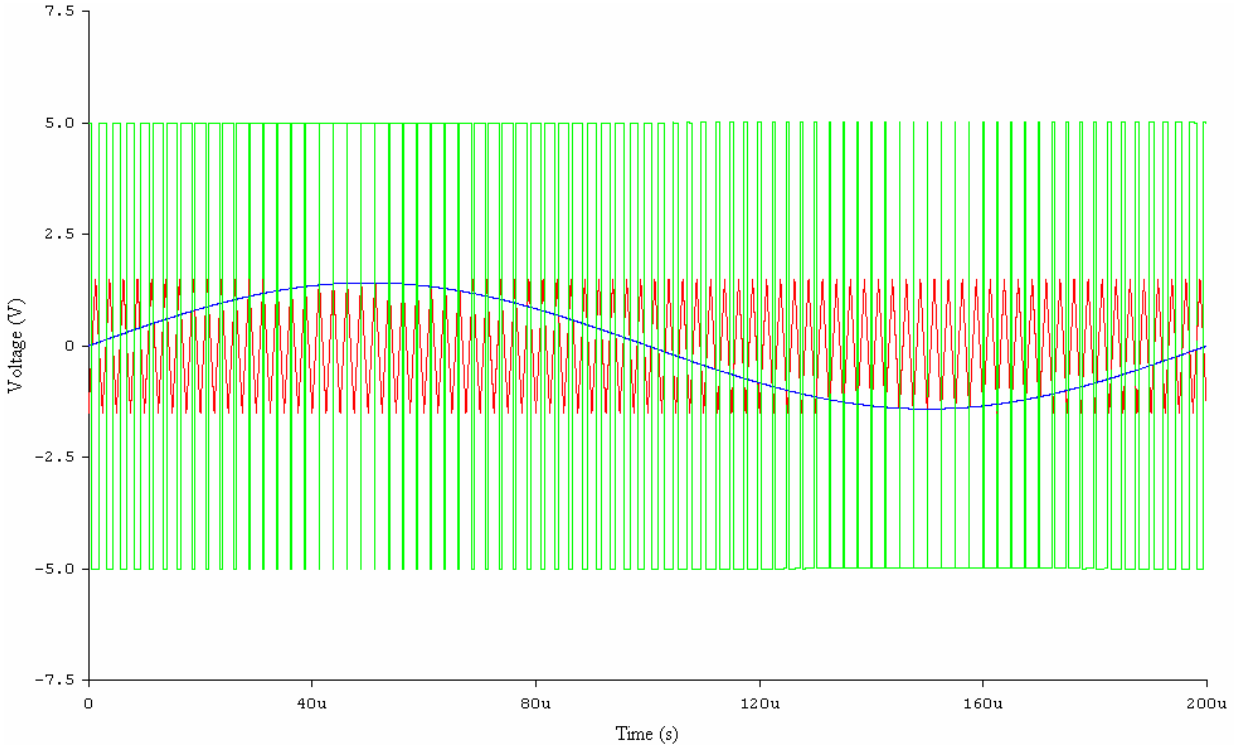
Class D topologies

Triwave modulation, PWM generation



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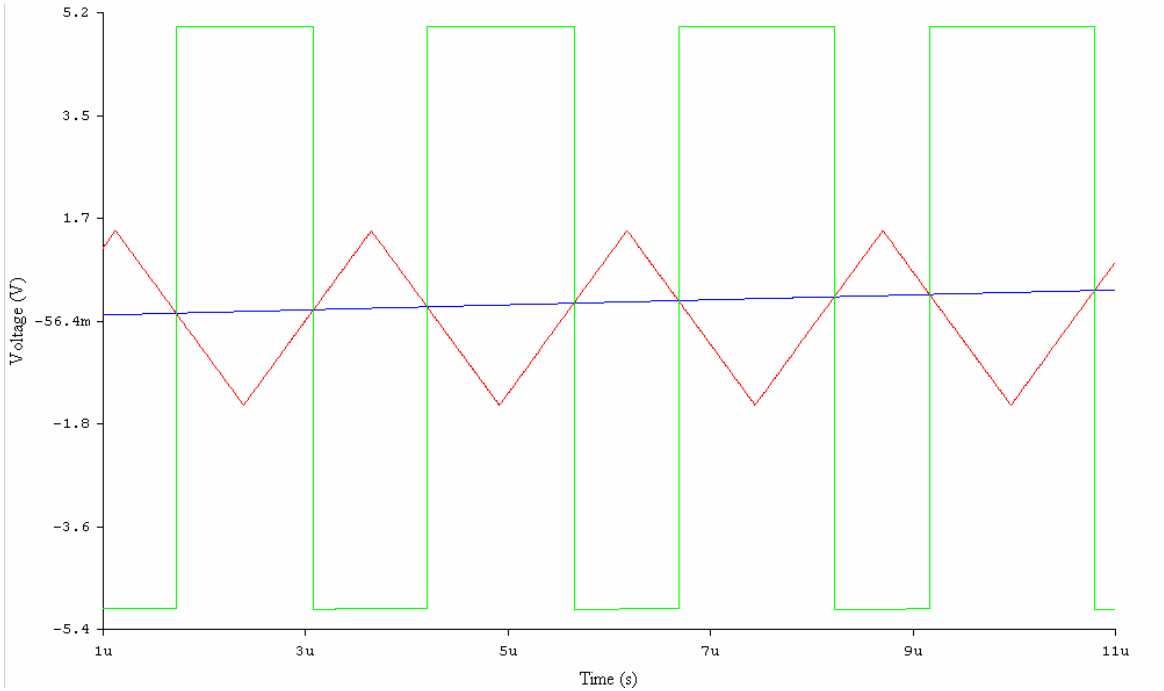
Class D topologies

Triwave modulation, PWM zoom



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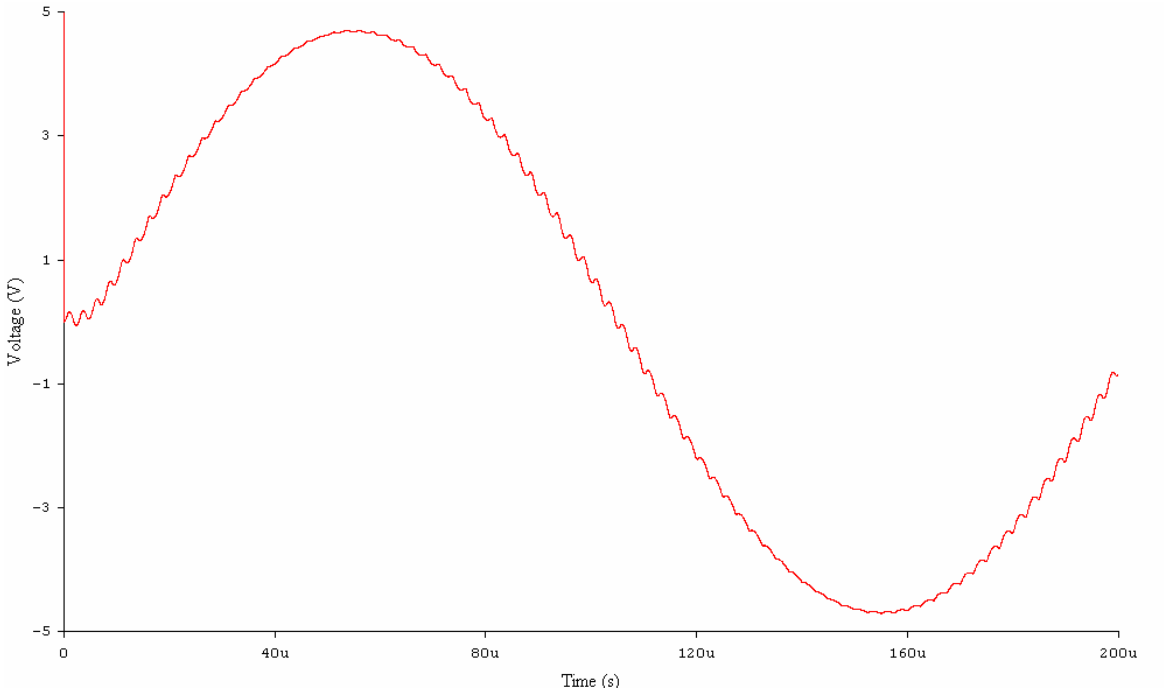
Class D topologies

Triwave modulation, output signal



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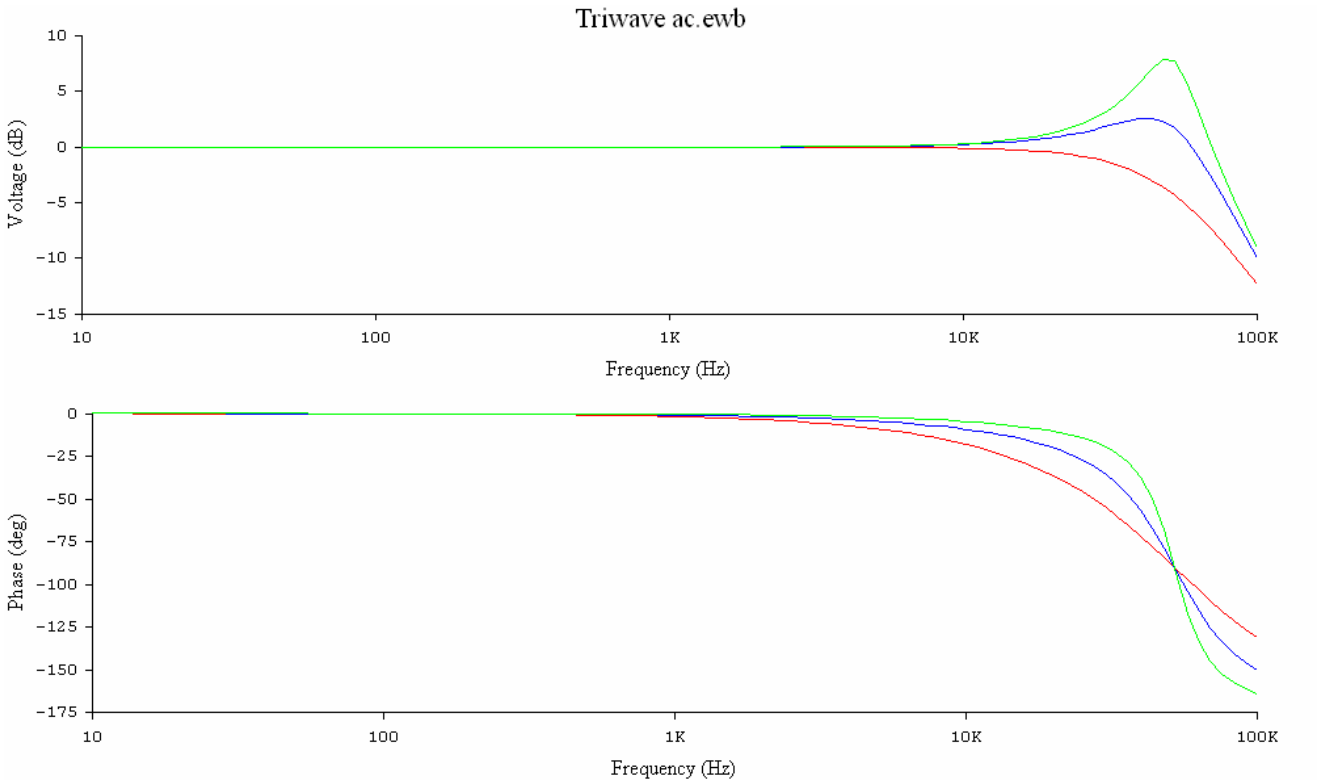
Class D topologies

Triwave modulation, frequency response



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Class D topologies

Triwave modulation, pro's and con's

Pro: Fixed switching frequency – nice clipping behavior
Pro: Global feedback loop can give up to ~20dB of negative feedback – helps reduce linear distortion

Con: Two signal paths, input to output & power rails to output – third order nonlinear distortion & crosstalk
Con: Fixed switching frequency – poor efficiency and high EMI
Con: Global feedback introduces nonlinear distortion
Con: Gain varies with supply voltage – requires feedforward
Con: Complexity, high parts count & high cost

Class D topologies

Class D Topology #2:
Digital modulation

A modern variation of the original triwave modulation topology, using a DSP to generate and control the PWM switching waveform.

Class D topologies

Digital modulation, pro's and con's

Pro: Fixed switching frequency? – nice clipping behavior
Pro: Global feedback loop can give up to ~20dB of negative feedback – helps reduce linear distortion

Con: Possible extra DSP distortion – quantization error & jitter
Con: Two signal paths, input to output & power rails to output – third order nonlinear distortion & crosstalk
Con: Fixed switching frequency? – poor efficiency and high EMI
Con: Global feedback introduces non linear distortion
Con: Gain varies with supply voltage – requires feedforward
Con: Complexity, high parts count & high cost

Class D topologies

Class D Topology #3:
Phase modulation – pre filter

An new & elegant modulation technique based on the self oscillation principle.

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Class D topologies

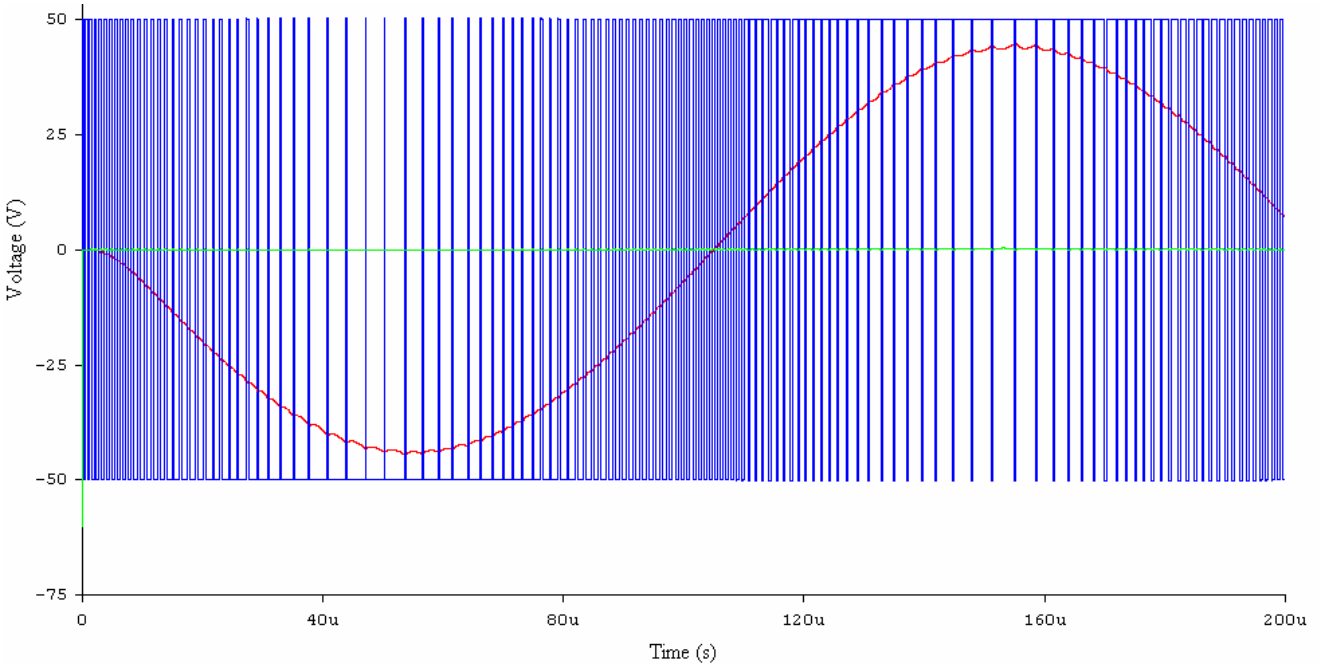
Phase modulation principle of operation

If the output is too low, increase it!

If the output is too high, decrease it!

Class D topologies

Phase modulation – pre filter, PWM generation



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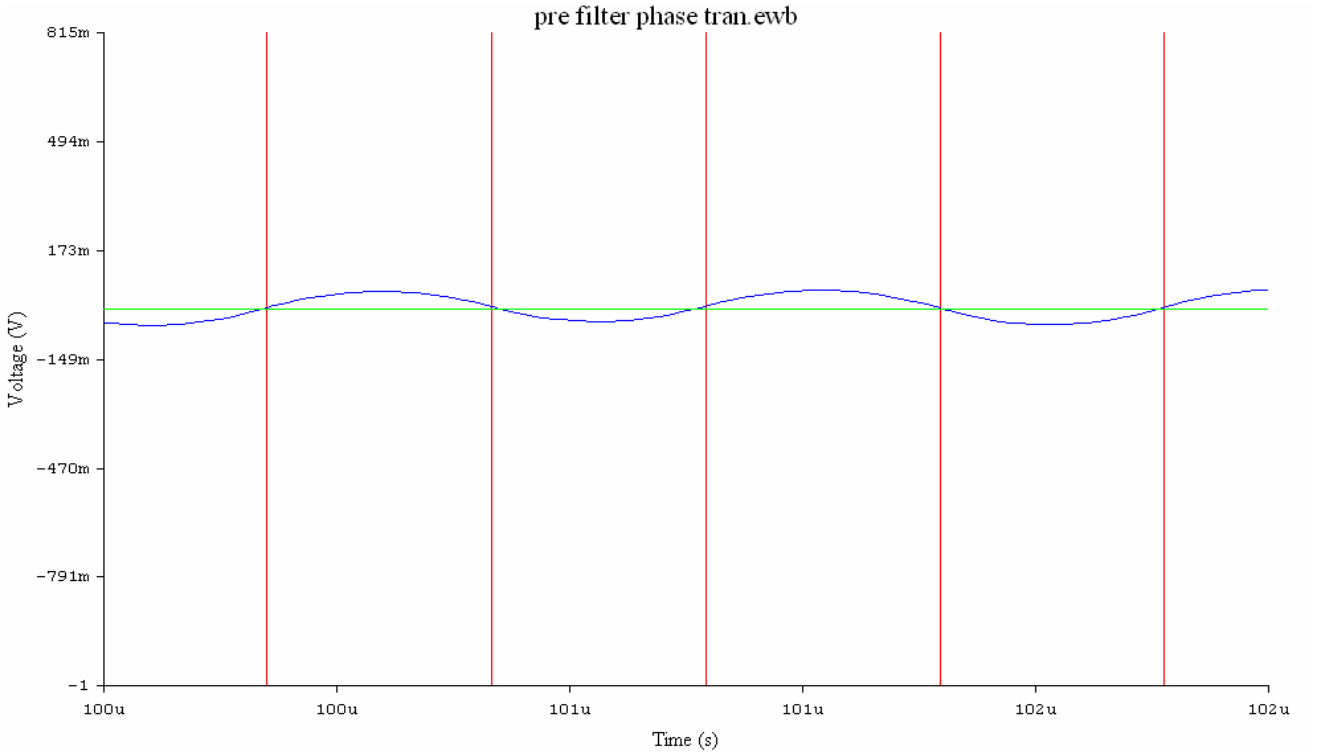
Class D topologies

Phase modulation – pre filter, PWM zoom



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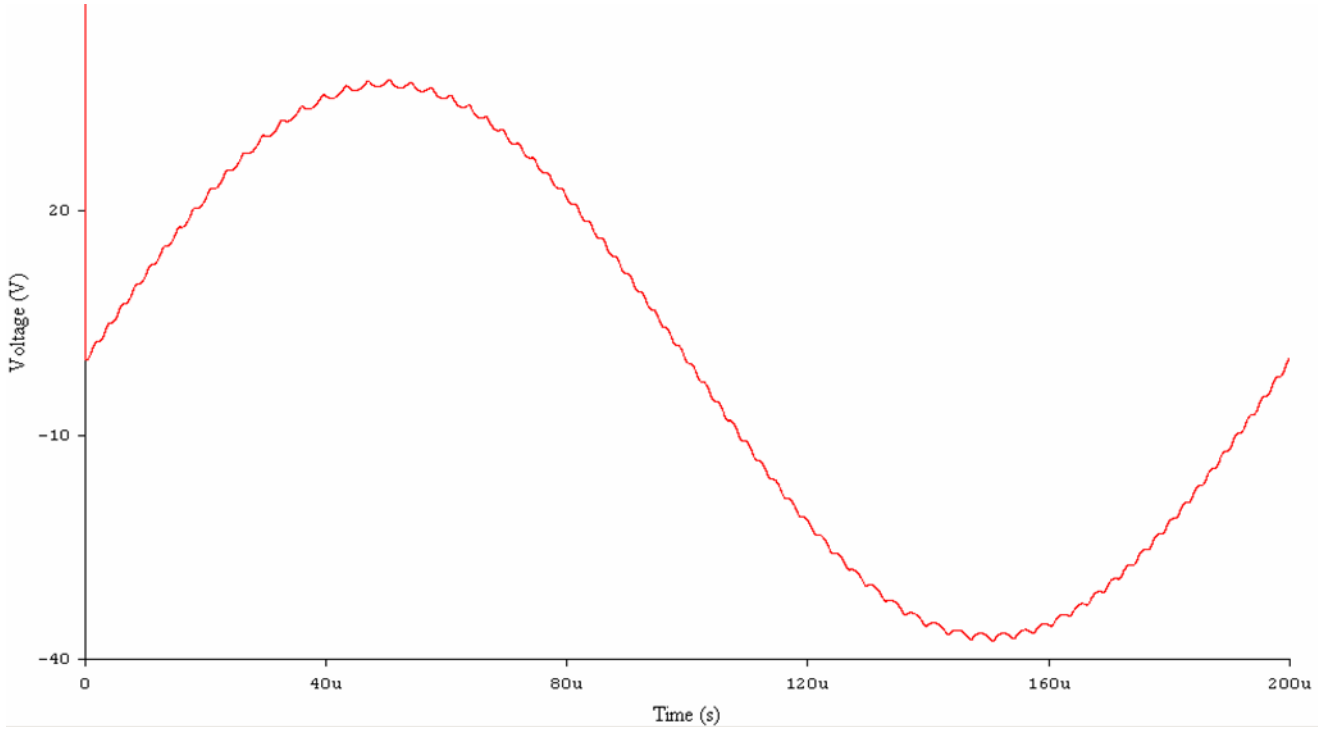
Class D topologies

Phase modulation – pre filter, output signal



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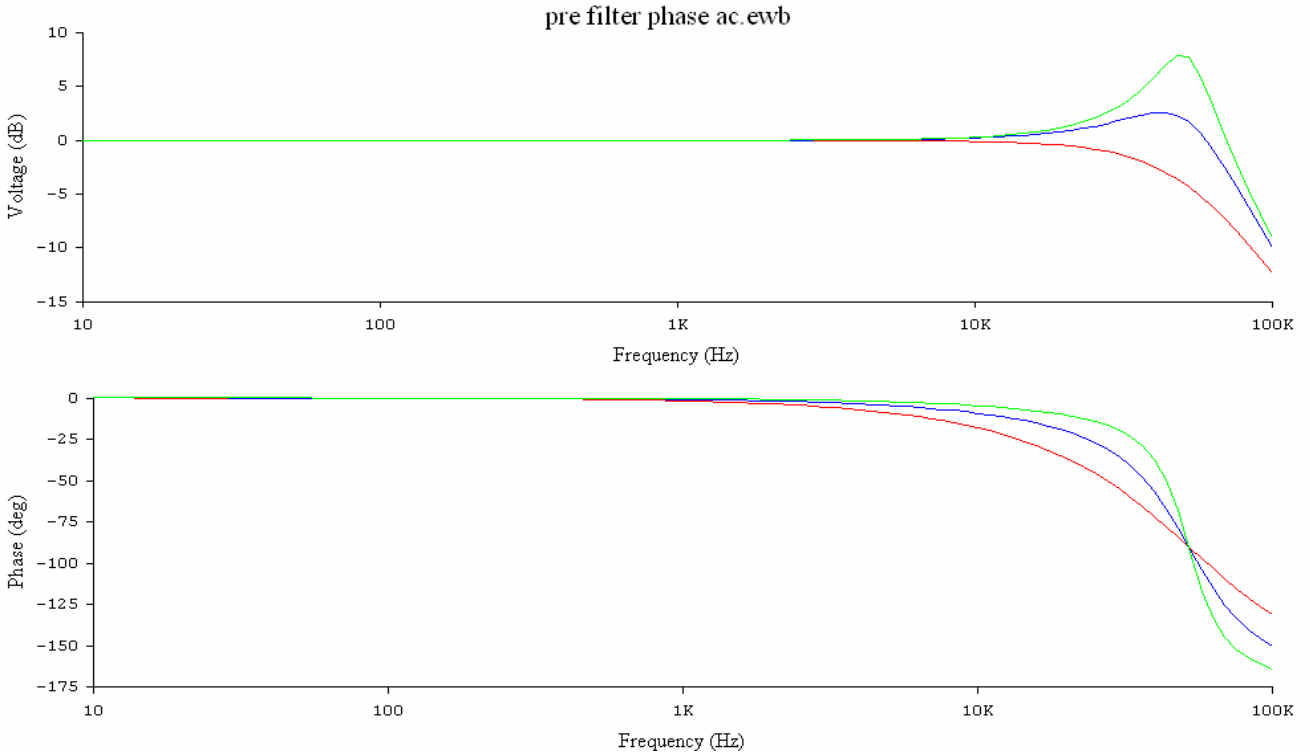
Class D topologies

Phase modulation – pre filter, frequency response



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Class D topologies

Phase modulation – pre filter, pro's and con's

Pro: Varying switching frequency – high efficiency and low EMI
Pro: High loop gain – low nonlinear distortion, high power suppply rejection ratio
Pro: Simplicity – low cost and robust

Con: Output filter left outside of the loop – load dependent frequency response

Class D topologies

Class D Topology #4:
Phase modulation – post filter

An new & elegant modulation technique based on the self oscillation principle.

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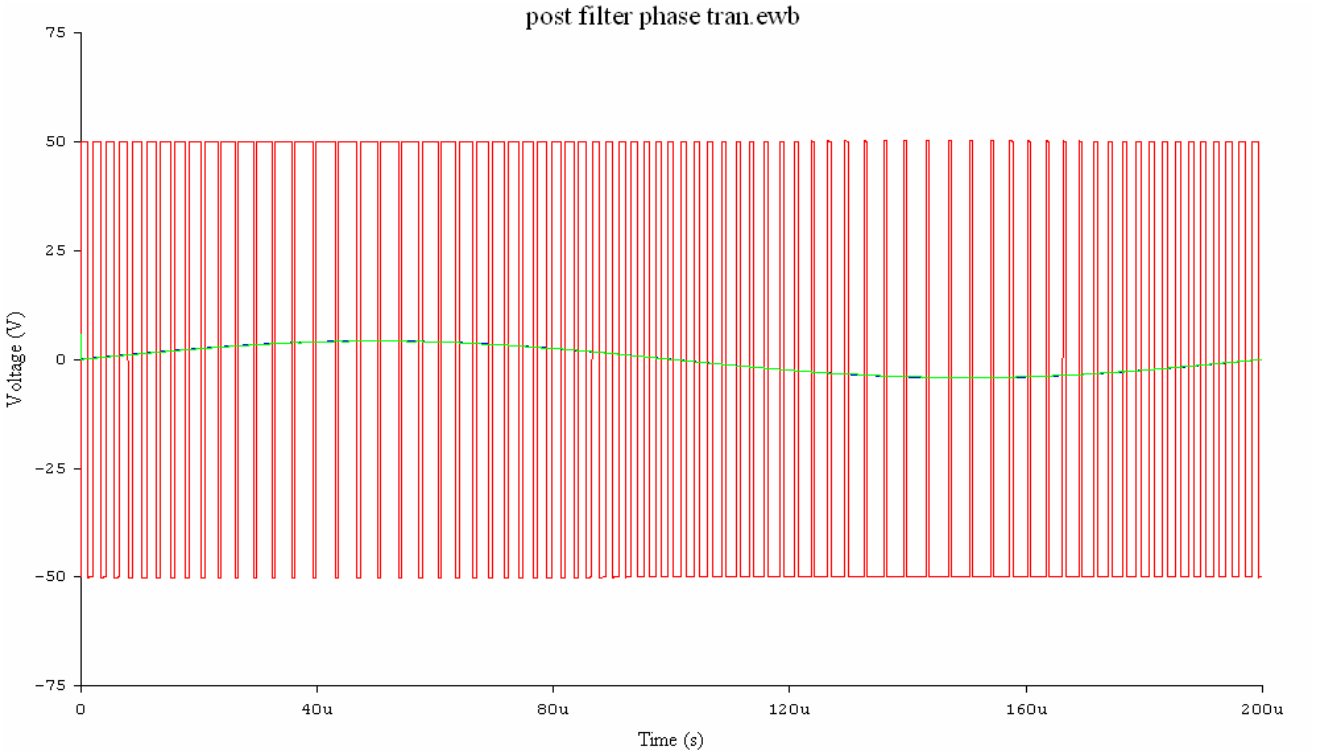
Class D topologies

Phase modulation – post filter, PWM generation



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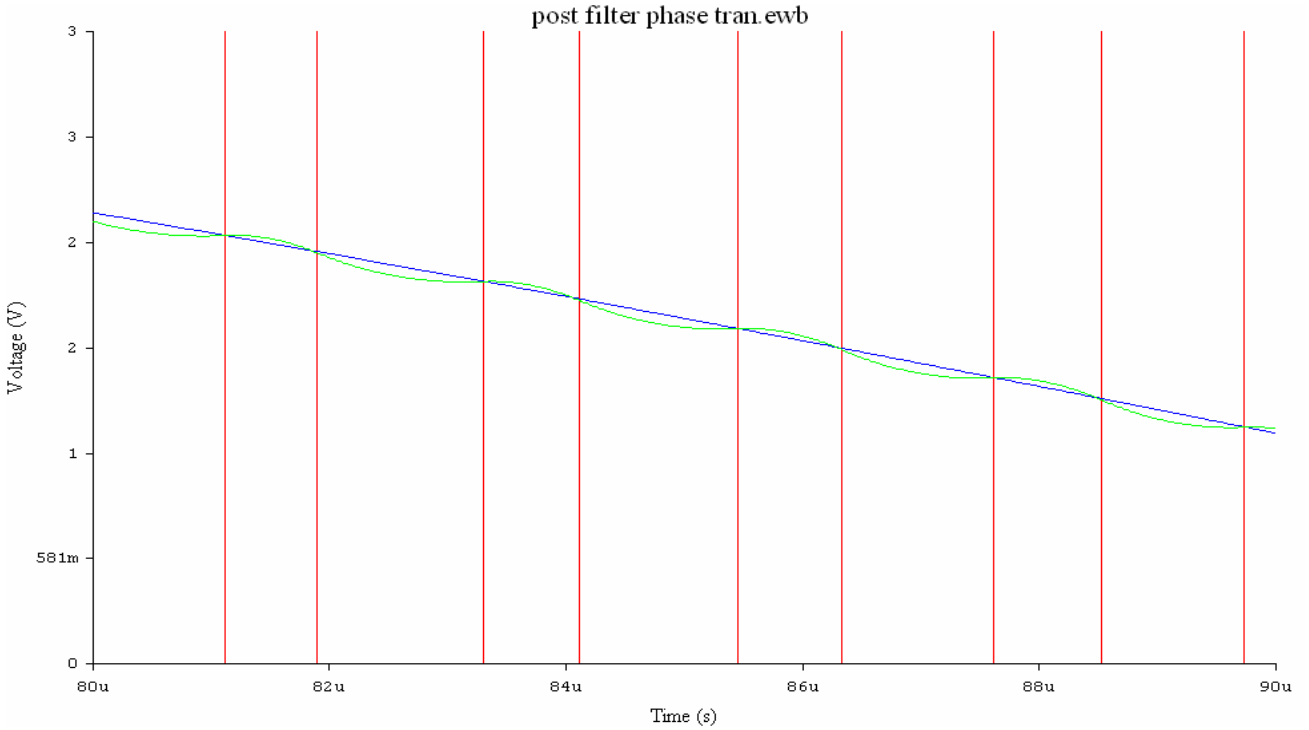
Class D topologies

Phase modulation – post filter, PWM zoom



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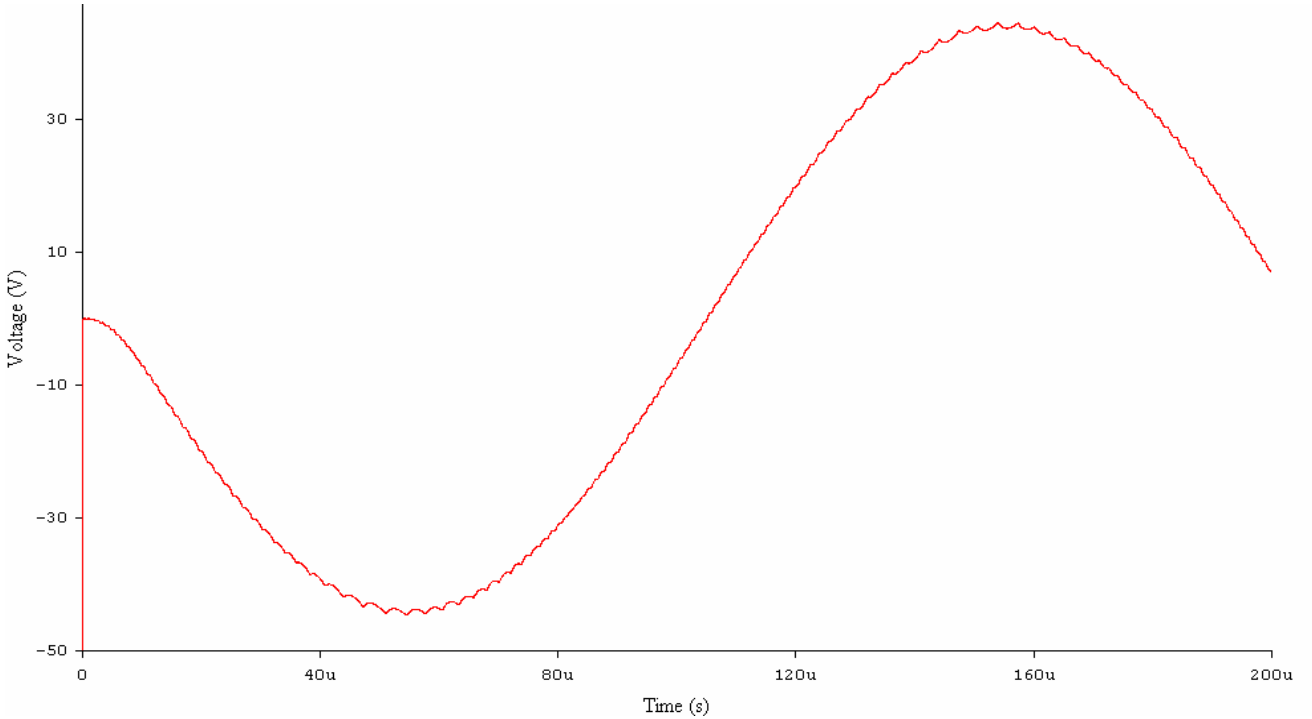
Class D topologies

Phase modulation – post filter, output signal



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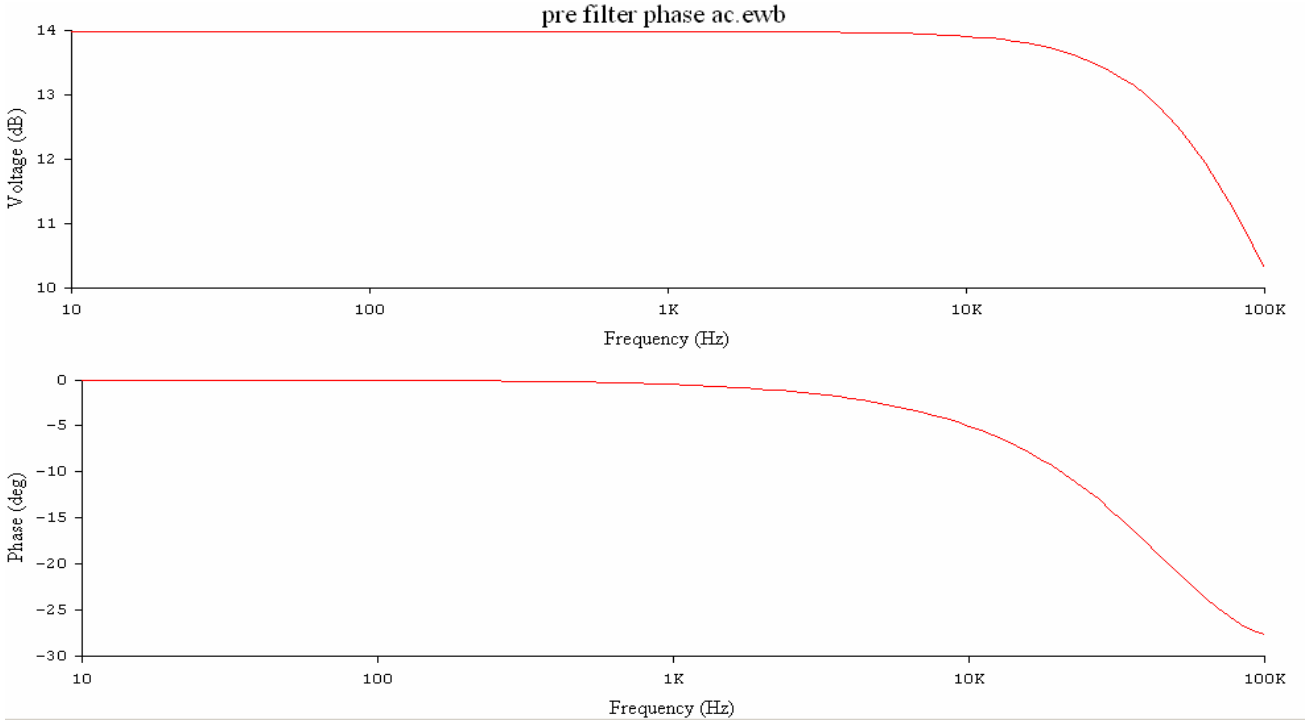
Class D topologies

Phase modulation – post filter, frequency response



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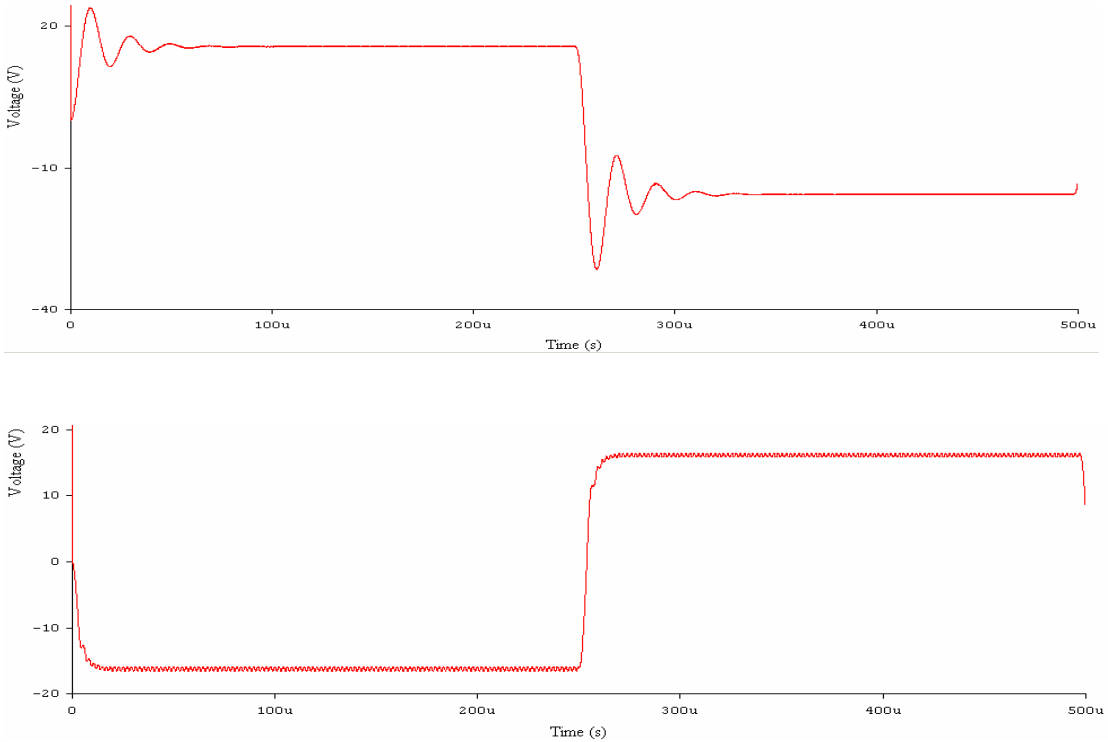
Class D topologies

Pre filter vs post filter modulation - transient response



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Class D topologies

Phase modulation – post filter, pro's and con's

Pro: Variable switching frequency – high efficiency and low EMI

Pro: High loop gain – low non linear distortion, high power supply rejection ratio

Pro: Straightforward – low component count and robust

Pro: Constant loop gain – constant distortion vs frequency

Pro: Output filter included in the loop – perfect frequency response and transient response

Con: Difficult to optimize

Summary

- Class B and H amplifiers have inherent performance limitations, especially in today's market for high power & efficiency
- Class B and H amplifiers become increasingly less practical as power levels increase
- Class D amplifiers are NOT all the same!
- Class D designers have many different topologies to choose from with different characteristics for noise, distortion, EMI, efficiency, reliability and cost
- Class D amplifiers CAN be designed & built with excellent sound quality
- Class D amplifiers offer far greater power output capability than class B or H amplifiers

Summary

- Class D amplifiers generate far less heat than other types of amps
- Class D amplifiers CAN be more reliable than class B or H amplifiers at high power
- Class D amplifiers CAN offer excellent EMI performance when designed properly
- Phase oscillating topologies are superior to triwave and digital modulation
- Pre filter phase modulation has the lowest overall nonlinear distortion
- Post filter phase modulation has the lowest overall linear distortion

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Summary

CLARIDY Amps™ Proudly Feature the Anaview Custom Controller IC

- Exclusive design partner & North American representative for Anaview switch mode control solutions
- IC suitable for switching amps up to 4000W
- Low distortion, excellent sound quality
- Compact size – reduced PCB area
- Low EMI
- Includes powerful gate drivers
- Digital dead time setting
- Ultra low propagation delay, 65ns
- High efficiency, environmentally friendly ”green power”

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CLARIDY Amps™

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Summary

- Proprietary two mode protection system with loss-less current sensing for greater reliability
- Available Anaview supervision/diagnostic solutions for external status monitoring of amplifier & speaker condition
- Class D amplifier power range from watts to kilowatts
- Switch mode power supplies ranging from watts to kilowatts for use with our stand alone amp modules
- Complete line of amplifier solutions for the O.E.M. market
- Standard & custom designs available
- Single & multi-channel solutions for home, pro-sound & automotive O.E. manufacturers
- Subwoofer & full range optimized designs
- Leading edge pre-amp solutions
- THX Ultra 2 amplifiers platforms possible

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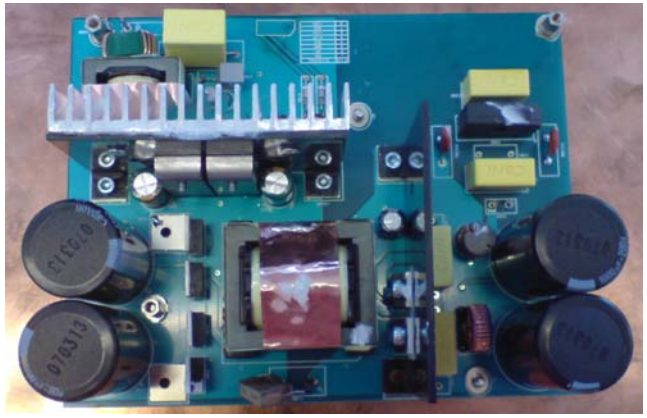
Product Example

Subwoofer Platforms – 200W & 300W

Features

•1x200+W, or 1x300+W @ 0.1% THD+N into 4 ohm load
•High efficiency, ~90%
•Built in power supply
•Low THD
•Low noise
•Excellent EMI performance
•Low output impedance
•Over current & voltage protection
•Thermally protected
•Differential inputs
•Clipping detection
•Low voltage DC supply to power available pre-amps
•Available as complete plate amp solutions
•Ready to ship Q4 2007



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Product Example

Subwoofer Platforms – 500W & 800W

Features

- 1x500+W, or 1x800+W @ 0.1% THD+N into 4 ohm load
- High efficiency, ~90%
- Built in power supply
- Low THD
- Low noise
- Excellent EMI performance
- Low output impedance
- Over current & voltage protection
- Thermally protected
- Differential inputs
- Clipping detection
- Low voltage DC supply to power available pre-amps
- Available as complete plate amp solutions
- Scheduled for availability Q2 2008

Under Development

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Product Example

Subwoofer Platforms – 1500W & 2000W

Features

- 1x1500+W, or 1x2000+W @ 0.1% THD+N into 4 ohm load
- High efficiency, ~90%
- Built in power supply
- Low THD
- Low noise
- Excellent EMI performance
- Low output impedance
- Over current & voltage protection
- Thermally protected
- Differential inputs
- Clipping detection
- Low voltage DC supply to power available pre-amps
- Available as complete plate amp solutions
- Scheduled for availability Q4 2008

Under Development

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CLARIDY Amps™
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Product Example

Full Range Platform – 200W

Features

- 1x200+W @ 0.1% THD+N into 4 ohm
- High efficiency, ~90%
- Built in power supply
- Low THD
- Low noise
- Excellent EMI performance
- Low output impedance
- Over current & voltage protection
- Thermally protected
- Differential inputs
- Low voltage DC supply to power pre-amp board
- Ready to ship Q4 2007

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Product Example

Full Range Module – 150W

Features

- 1x150W @ 0.1% THD+N into 4 ohm
- High efficiency, >92%
- Requires external power supply
- Low THD
- THD+N <0.002% @ 10W, 1kHz
- Low noise
- Excellent EMI performance
- Burst mode over current protection
- Over voltage protection
- Thermal protection
- Differential inputs
- Clipping protection
- 2 Modules Bridgeable to 300W into 8 ohm load
- Suitable for multi channel use
- Ready to ship Q4 2007

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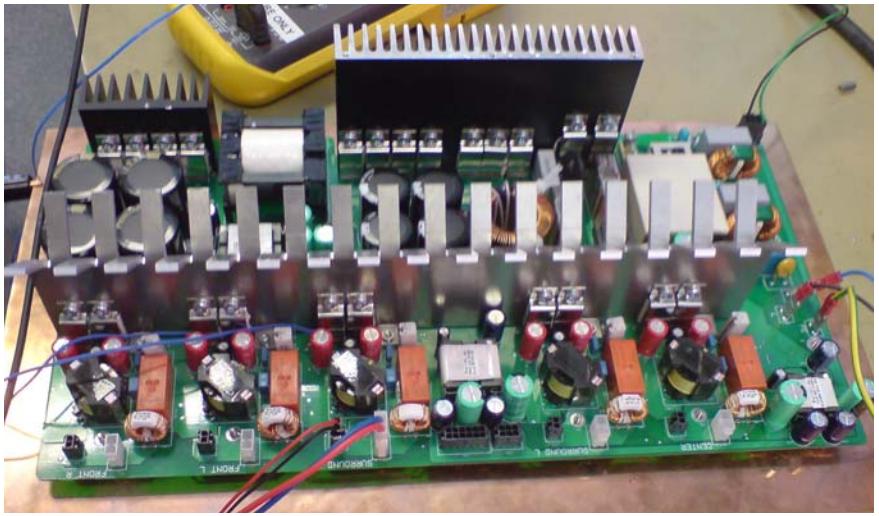
Product Example

5x120W Receiver Platform

Features

- 5x120W @ 0.1% THD+N
- Wide input voltage range
- Sine-shaping input stage
- Lowest THD in the industry
- Ready to ship Q4 2007



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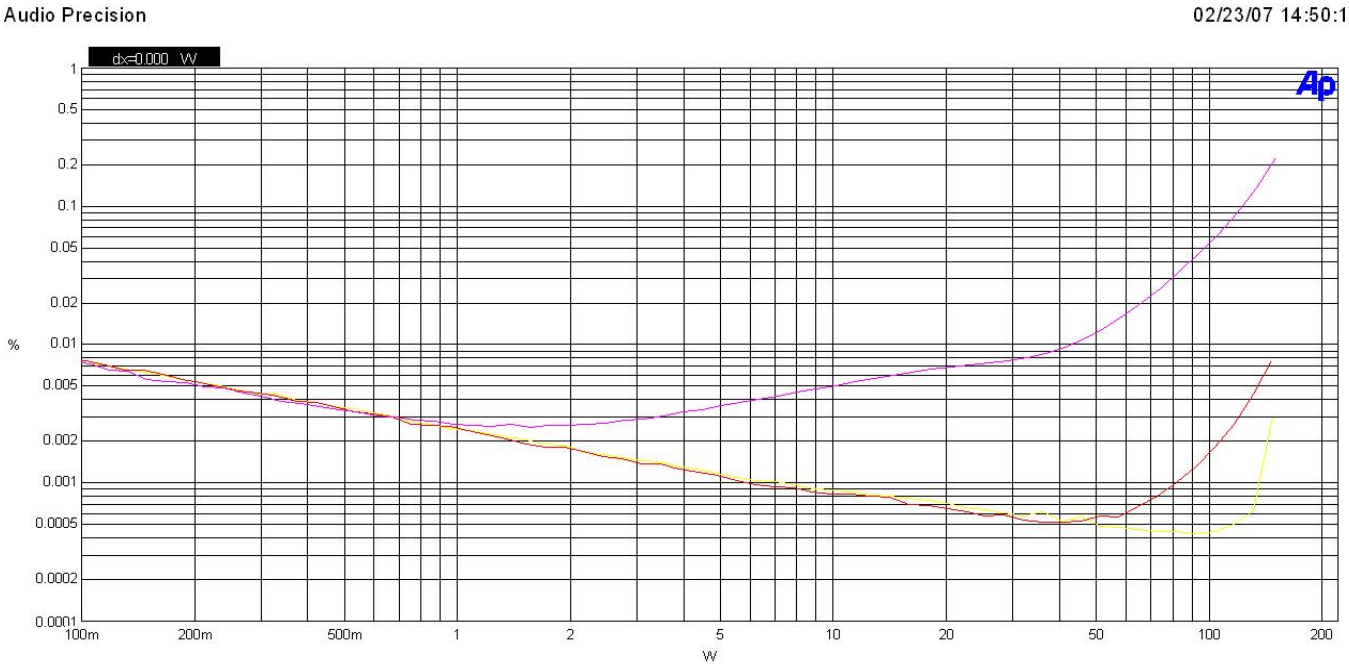
Product Example

5x120W Receiver Platform



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment	Cursor1	Cursor2
1	1	Yellow	Solid	1	Anlr.THD+N Ratio	Left		□..	¾..
2	1	Red	Solid	1	Anlr.THD+N Ratio	Left		□..	¾..
3	1	Magenta	Solid	1	Anlr.THD+N Ratio	Left		□..	¾..

THD+N 100Hz, 1kHz and 6.67kHz

THDvsPWR_8ohm_FRONT_R.at27

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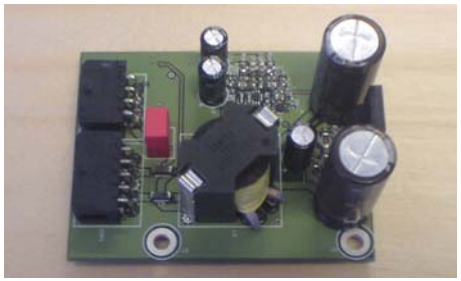
Product Example

Post filter modulation amplifier 130W/4ohm

Features

- 50uVrms idle noise unweighted full band
- 5mV typical DC offset
- 500mV peak switching residual
- 400kHz idle switching frequency
- No zobel network
- 2W idle losses per channel including auxiliary supplies



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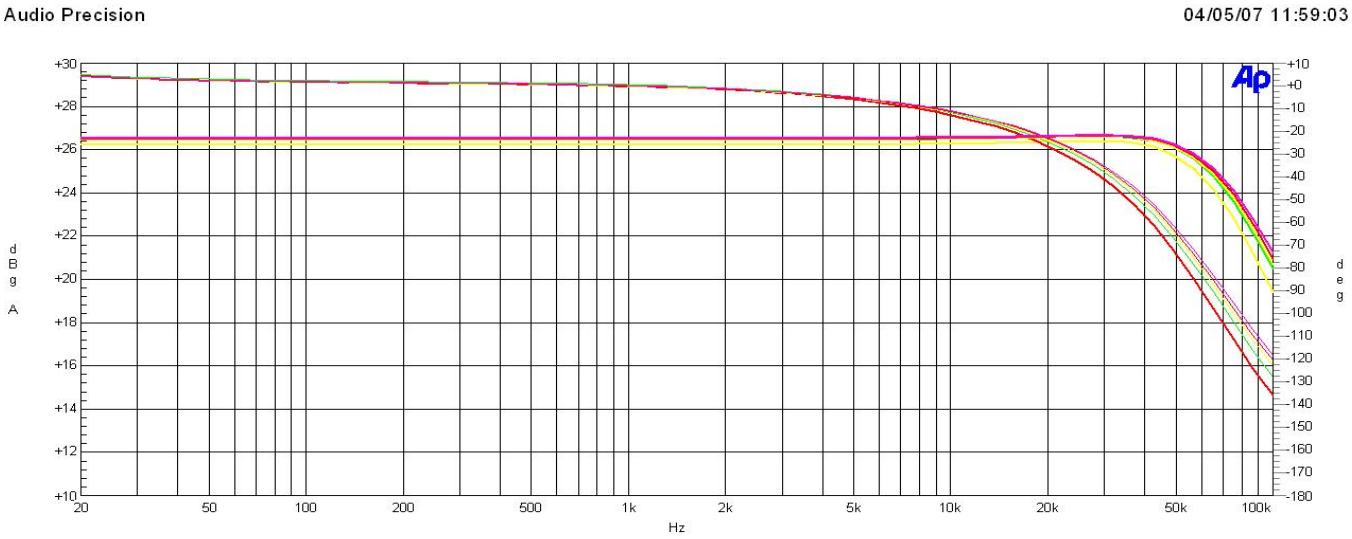
Product Example

Frequency response into 2ohm, 4ohm, 8ohm, 16ohm and open load



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Yellow	Solid	2	Anlr.Level A	Left	2ohm
1	2	Red	Solid	2	Anlr.Phase	Right	
2	1	Green	Solid	2	Anlr.Level A	Left	4ohm
2	2	Green	Solid	1	Anlr.Phase	Right	
3	1	Yellow	Solid	2	Anlr.Level A	Left	8ohm
3	2	Yellow	Solid	1	Anlr.Phase	Right	
4	1	Red	Solid	2	Anlr.Level A	Left	16ohm
4	2	Red	Solid	1	Anlr.Phase	Right	
5	1	Magenta	Solid	2	Anlr.Level A	Left	Open load

Freq resp loads.at27

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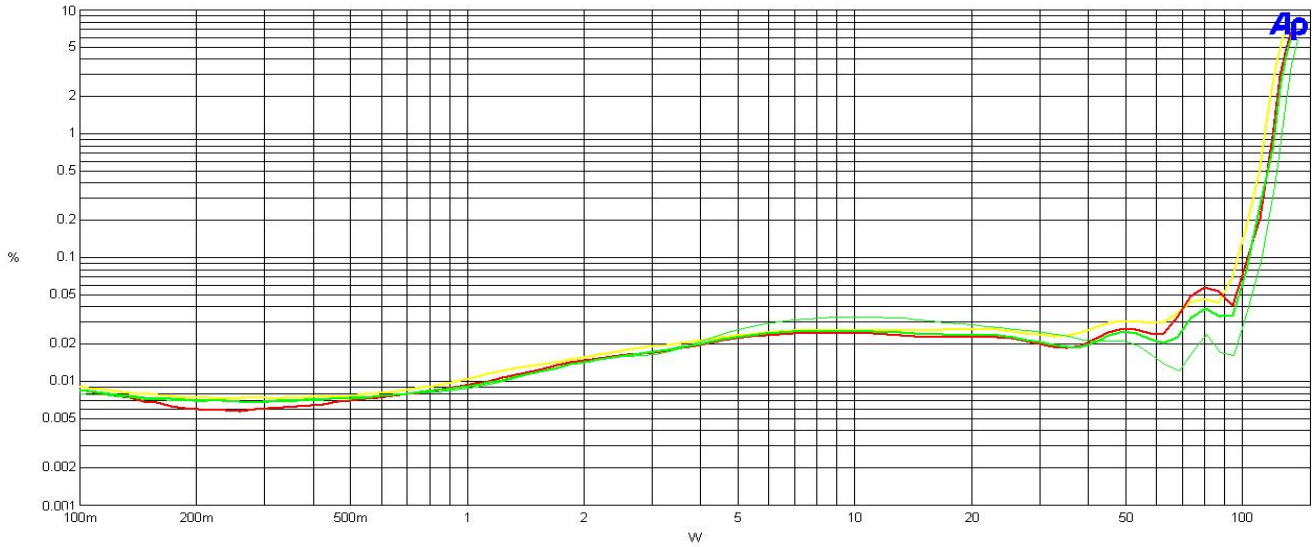
Product Example

THD+N vs power into 4ohm @ 20Hz, 100Hz, 1kHz and 6.67kHz

Audio Precision 04/05/07 12:20:47



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Yellow	Solid	2	Anlr.THD+N Ratio	Left	20Hz 4ohm
2	1	Red	Solid	2	Anlr.THD+N Ratio	Left	100Hz 4ohm
3	1	Green	Solid	2	Anlr.THD+N Ratio	Left	1kHz 4ohm
4	1	Green	Solid	1	Anlr.THD+N Ratio	Left	6.67kHz 4ohm

THDvsPWR 32V rails.at27

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