PURIFI

PURE SOUND

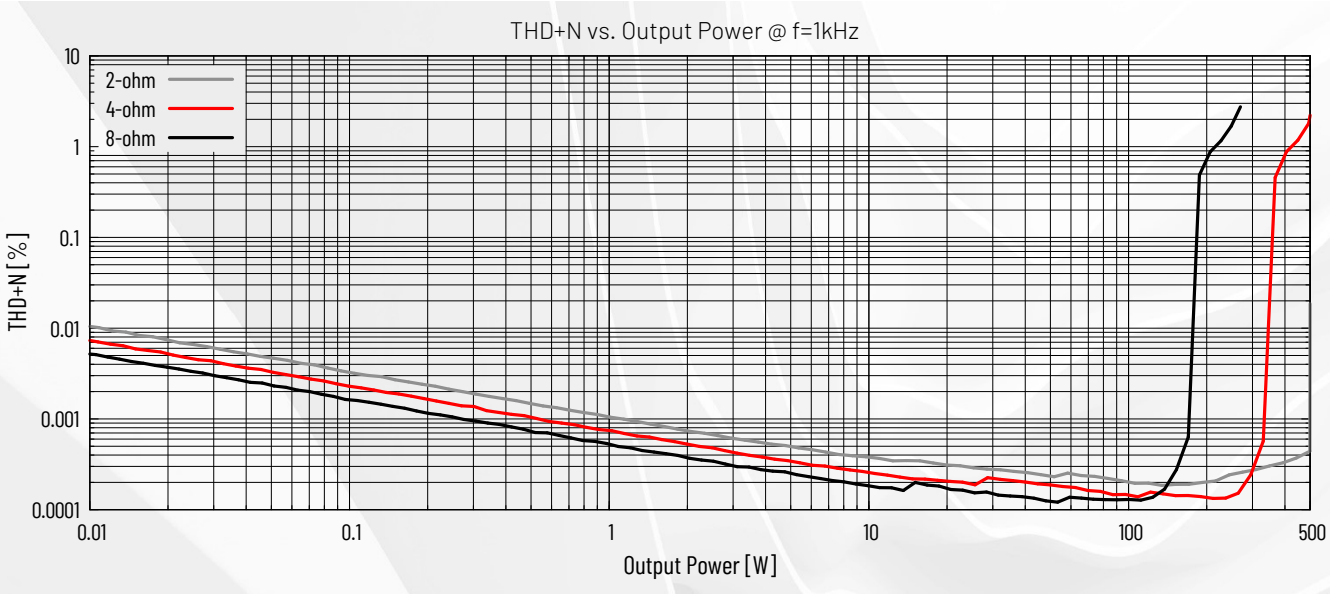
Building a Straight Wire to the Soul of Music

1ET400A
PRODUCT BRIEF

- Single-channel, analog-input Class D amplifier module
- Negligible THD and IMD
- Extraordinarily low noise
- Load-invariant response
- Exceptionally clean clipping
- Low losses & high efficiency
- Easy to integrate

KEY SPECIFICATIONS

Output Power	450W @ 1% THD, 4Ω
Output Current	~25A
THD+N	<0.00017% (-116dB) @ 100W, 4Ω, 20-20kHz
Dynamic Range	~131dB(A)
Output Noise	~11.5µV(A)
Gain	12.8dB
Output Impedance	<65µΩ @ 1kHz
Efficiency	>94%
Idle losses (output stage)	~1.7W
Supply	±25V to ±65V DC
Size	82x63x35mm



1ET400A is a single-channel, ultra-high performance, analog-input Class D Amplifier module capable of over 400W of power at an audio quality level that sets the standard for power amplifiers of any operating class. Its compact size and high reliability makes it fit a broad range of applications, while its audio quality makes it the undisputable choice even in applications where all the premium is on sound quality.

PURIFI's continuing research into nonlinear control theory has produced the first mathematically exact large-signal model of self-oscillating amplifier controllers. This breakthrough allows complete optimization of the feedback circuit and improves performance by at least an order of magnitude over existing implementations. The amplifier module further incorporates a comprehensive protection system that makes it tremendously robust and easy to integrate.

These circuits and methods provide many practical and audible benefits:

- ***High loop gain (>75dB) in the entire audio band***
  - *This figure corresponds to an unprecedented 110MHz Gain-Bandwidth Product and produces consistent ultra-high performance across the audio spectrum unmatched by audio amplifiers of any technology or operating class.*
- ***Negligible Intermodulation Distortion (IMD)***
  - *A very good measure for how well an amplifier handles complex signals. Sonically low IMD means a highly resolved and stable stereo image across the whole spectrum, even during very complex and busy passages.*
- ***THD remains extremely low at any frequency and any power level*** *right until clipping*
  - *Translates into a total lack of sonic signature, and an ability to reproduce any type of music without preference for genre or production style.*
- ***Negligible output noise***
  - *No audible noise. Deep black silences and a generous and detailed sound even at very low playback volumes.*
- ***High power supply rejection ratio (PSRR)***
  - *The module places no particular demands on the power supply quality. A simple off-the-shelf unregulated SMPS will not degrade audio performance.*
- ***Load-invariant frequency response and negligible output impedance***
  - *The amplifier handles difficult loudspeakers with ease, including those that challenge most other amplifiers.*
- ***Controlled, second-order low-pass response***
  - *Very flat audio-band response with a sensible, 60kHz bandwidth.*
  - *Reduced sensitivity to out-of-band noise from DACs, reducing the requirements on the DAC reconstruction filter. This leaves a shorter signal path between DAC and loudspeaker.*
  - *Problem-free operation with outboard DACs over which you may have no control.*
- ***Very low idle losses and reduced electromagnetic interference (EMI)***
  - *The enormous loop gain allows relaxed timing of the power MOSFETs without degrading audio performance.*
  - *Idle losses are minimized.*
  - *Very little to no effort needed to pass regulatory tests.*
- ***Exceptionally clean clipping and clipping-recovery*** *in both voltage and current domains*
  - *Clips cleanly and recovers immediately without "overhang". Current limiting is equally instantaneous and glitch free. This guarantees the smallest amount of audible artefacts when pushed into clipping or overload protection.*
- ***Overall implementation/integration ease*** *saves save time and cost for the system integrator*
  - *Architecture completely eliminates heterodyning in multichannel applications.*

1 Specifications (selected items)

1.1 Recommended Operating Conditions

Referenced to GND unless otherwise noted.

Parameter		Typ	Unit
Power Supplies			
±VP	Power Stage, positive rail voltage	±65	V
VDR	Gate Drive, voltage (must be referenced to -VP)	15	V
±VOP	OPAMPs, positive rail voltage	±12	V
VD	Digital, voltage	3.3	V
I/O's			
R_L	Speaker Load, resistive	2[1)]-∞	Ω

1) The amplifier is stable into loads <2Ω. Output power may be limited by the Over Current Protection system.

Table 1 Recommended Operating Conditions

1.2 Audio Characteristics

R_L=4Ω, T_A=25° free operating air, f=1kHz. Refer to Datasheet for detailed operating conditions.

Parameter		Conditions	Typ	Unit
P_O	Output Power, Short term	R_L= 8Ω, 1%THD	227	W
		R_L= 4Ω, 1%THD	450	W
		R_L= 2Ω, 1%THD	450[1)]	W
	Output Power, Continuous	-	(as limited by thermal system)	-
THD+N	Total Harmonic Distortion + Noise	P_O=1W, f=1kHz	0.0007	%
		P_O=10W, f=1kHz	0.00026	%
		P_O=100W, f=1kHz	0.00015[2)]	%
		P_O=1W, f=20-20kHz	0.0007	%
		P_O=10W, f=20-20kHz	0.00029	%
		P_O=100W, f=20-20kHz	0.00017[2)]	%
IMD	Intermodulation Distortion, CCIF	P_O=1W, f=18kHz+19kHz	0.00025	%
		P_O=10W, f=18kHz+19kHz	0.00022	%
		P_O=100W, f=18kHz+19kHz	0.00027	%
	Dynamic Intermodulation Distortion, DIM	P_O=1W, DIM30	0.002[2)]	%
		P_O=10W, DIM30	0.002[2)]	%
		P_O=100W, DIM30	0.002[2)]	%
ICN	Idle Noise, speaker output	A-weighted	11.5	µV
DNR	Dynamic Range	A-weighted, rel. to short term P_O, R_L= 4Ω	131	dB
SNR	Signal to Noise Ration	A-weighted, rel. to short term P_O, R_L= 4Ω	131	dB
BW	Frequency Response, upper -3dB/-6dB	R_L= 8Ω, V_o=2.83V@1kHz (=1W)	60/75	kHz
		R_L= 4Ω, V_o=2.83V@1kHz	60/75	kHz
		R_L= 2Ω, V_o=2.83V@1kHz	60/75	kHz
	Frequency Response, lower -3dB	-	(DC coupled)	-
	Frequency Response, flatness	R_L= 8Ω, f= 20-20kHz	±0.01	dB
		R_L= 4Ω, f= 20-20kHz	±0.01	dB
		R_L= 2Ω, f= 20-20kHz	±0.01	dB
		R_L= ∞Ω, f= 20-20kHz	±0.01	dB
	Frequency Response, load variation	R_L= 2 -∞Ω, f= 20-20kHz	±0.01	dB
Z_O	Output Impedance[3)]	1kHz, I_{out}=1A	0.07	mΩ
		20-20kHz, I_{out}=1A	<0.65	mΩ

1) Power is limited by overcurrent protection system (OCP) and highly dependent on thermal conditions
2) THD @ 100W and DIM readings limited by analyzer
3) Kelvin measurement on the output connector

Table 2 Audio Characteristics

1.3 Typical Audio Performance, Graphs

Refer to Datasheet for detailed operating conditions.

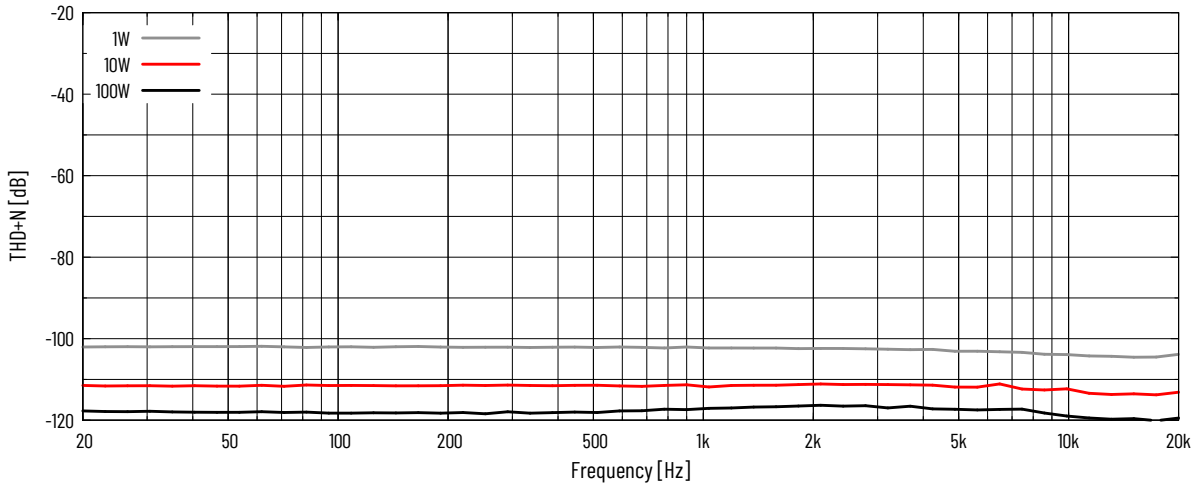


Figure 1 THD [dB] vs. Frequency @ 4Ω

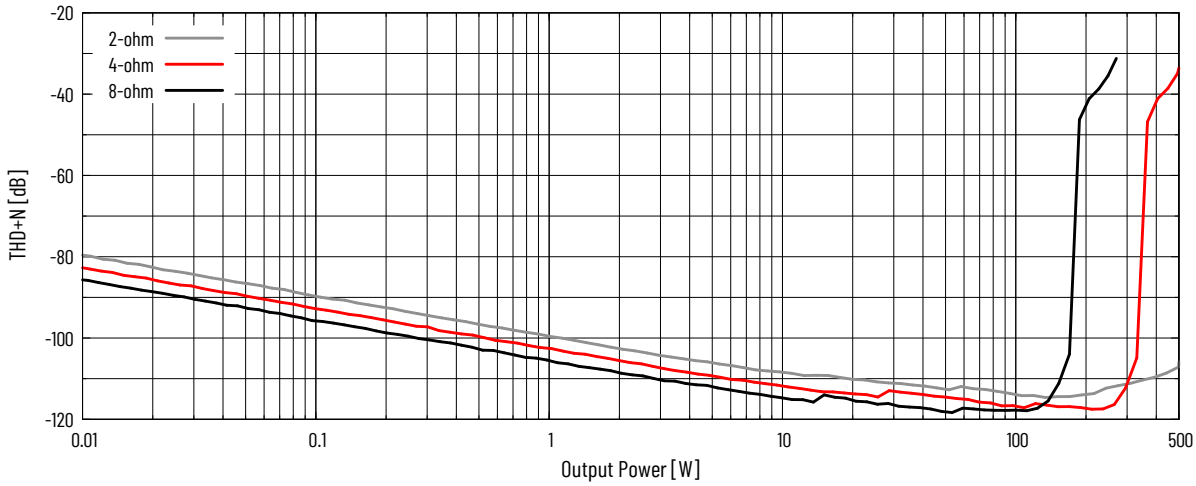


Figure 2 THD+N [dB] vs. Power @ f=1kHz

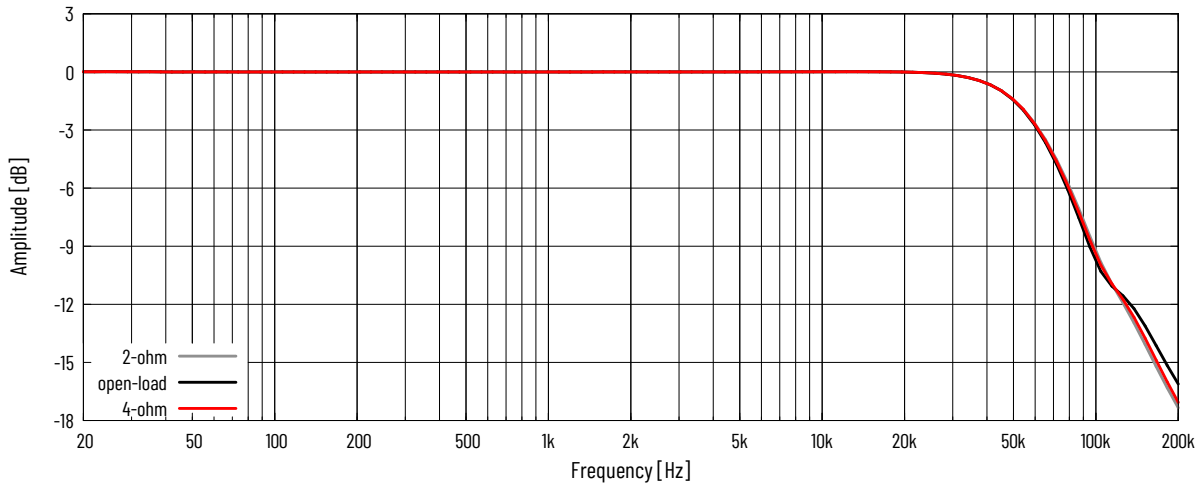


Figure 3 Frequency Response @ V_i=2.83V

FFT: 16K/48kHz/32x avg/Equiripple. Refer to Datasheet for detailed operating conditions.

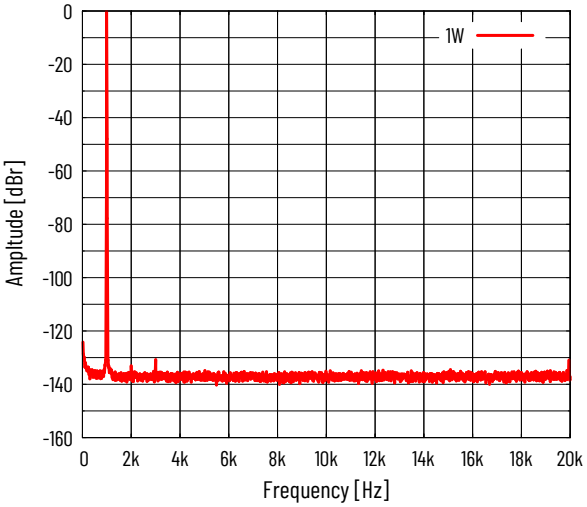


Figure 4 Frequency Spectrum (FFT) @ 1kHz, 1W, 4Ω

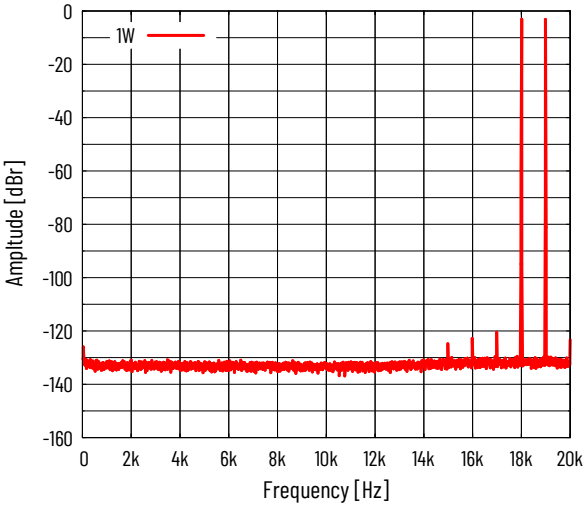


Figure 5 Intermodulation Distortion @ 18+19kHz, 1W, 4Ω

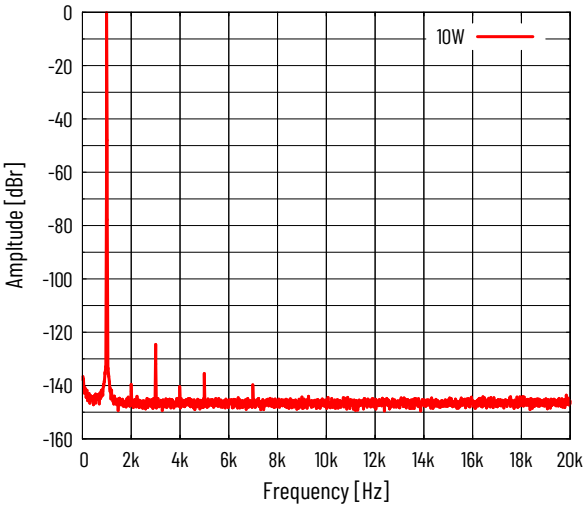


Figure 6 Frequency Spectrum (FFT) @ 1kHz, 10W, 4Ω

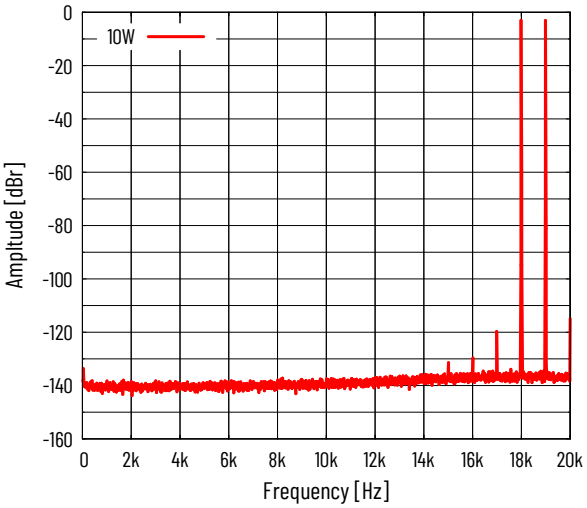


Figure 7 Intermodulation Distortion @ 18+19kHz, 10W, 4Ω

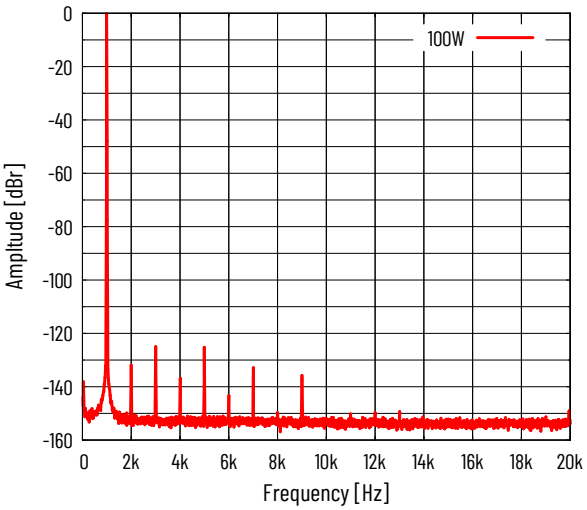


Figure 8 Frequency Spectrum (FFT) @ 1kHz, 100W, 4Ω

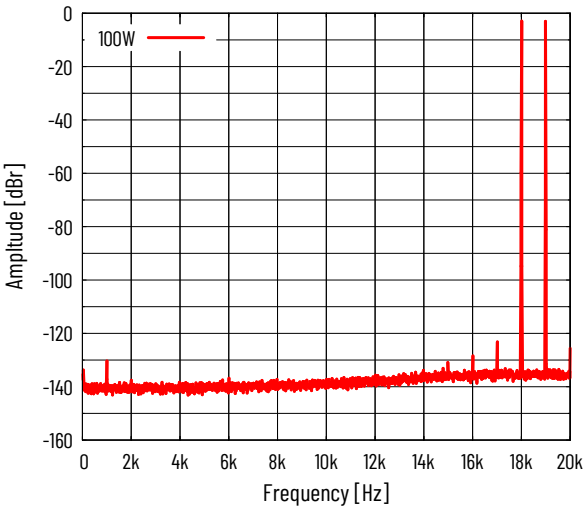


Figure 9 Intermodulation Distortion @ 18+19kHz, 100W, 4Ω

Refer to Datasheet for detailed operating conditions.

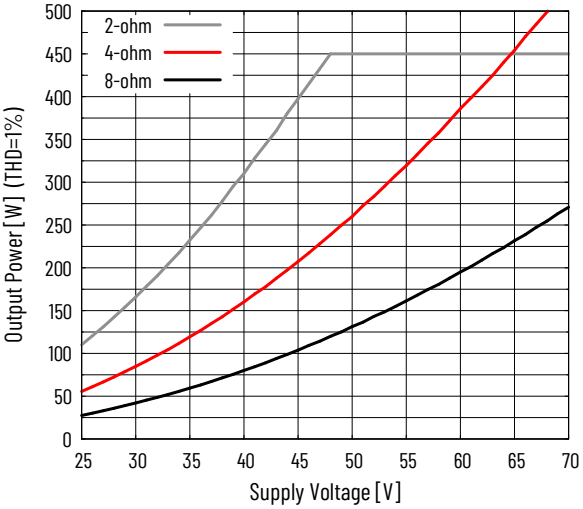


Figure 10 Output Power vs. VP @ 1% THD

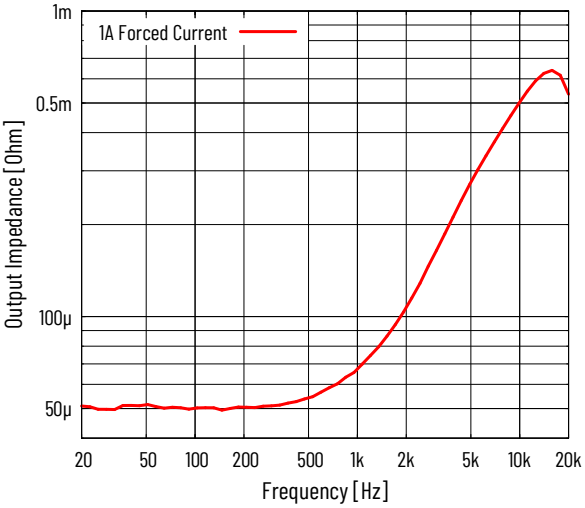


Figure 11 Output Impedance vs. Frequency

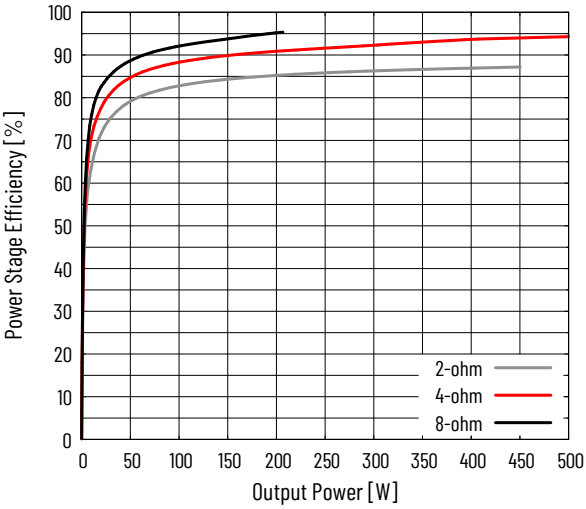


Figure 12 Power Stage Efficiency vs. Output Power

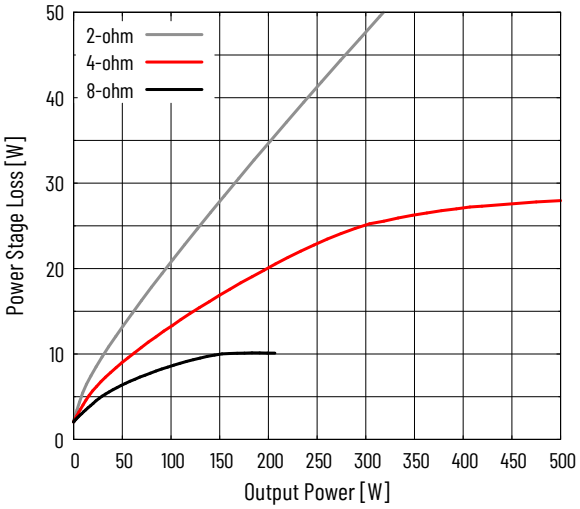


Figure 13 Power Stage Loss vs. Output Power (one channel)

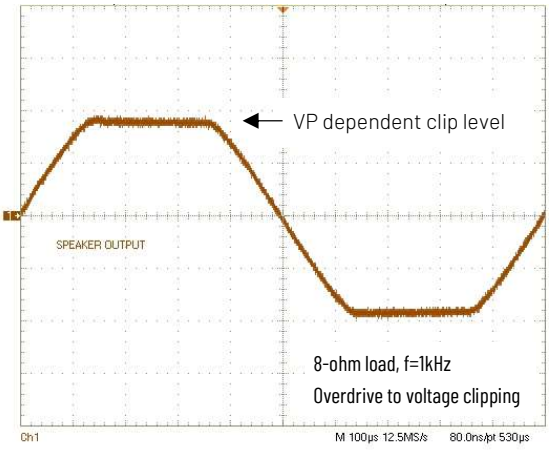


Figure 14 Voltage Clipping/Recovery (behavior)

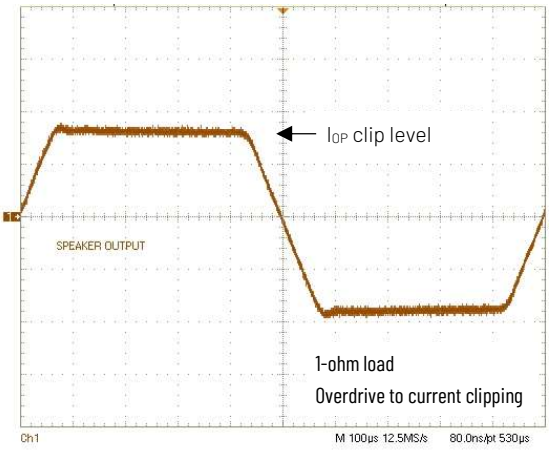


Figure 15 Current Clipping/Recovery (behavior)

1.4 Electrical Characteristics

Refer to Datasheet for detailed operating conditions.

Parameter		Conditions	Min	Typ	Max	Unit
Current Consumption & Efficiency						
$\lvert I_{VP} \rvert$	Power Stage supply, current	(+VP,-VP), Idle		13		mA
I_{DR}	Gate Drive supply, current	(VDR), Normal operation		35		mA
$\lvert I_{OP} \rvert$	OPAMPs supply, current	(+VOP, -VOP), Normal operation		27		mA
I_{VD}	uC and logic supply, current	(VD), Normal operation		10		mA
η	Efficiency	R_L= 8Ω		95		%
		R_L= 4Ω, Full rated power		94		%
Audio Inputs & Output						
R_{in}	Input impedance	Differential, pos. to neg. input		4.4		kΩ
		Single-ended, inverting input driven		2.2		kΩ
A_V	Voltage Gain	V_o/V_i		12.8		dB
$V_{in,1\%THD}$	Differential input voltage	To get 1% THD @ R_L= 4Ω, VP=±65V [1]		9.6		Vrms
CMRR	Common Mode Rejection Ratio	Audio input, 1kHz		>60		dB
PSRR	Power Supply Rejection Ratio	Forced 1Vrms f≤1kHz ripple, either rail		>90		dB
$\lvert V_{o\_DC} \rvert$	Speaker Output, DC offset	Analog inputs shorted		<10		mV
f_s	Switching frequency	Idle (indicative)		500		kHz
		Positive clipping		>50		kHz
		Negative clipping		0		Hz
Protection Systems						
I_{OCP}	Overcurrent Protection, threshold	Current limit		25		A
f_{DCP}	DC Protection, Speaker terminal	Detection filter corner frequency		2.5		Hz
$\lvert V_{DCP} \rvert$		Voltage limit, low-pass filtered signal		12		V
T_{OTP}	Thermal Protection, Heatsink	over-temperature		75		°C
T_{UTP}		under-temperature		0		°C
$\lvert OVP_{VP} \rvert$	Overvoltage Protection, threshold	(+VP, -VP)		|75|		V
OVP_{DR}		(VDR)		15.5		V
$\lvert OVP_{OP} \rvert$		(+VOP, -VOP)		|20|		V
$\lvert UVP_{VP} \rvert$	Undervoltage Protection, threshold	(+VP, -VP)		|20|		V
UVP_{DR}		(VDR)		9.5		V
$\lvert UVP_{OP} \rvert$		(+VOP, -VOP)		|11|		V

1) Equivalent of nominal output power (P_O) into 4Ω, see Table 2

Table 3 Electrical Characteristics

2 Mechanical Specifications

2.1 Dimensions

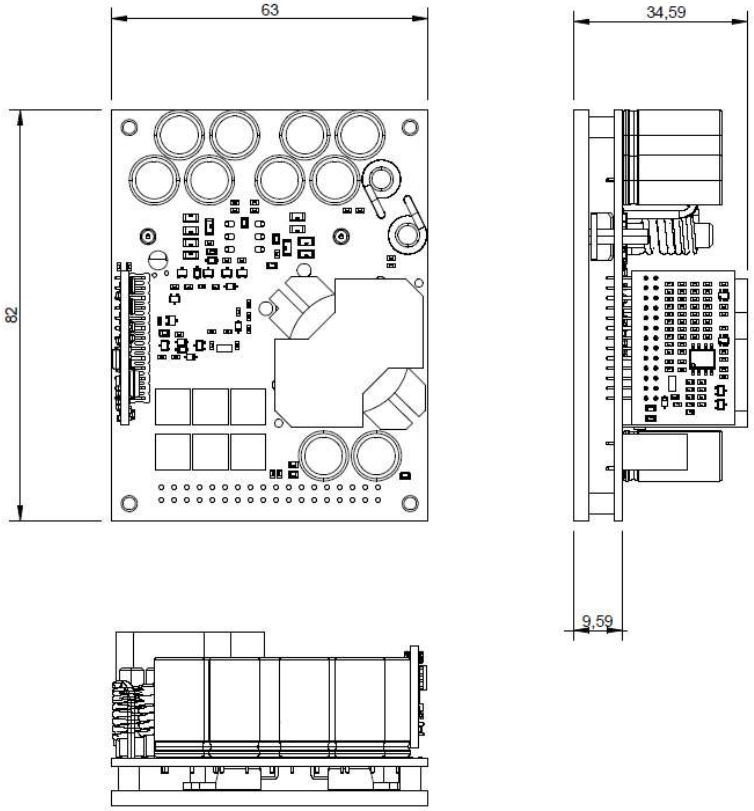


Figure 16 Dimensions

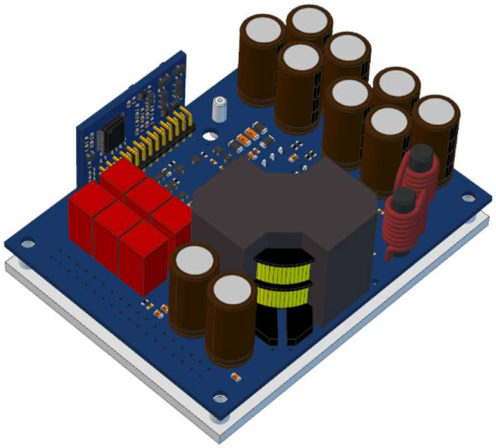


Figure 17 3D Model view