AudioMAX™ LX1710/1711

Class-D Mono Power Amplifier Controller IC

PRODUCTION

DESCRIPTION

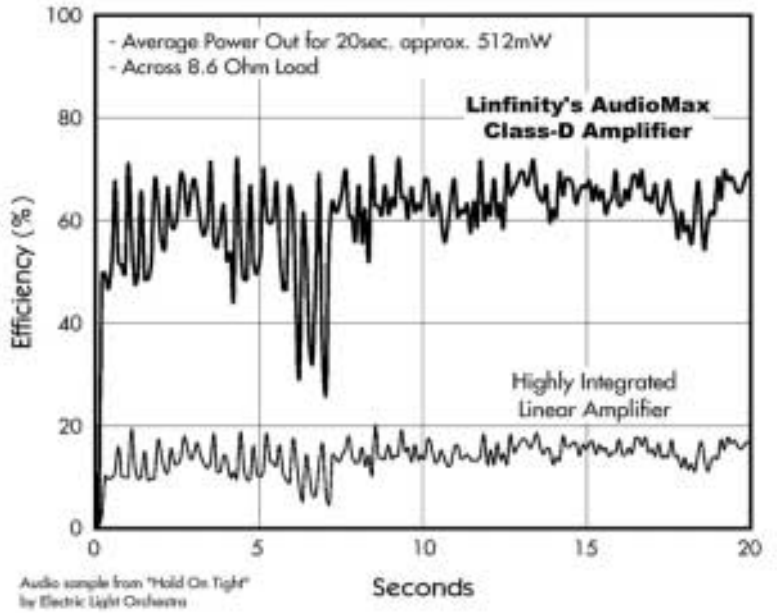
The LX1710/1711 is a monolithic high performance integrated class-D controller IC designed for high efficiency audio requirements such as portable or battery operated products, automotive amplifier, and multimedia applications. This high frequency, full audio bandwidth switching power amplifier controller, is a completely new design with dramatically improved performance over Linfinity's previous generation amplifier products. Enhancements include better SNR, lower noise floor, and reduced THD. Combined with output power MOSFET's and an output filter, the LX1710/1711 is a complete class-D audio solution.

A complete audio amplifier module is available to quickly evaluate the LX1710 controller. Simply connect the amplifier to the power source, audio signal, and speakers. Reference designs support a variety of requirements including multi channel systems, subwoofers, and various speaker loads (2Ω, 4Ω, 8Ω). The versatile amplifier solution can easily be adjusted for frequency response, optimized for efficiency and performance, or designed to minimize PCB area and component count. The LX1710/LX1711 is available in a space saving 28-pin SSOP package.

IMPORTANT: For the most current data, consult *MICROSEMI*'s website: **http://www.microsemi.com**

PRODUCT HIGHLIGHT

Class-D Amplifier Efficiency Comparison



KEY FEATURES

- Integrated Switching Class-D Single Channel Controller IC
- Full 20Hz-20kHz Audio Bandwidth
- High Fidelity (LX1710) Or High Power (LX1711) Versions Available
- Single Supply Operation
- THD+N <0.05% Typical (1Wrms, 1kHz, 4Ω)
- Maximum Efficiency 80%-85%
- Output Power >50Wrms (LX1711, 4Ω, 1% THD+N)
- PSRR –70dB Typical
- Differential Input To Minimize Noise Effects
- Supports Multi-Channel Systems
- Complete LXE1710 Amplifier Evaluation Module Available
- 28-Pin SSOP Package

APPLICATIONS/BENEFITS

- Notebook Computers
- Desktop Computers
- Multimedia Speakers
- Automotive Amplifiers And Headunits
- Battery Operated Equipment (Megaphone, PA System)
- Portable Audio (Boom Box)
- Wireless Speakers
- High Power Subwoofer

PACKAGE ORDER INFO

T_J (°C)	V_{DD}	**DB** Plastic SSOP 28-PIN
0 to 70	7V-15V	LX1710CDB
	7V-25V	LX1711CDB

Rev. 1.3a, 2002-05-03

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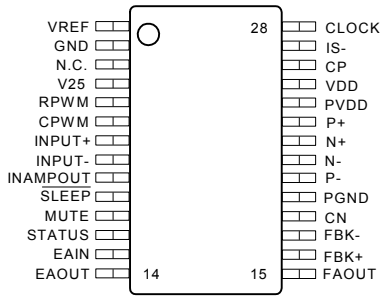
THERMAL DATA

DB PACKAGE

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	50°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUT



DESCRIPTION (CONTINUED)

The mono output controller is available in either an LX1711 high power version (>50Wrms, 4Ω) with a supply voltage range of 7V-25V or an LX1710 high fidelity version (better SNR performance) with a supply voltage range of 7V-15V. The current rating of the external MOSFET's, the available supply voltage, and speaker load primarily limits the maximum output power. The amplifier provides high fidelity performance and it designed to operate over the full 20Hz to 20kHz audio band. Signal distortion measurements yield THD+N levels less than 0.05% (1kHz, 1Wrms). Efficiency is greater than 80% typical, which eliminates the need for heatsinks, even at maximum output power.

The AudioMAX™ solution requires a single supply voltage, simplifying input power requirements where a dual supply may not be available. To minimize potential environmental noise issues and ease the integration of the amplifier into a variety of applications, features such as a balanced/differential audio input and a high power supply rejection ratio help reduce the effects of noise from the audio signal or power supply.

FUNCTIONAL PIN DESCRIPTION

Pin Name	Description	Pin Name	Description
VREF	5V Reference	**FAOUT**	Feedback Amplifier Output
GND	Low Current Ground	**FBK+**	Feedback Amplifier Non-Inverting Input
N.C.	No Connect	**FBK-**	Feedback Amplifier Inverting Input
V25	2.5V Reference	**CN**	Supply Decoupling for NFET Drivers
RPWM	PWM Resistor Connection	**PGND**	Output Driver High Current Ground
CPWM	PWM Capacitor Connection	**P-**	Drive for PFET on Negative Half of Bridge
INPUT+	Positive Audio Input	**N-**	Drive for NFET on Negative Half of Bridge
INPUT -	Negative Audio Input	**N+**	Drive for NFET on Positive Half of Bridge
INAMPOUT	Input Amplifier Output	**P+**	Drive for PFET on Positive Half of Bridge
$\overline{\text{SLEEP}}$	Sleep Input (active low)	**PVDD**	Output Driver Supply Voltage
MUTE	Mute Input (active high)	**VDD**	Analog Supply Voltage
STATUS	UVLO Indicator (Open Collector Output)	**CP**	Supply Decoupling for PFET Drivers
EAIN	Inverting Input of Error Amplifier	**IS -**	Current Limit Sense Input
EAOUT	Error Amplifier Output	**CLOCK**	Input / Output Clock for Synch Operation

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage (PVDD, VDD) ..... -0.3V to 30V
SLEEP, STATUS, FBK+, FBK- ..... -0.3V to V_{DD} +0.3V
IS- ..... PV_{DD} –2 to PV_{DD} to +0.3V
RPWM, CPWM, MUTE ..... -0.3V to V_{REF}+0.3V
INPUT +, INPUT -, INAMPOUT ..... -0.3V to V_{REF}+0.3V
EAIN, EAOUT, FAOUT ..... -0.3V to V_{REF}+0.3V
CLOCK ..... -0.3V to C_N +0.3V
Operating Junction Temperature Plastic (DB Package) ..... 125°C
Storage Temperature Range ..... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

Note 1: Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, the following specifications apply over the operating ambient temperature 0°C < TA < 70°C.
Test conditions: RPWM = 49.9k, CPWM = 100pF, VDD = PVDD = 15V

Parameter	Symbol	Test Conditions	LX1710 / 1711 Min	Typ.	Max	Units
Evaluation Module (See Figure 2)						
Supply Voltage LX1710	V_{DD}		7		15	V
LX1711			7		25	
Power Supply Rejection Ratio	PSRR	V_{IN} = 15V, V_{RIPPLE} = 1V_{RMS}, 10Hz to 10kHz		-70		dB
Output Power	P_O	V_{IN} = 15V, R_L=4Ω, THD+N=1%, 10Hz to 22kHz		25		W
		V_{IN} = 25V, R_L=4Ω, THD+N=1%, 10Hz to 22kHz		54		
Efficiency		V_{IN} = 15V, f_{IN} = 1kHz, P_O = 10W		82		%
		V_{IN} = 15V, f_{IN} = 1kHz, P_O = 20W		85		
Total Harmonic Distortion Plus Noise	THD+N	f_{IN} = 1kHz, P_O = 1W		.05		%
		f_{IN} = 20Hz to 20kHz, P_O = 1W			.3	
Signal-To-Noise Ratio	SNR	R_L = 4Ω, P_O = 1W		81		dBr
Oscillator Section						
Oscillator Frequency	F_{OSC}			335		kHz
Charge Current	I_{CHG}	(varies with V_{DD} pin voltage)		-110		µA
Discharge Current	I_{DIS}	(varies with V_{DD} pin voltage)		110		µA
Oscillator Peak Voltage	V_{PK}	(varies with V_{DD} pin voltage)		3.4		V
Oscillator Valley Voltage	V_{VAL}	(varies with V_{DD} pin voltage)		1.6		V
Voltage Stability		V_{DD} = 8V to 25V		0.6	2	%
Temperature Stability		T_A = 0°C to 70°C		1.0	2	%
		T_A = -40°C to 125°C		1.5		%
Error Amplifier						
Input Offset Voltage	V_{IO}			5		mV
DC Open Loop Gain	A_{OL}			60		dB
Unity Gain Bandwidth	UGBW			7		mHz
High Output Voltage	V_{OH}	I_{OUT} = -100µA	V_{REF} –1			V
Low Output Voltage	V_{OL}	I_{OUT} = +100µA			50	mV
Input Common Mode Range						
Input Bias Current	I_{IN}	V_{IN} = 1V to V_{REF}			1	µA
Input Amplifier						
Stage Gain		Set by Internal Resistors	3.465	3.5	3.535	V/V
Output Voltage, High	V_{OH}	I_{OUT} = -100µA	3.85			V

ELECTRICAL CHARACTERISTICS (CONTINUED)

Parameter		Symbol	Test Conditions	LX1710 / 1711 Min	LX1710 / 1711 Typ.	LX1710 / 1711 Max	Units
Output Voltage, Low		V_{OL}	I_{OUT} = +100µA			1.3	mV
Input Impedance					42		kΩ
Feedback Amplifier							
Stage Gain	LX1710		Set by Internal Resistors	89	91	93	mV/V
	LX1711		Set by Internal Resistors	56	57	58	mV/V
Input Impedance					388		kΩ
Current Limit Comparator							
Voltage Sense Threshold				190	210	230	mV
Blanking Pulse Delay					500		ns
Response Time			Excluding blanking pulse		250		ns
I_{UM} Pulses required to Current Limit Latch				9	9	9	cycles
Consecutive Clear Pulses required to reset I_{UM} counter				2	2	2	cycles
Reference Voltage Section							
Initial Accuracy					5.000		
Voltage Stability					± 25	± 50	mV
Temperature Stability			T_A = 0°C to 70°C		2	5	mV
			T_A = -40°C to 125°C		4	10	mV
Line Regulation			V_{DD} = 9V to 15V		0.5		mV
Load Regulation			I_{OUT} = 0 to 20mA		5		mV
Under voltage Lockout Section							
Start Threshold Voltage					6.5		V
UV Lockout Hysteresis				0.5	6.5		V
UVLO Delay To Output Enable					62,500		clkcyc
Supply Current							
Sleep Current			$\overline{SLEEP}$ Input = 0V, T_A = 25°C		25		µA
Operating Current			$\overline{SLEEP}$ Input = 2V, V_{IN} = 15V, No MOSFETs connected		2.9	5.0	mV
Sleep to Output Enable					62,500		clkcyc
Sleep Threshold				1.2	1.45	1.6	V
Mute Section							
Mute Threshold				1.6	1.7	1.8	V
Output Drivers for N-Channel MOSFETs							
NFET Drivers, Low Level Voltage		V_{OL}	I_{SINK} = 3mA		30	100	mV
			I_{SINK} = 75mA		1.5	2.0	V
NFET Drivers, High Level Voltage		V_{OH}	I_{SOURCE} = 3mA, C_N = 5.2V applied externally		30	100	mV
			I_{SOURCE} = 75mA, C_N = 5.2V applied externally		1.5	2.0	V
Output Drives For P-Channel MOSFETs							
PFET Drivers, Low Level Voltage		V_{OL}	I_{SINK} = 3mA		30	100	mV
			I_{SINK} = 75mA		1	1.5	V
PFET Drivers, High Level Voltage		V_{OH}	I_{SOURCE} = 3mA, C_P = 5.2V (applied externally)		30	100	mV
			I_{SOURCE} = 75mA, C_P = 5.2V (applied externally)		1	1.5	V

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BLOCK DIAGRAM

LX1710/11 SIMPLIFIED BLOCK DIAGRAM

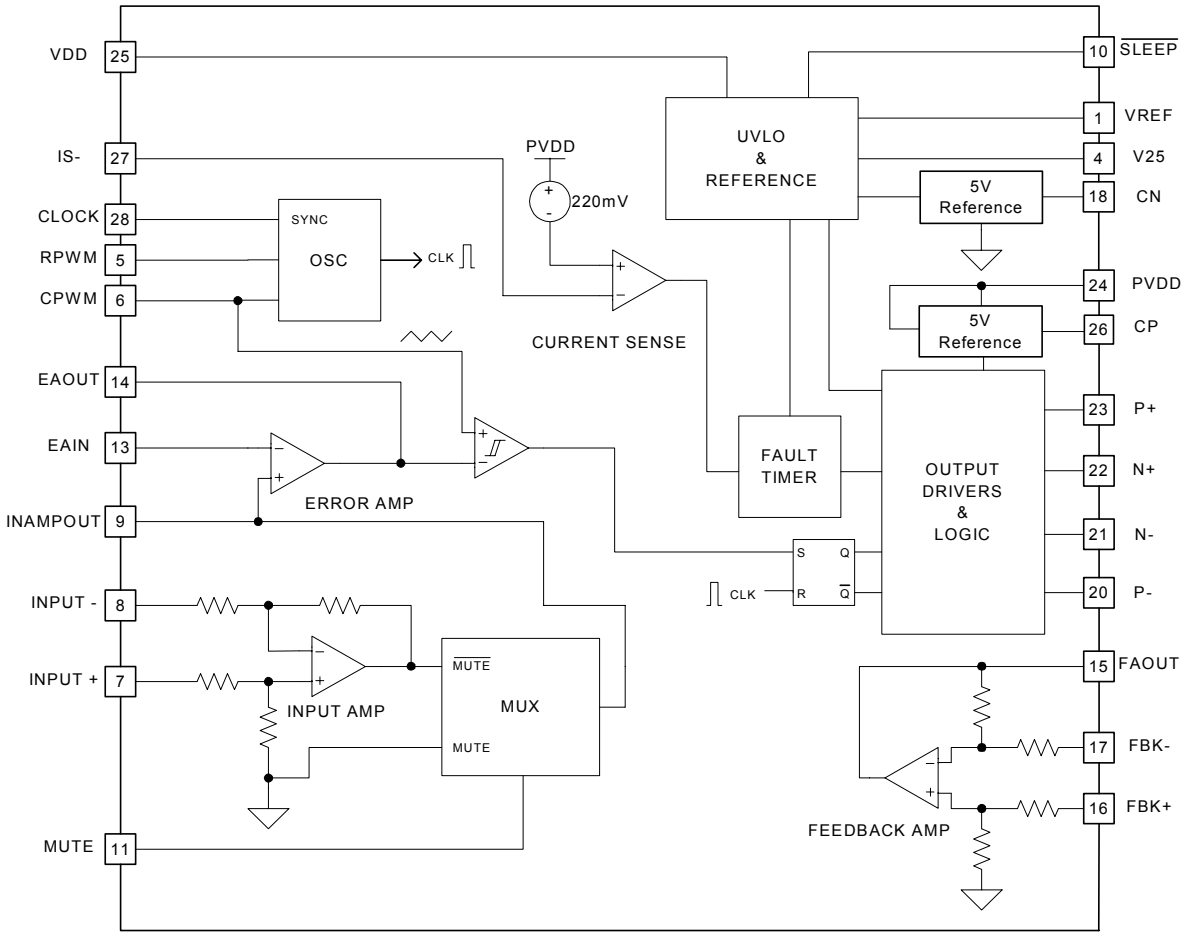

Figure 1 - LX1710 Block Diagram

APPLICATION INFORMATION

Frequency Synchronization

Two or more LX1710 / LX1711 oscillators can be configured for synchronous operation. One unit, the master, is programmed for the desired frequency with the R_{PWM} and C_{PWM} as usual. Additional units will be slave units, and their oscillators will be disabled by leaving the R_{PWM} pin disconnected. The CLOCK pin and the C_{PWM} pin of the slave units should be tied to the CLOCK pin and the C_{PWM} pin of the master unit respectively. In this configuration, the CLOCK pins of the slave units begin receiving instead of transmitting clock pulses. Also, the C_{PWM} pins quit driving the PWM capacitor in the slave units. Note that for optimum performance, all slave units should be located within a few inches of the master unit.

Oscillator Configuration (R_{PWM} and C_{PWM} selection)

The oscillator is programmed by the external timing components R_{PWM} and C_{PWM}. For a nominal frequency of 333kHz, R_{PWM} and C_{PWM} should be set to 49.9kOhms and 100pF respectively. Note that in order to keep the slope of the PWM ramp voltage proportional to the supply voltage, both the ramp peak and valley voltages, and the charge and discharge currents are proportional to the supply voltage. This keeps the frequency relatively constant while keeping the slope of the PWM ramp proportional to the voltage on the VDD pin. For operating frequencies other than 333kHz, the frequency can be approximated by the following equation:

$$\text{Frequency} = \frac{1}{(0.577)(R_{PWM})(C_{PWM}) + 320ns}$$

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TYPICAL APPLICATION

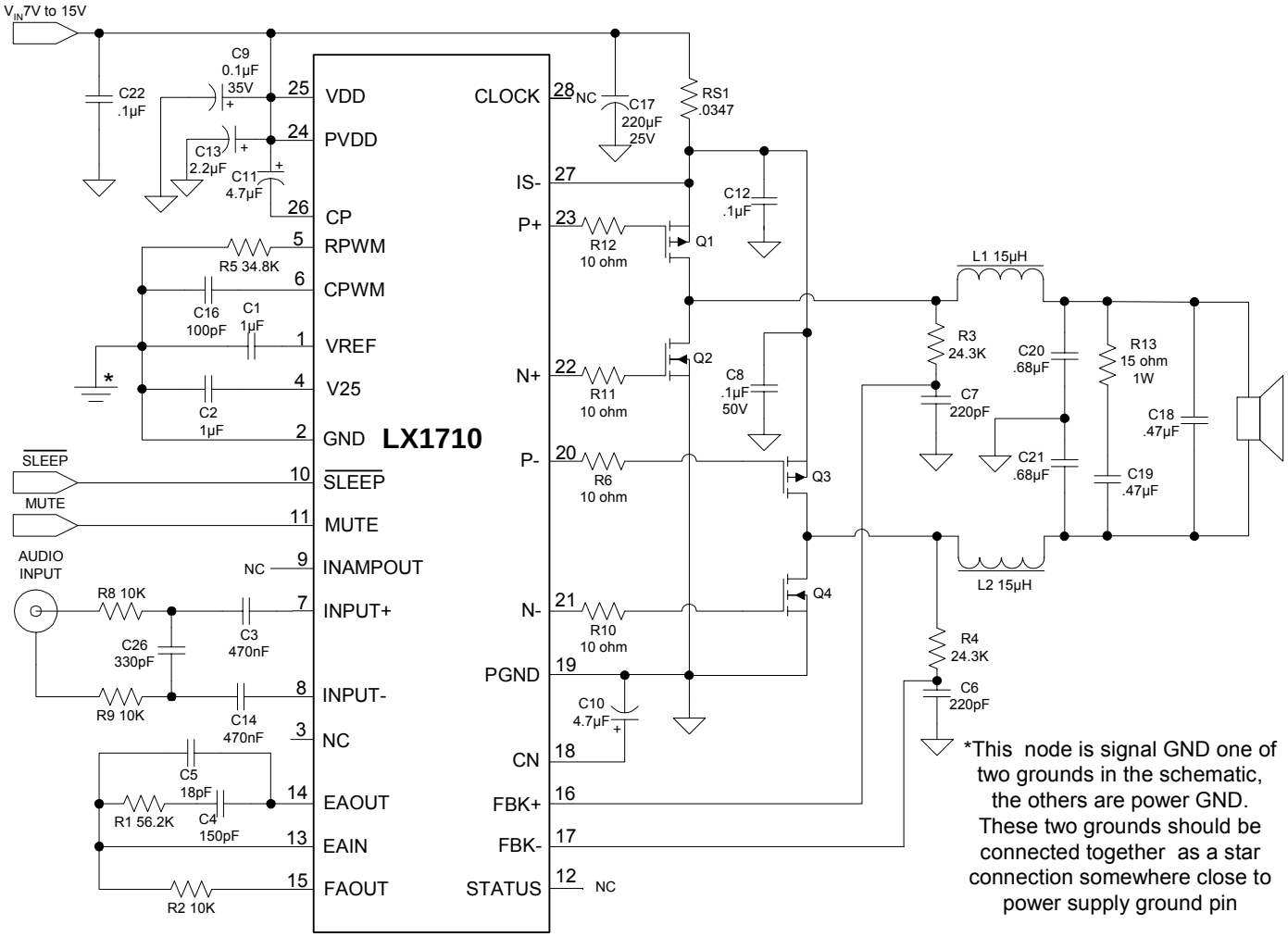

Figure 2 – Typical Class-D Switching Amplifier Circuit Application

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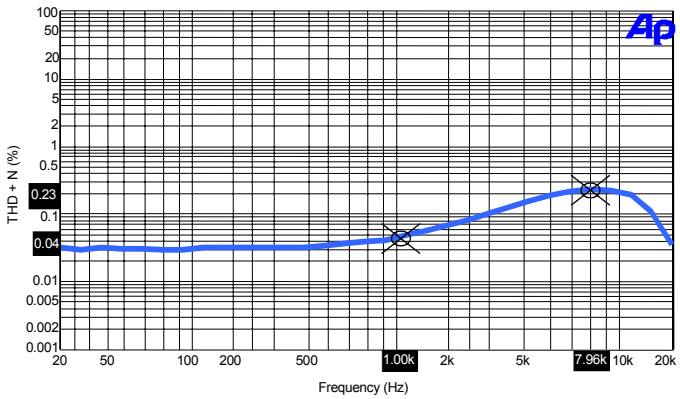
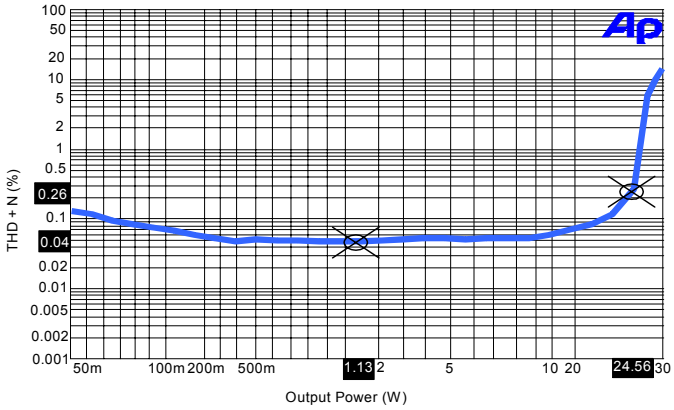
THD+N VS. FREQUENCY



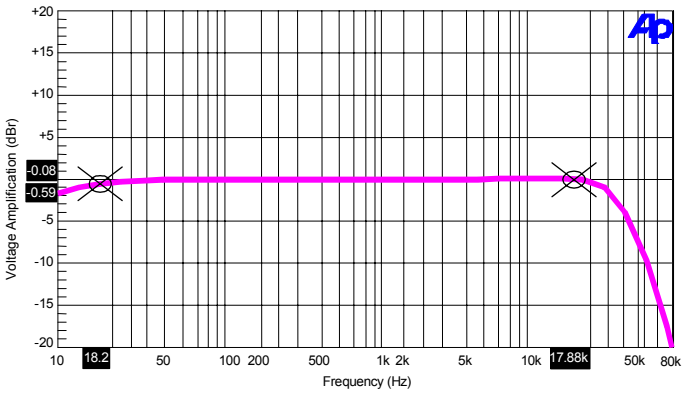
V_{IN} = 15V
R_L = 4Ω
P_O =1 W_{RMS}

THD+N VS. OUTPUT POWER



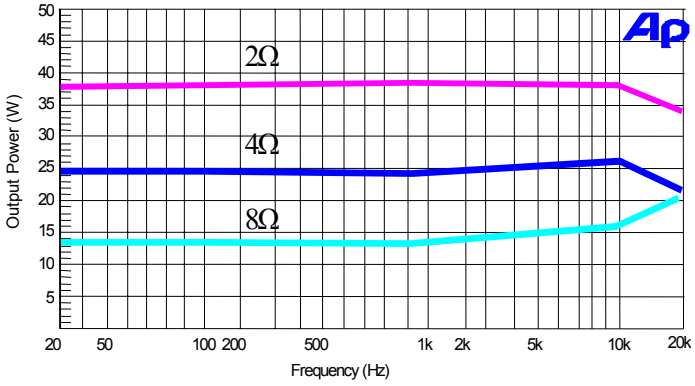
V_{IN} = 15V
f_{IN} =1 kHz
R_L = 4Ω

FREQUENCY RESPONSE



V_{IN} = 15V
R_L = 4Ω
P_O = 1W_{RMS}

POWER BAND



V_{IN} = 15V
THD+N = 1%

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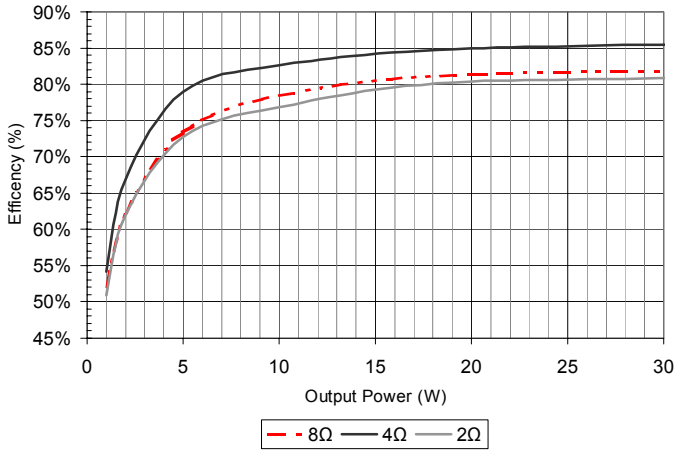
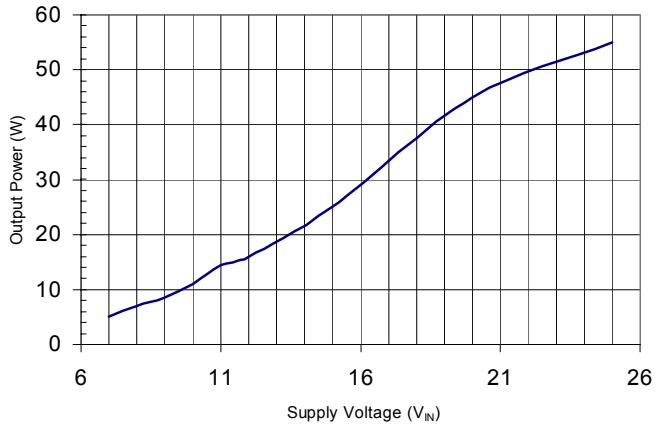
EFFICIENCY VS. OUTPUT POWER



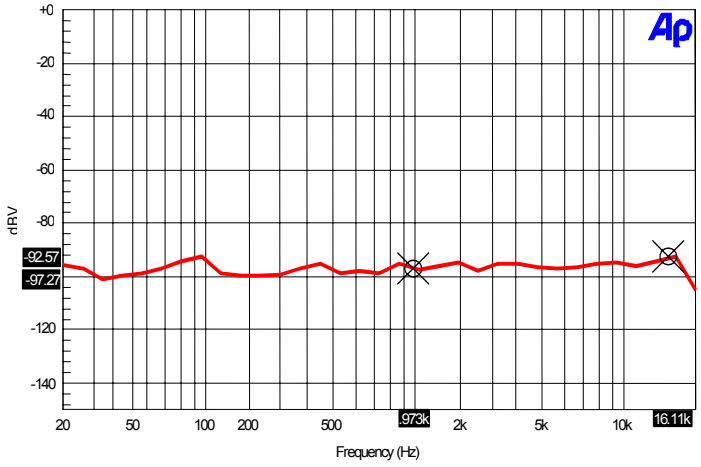
V_{IN} = 15V
f_{IN} = 1kHz

OUTPUT POWER VS. SUPPLY VOLTAGE



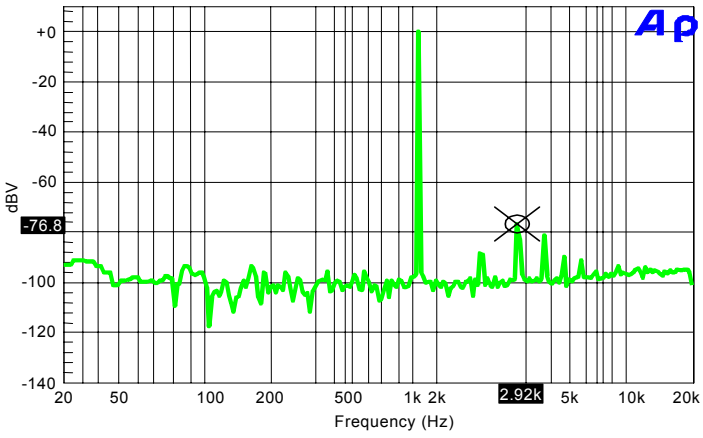
f_{IN} = 1kHz
R_L = 4Ω
THD+N = 1%

NOISE FLOOR FFT



V_{IN} = 15V
R_L = 4Ω
10Hz – 22 kHz Bandwidth
A - weighted

OUTPUT SPECTRUM



V_{IN} = 15V
R_L = 4Ω
f_{IN} = 1kHz
P_O = 1W_{RMS}
SNR = 81 dBr
10Hz – 22kHz Bandwidth
A - weighted

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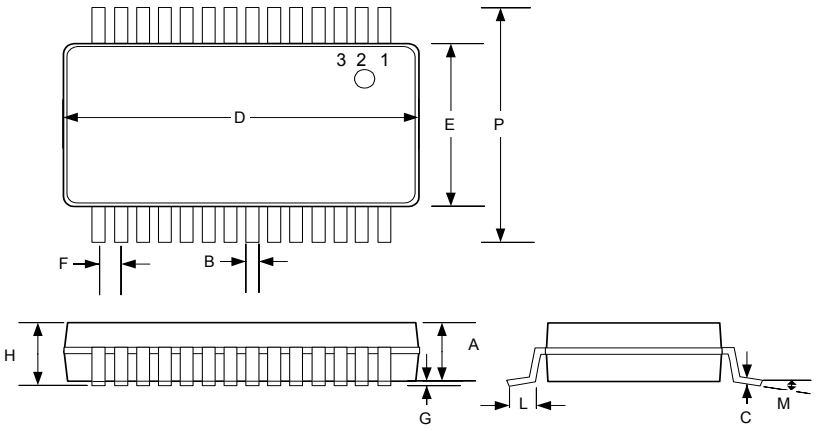
MECHANICAL DIMINSIONS



DIM	Millimeters		Inches	
	MIN	MAX	MIN	MAX
A	1.65	1.85	0.065	0.073
B	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	9.90	10.50	0.390	0.413
E	5.00	5.60	0.197	0.221
F	0.65 BSC		.0025 BSC	
G	0.05	0.21	0.002	0.008
H	1.73	2.00	0.068	0.078
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311
***LC**		0.10		0.004

*Lead Coplanarity

Note:

1. Dimensions do not include mold flash or protrusions; these shall not exceed 0.15mm (.006") on any side. Lead dimension shall not include solder coverage.

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