2.7-W MONO CLASS-D AUDIO POWER AMPLIFIER

GENERAL DESCRIPTION

The TMPA2155DM is a mono class-D audio power amplifier IC. With BTL(Bridge-Tied-Load) configuration, it delivers up to 2.7W power into a 3 ohms load or 2.3W power into a 4 ohm load or 1.5W power into an 8 ohm load. No external heat-sink is required.

For multiple-input applications, independent gain control and corner frequency can be implemented by summing the input sources through resistor ratio and input capacitor values.
Automatic voltage gain control makes the best use of battery.

Analog input signal is converted into digital output which drives directly to the speaker. High power efficiency is achieved due to digital output at the load. The audio information is embedded in PWM（Pulse Width Modulation）.

APPLICATIONS

Multimedia application includes Cellular Phones, PDAs, DVD/CD players, TFT LCD TVs/Monitors, 2.1 channel/5.1 channel audio systems, USB audio. It is also ideal for other portable devices like Wireless Radios.

FEATURES

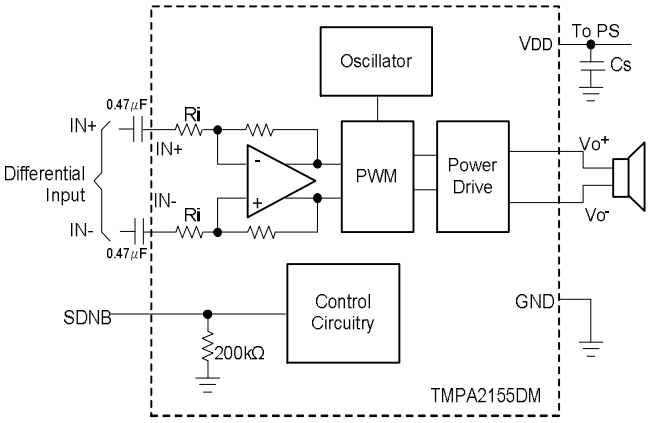
- 2.5V to 6V Single Supply
- Up to 2.7W at 5V, 3 ohms
- Up to 85% Power Efficiency
- Automatic output power control (APC)
- 2.2mA Quiescent Current at 5V
- Less Than 0.2uA Shutdown Current
- Pop-less Power-Up, Shutdown and Recovery
- Differential 250 KHz PWM Allows BTL to Doubles Output Power and Eliminates LC Output Filter
- Compatible with earphone application
- Thermal Shutoff and Automatic Recovery
- Short-Circuit Protection
- Differential Signal Processing Improves CMRR

Package

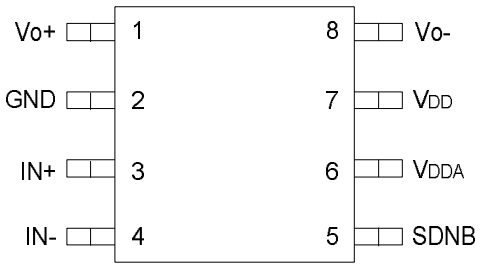
TSSOP8, SOP8 Available

For best performance, please refer to
http://www.taimec.com.tw/English/EVM.htm
http://www.class-d.com.tw/English/EVM.htm
for PCB layout.

REFERENCE CIRCUIT



TOP VIEW



（Please email david@taimec.com.tw for complete datasheet.）

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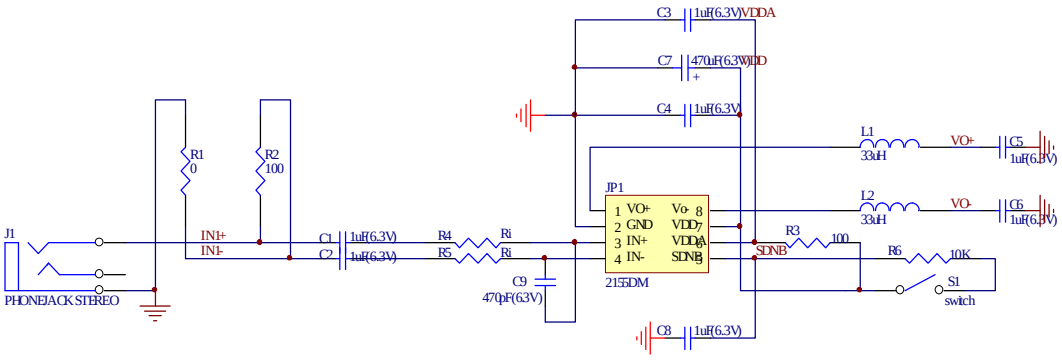
Note that the external components or PCB layout should be designed not to generate abnormal voltages to the chip to prevent from latch up which may cause damage to the device.

Typical Application



ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range unless otherwise noted(1)

Supply voltage, V_{DD}	In normal mode	-0.3V to 6V	V
	In shutdown mode	-0.3V to 7V	V
Input voltage, V_I		-0.3V to V_{DD}+0.3V	V
Continuous total power dissipation		See package dissipation ratings	
Operating free-air temperature, T_A		-20 to 85	°C
Operating junction temperature, T_J		-20 to 150	°C
Storage temperature, T_{stg}		-40 to 150	°C

(1) Stresses beyond those listed under"absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions "is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITONS

		MIN	NOM	MAX	UNIT
Supply voltage, V_{DD}		2.5		6	V
High-level input voltage, V_{IH}	SDNB	2		V_{DD}	V
Low-level input voltage, V_{IL}	SDNB	0		0.8	V
Operating free-air temperature, T_A		-20		85	°C

PACKAGE DISSIPATION RATINGS

PACKAGE	DERATING FACTOR	$T_A \leq 25$ °C POWER RATING	$T_A = 70$ °C POWER RATING	$T_A = 85$ °C POWER RATING
SOP8	6.39mW/ °C	0.799W	0.511W	0.415W

ELECTRICAL CHARACTERISTICS

T_A=25 °C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$\lvert V_{OS} \rvert$	Output offset voltage (measured differentially)	V_I=0V,Av=2, $V_{DD}=V_{DDA}$=2.5V to 5.5V		25		mV
PSRR	Power supply rejection ratio	$V_{DD}=V_{DDA}$=2.5V to 5.5V		-75	-55	dB
CMRR	Common mode rejection ratio	$V_{DD}=V_{DDA}$=2.5V to 5.5V, V_{IC}=1Vpp, RL=8Ω		-55	-50	dB
$\lvert I_{IH} \rvert$	High-level input current	$V_{DD}=V_{DDA}$=5.5V, V_I=5.8V (SDNB)			40	μA
$\lvert I_{IL} \rvert$	Low-level input current	$V_{DD}=V_{DDA}$=5.5V, V_I=-0.3V (SDNB)			1	μA
I_Q	Quiescent current	$V_{DD}=V_{DDA}$=5V, no load		2	3	mA
I_Q (SD)	Shutdown current	V(SDNB)=0.8V, $V_{DD}=V_{DDA}$=2.5V to 5.5V		0.2	0.5	μA
$r_{DS(on)}$	Static drain-source on-state resistance	$V_{DD}=V_{DDA}$=5.5V		790		mΩ
f(sw)	Switching frequency	$V_{DD}=V_{DDA}$=2.5V to 5.5V	200	250	300	kHz
*Av	BTL Gain	$V_{DD}=V_{DDA}$=2.5V to 5.5V, RL=8Ω	17	21	25	V/V
R_{SDNB}	Resistance from shutdown to GND	V(SDNB)=5V		200		kΩ
Z_I	Input impedance	IN+, IN-	12	15	18	kΩ

*The gain of the amplifier is determined by, for $V_{DD}=V_{DDA}$ =2.5V to 5.5V

$$Gain = \frac{320kohms}{Ri + 15kohms}$$ where Ri is the external serial resistance at the input pin.

OPERATING CHARACTERISTICS

T_A=25 °C, R_L=8Ω speaker (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
P_O	Output power / Ch	R_L=8Ω	V_{DD}=AV_{DD}=5V. THD+N=10%,f=1kHz.		1.5		W
		R_L=4Ω			2.3		W
		R_L=3Ω			2.7		W
THD+N	Total harmonic distortion plus noise	V_{DD}=AV_{DD}=5V, P_O=0.85W, R_L=8Ω, f=1kHz			0.55		%
		V_{DD}=AV_{DD}=5V, P_O=1.3W, R_L=4Ω, f=1kHz			0.55		
		V_{DD}=AV_{DD}=5V, P_O=1.5W, R_L=3Ω, f=1kHz			0.64		
SNR	Signal-to-noise ratio	V_{DD}=AV_{DD}=5V, P_O=1W, R_L=8Ω			85		dB
Crosstalk	Crosstalk between outputs	V_{DD}=AV_{DD}=5V, P_O=1W R_L=8Ω			-60		dB

TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	PIN NO		
GND	2	I	Digital ground
IN-	4	I	Negative differential input
IN+	3	I	Positive differential input
SDNB	5	I	Shutdown terminal (active low logic)
V_{DD}	7	I	Digital Power supply
V_{DDA}	6	I	Analog Power supply
V_O+	1	O	Positive BTL output
V_O-	8	O	Negative BTL output

TYPICAL CHARACTERISTICS

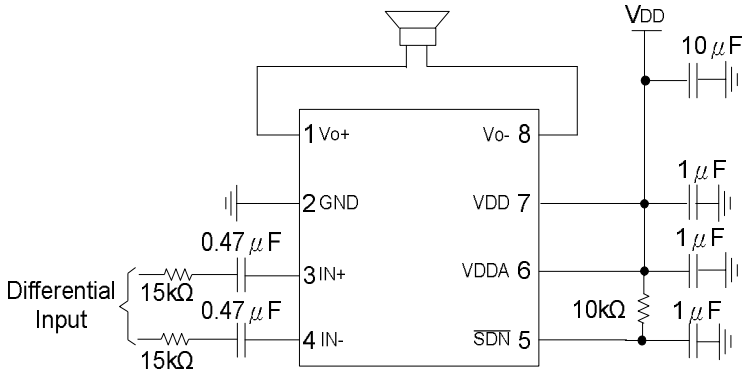
Note 1. Input coupling 1μF capacitors are used for all measurements.

2. Differential inputs are applied and BTL outputs are measured.

3. Balanced LC filter is used for THD+N measurement and power efficiency measurement.

4. Characteristic frequency of the LC filter is set 41KHz unless otherwise specified.

APPLICATION INFORMATION



Suppose source impedance of the input is relatively smaller than 15k ohms.

Figure.1 Differential Input With Gain= $\frac{320k}{15k+15k}$ = 10.6

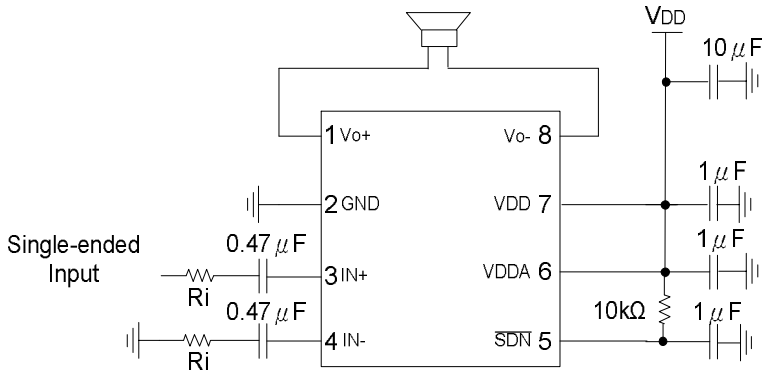
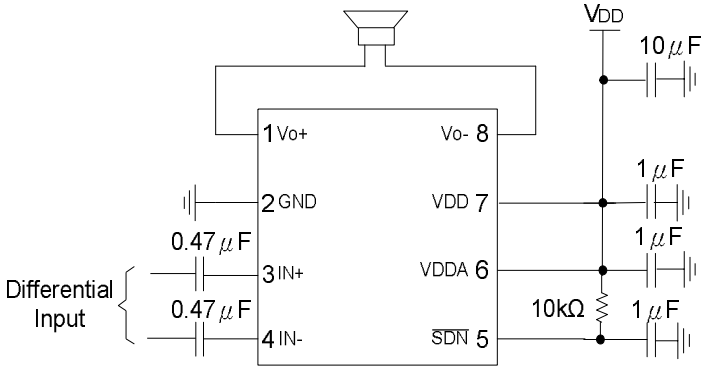
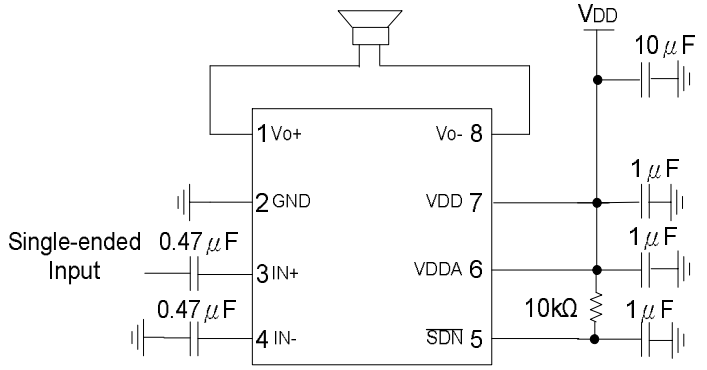


Figure.2 Single-ended Input With Gain= $\frac{320k}{15k+Ri}$



Suppose source impedance of the input is much smaller than 15k.

Figure.3 Differential Input With Gain= $\frac{320k}{15k}$ = 21



Suppose source impedance of the input is much smaller than 15k.

Figure.4 Single-ended Input With Gain= $\frac{320k}{15k}$ = 21

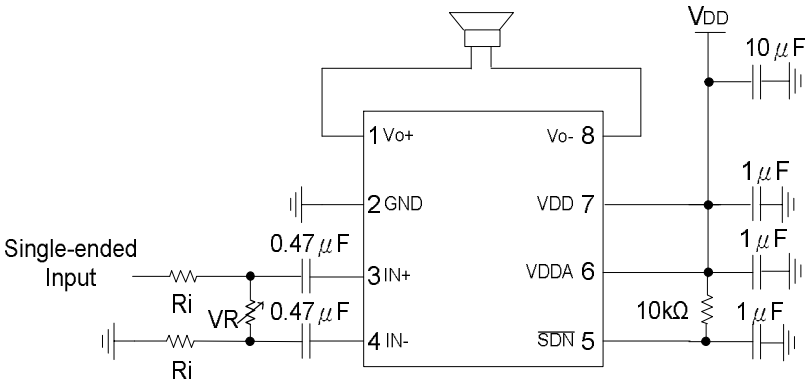


Figure.5 Single-ended Input With Gain Control

Input Resistors and Gain

The gain of the amplifier is determined by, for VDD=VDDA =2.5V to 5.5V

$$Gain = \frac{320kohms}{Ri + 15kohms}$$ where Ri is the source impedance of the input signal.

Note：Please refer to document 010 APP for more application examples.

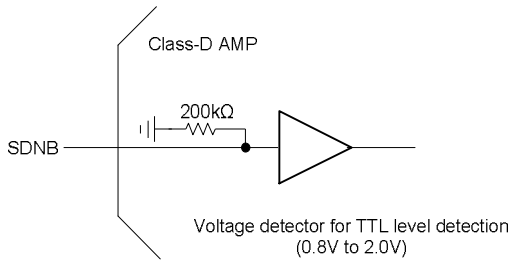
DETAILED DESCRIPTION

Efficiency

The output transistors of a class D amplifier act as switches. The power loss is mainly due to the turn on resistance of the output transistors when driving current to the load. As the turn on resistance is so small that the power loss is small and the power efficiency is high. With 8 ohm load the power efficiency can be better than 85%.

Shutdown

The shutdown mode reduces power consumption. A LOW at shutdown pin forces the device in shutdown mode and a HIGH forces the device in normal operating mode. Shutdown mode is useful for power saving when not in use. This function is useful when other devices like earphone amplifier on the same PCB are used but class D amplifier is not necessary.
Internal circuit for shutdown is shown below.



Pop-less

The shutdown pin is designed to give pop-less start up. The RC delay provided by external R(=100k ohms) and external C(=1uF) introduces enough delay for the internal circuitry to be stable before the signal is fed to the speaker. This delay is good for shutdown ON-OFF and power UP-DOWN operations.

Voltage gain

The voltage gain is defined in the table on page 3. For lower voltage gain one can add external input resistors to input pins. If external resistors are used they should be well matched. Well matched input resistors are also required even for single ended input configuration for low noise.

Automatic output Power Control (APC)

The voltage gain is self adjusted in the chip over voltage range. This means that, regardless supply voltage change, the output power keeps about the same for a given input level from V_{DD}=5.5v to 2.5v. It allows the best use of the battery.

Differential input VS single ended input

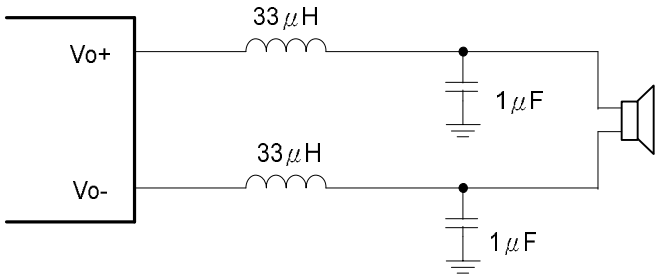
Differential input offers better noise immunity over single ended input. A differential input amplifier suppresses common noise and amplifies the difference voltage at the inputs. For single ended applications just tie the negative input end of the balanced input structure to ground. If external input resistors are used, the negative input has to be grounded with a series resistor of the same value as the positive input to reduce common noise.

Output filter

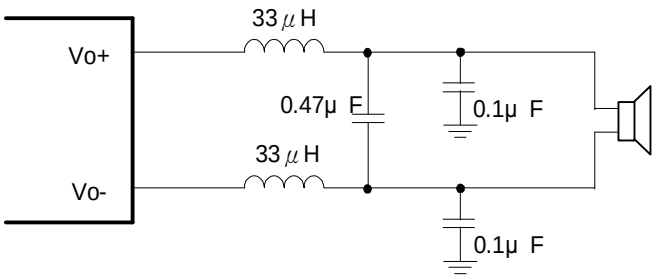
Ferrite bead filter can be used for EMI purpose. The ferrite filter reduces EMI around 1 MHz and higher（FCC and CE only test radiated emissions greater than 30 MHz）. When selecting a ferrite bead, choose one with high impedance at high frequencies, but low impedance at low frequencies.

Use an LC output filter if there are low frequency（＜1 MHz）EMI sensitive circuits and/or there are long wires from the amplifier to the speaker. EMI is also affected by PCB layout and the placement of the surrounding components.

The suggested LC values for different speaker impendence are showed in following figures for reference.

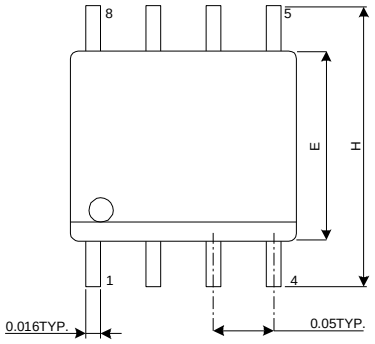


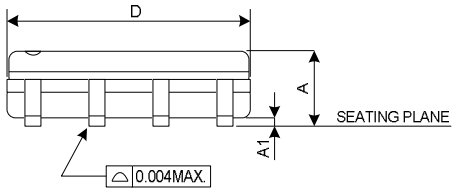
Typical LC Output Filter (1)

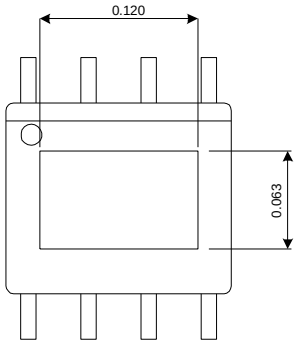


Typical LC Output Filter (2)

Physical Dimensions (IN MILLIMETERS)



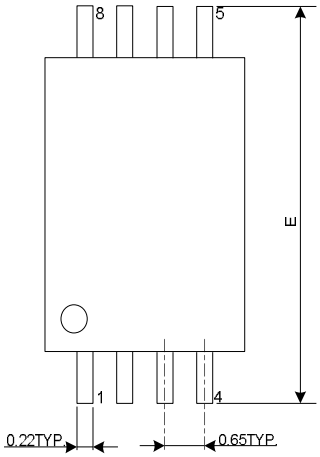


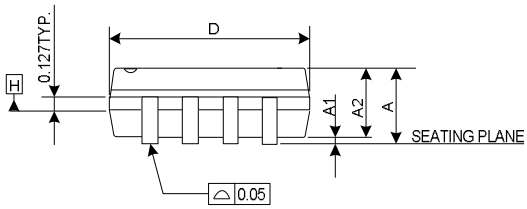


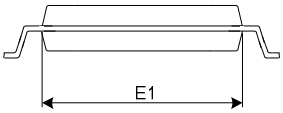
SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244

SOP8

Physical Dimensions (IN MILLIMETERS)







SYMBOLS	MIN.	NDM.	MAX.
A	-	-	1.20
A1	0.05	-	0.15
A2	0.96	1.01	1.06
D	2.90	3.00	3.10
E	6.40 BSC		
E1	4.30	4.40	4.50

TSSOP8

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