MT6905

Ultra Low EMI,
5W Filterless, Class-D Audio Amplifier

DISCRIPTION

MT6905 is a 5W audio class-D amplifier. It is low noise, filter-free with PWM architecture, minimizing external component count, PCB area, system cost.

The chip features very low 0.1% THD+N, high 90dB SNR, and therefore offer high quality sound. MT6905 delivers up to 5W power into a 2Ω load with an efficiency up to 80% and 1.6W into a 8Ω load with an efficiency up to 92%.

The MT6905 features a low-power consumption shutdown mode. The gain of the MT6905 is externally configurable which allows independent gain control from multiple sources by summing the signals. Output short circuit and thermal overload protection prevent the device from damage during fault conditions

The high efficiency and a low shutdown current make the MT6905 an ideal choice for both battery-powered speakers and portable devices.

MT6905 integrates Maxic's unique EMI suppression technique, can work with FM tuner without extra Ferrite-bead components.

ORDERING INFORMATION

Part #	Package	Remarks
MT6905	SOP-8	Tube 100/tube

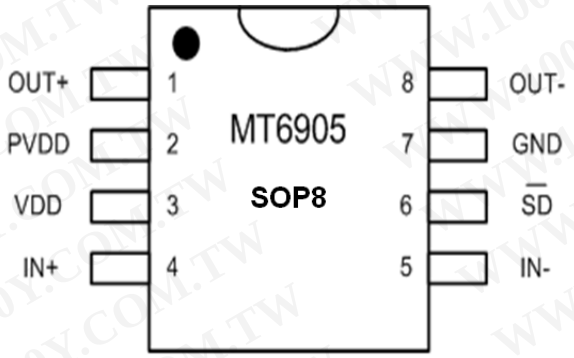
FEATURES

- High output power
  5W @ VDD=PVDD= 5.5V, RL= 2Ω, THD+N = 10%
- 2.5V~5.5V single supply operation
- Filterless and ultra-low EMI, can work with FM tuner without extra Ferrite-bead components
- Less than 0.1% THD+N
- Excellent Power up/down "Pop sound" suppression
- Low quiescent current and low-power shutdown current
- Few external components to save the space and cost
- Over current/Short circuit and over temperature protection
- Available in SOP8 package (Pb-free)

APPLICATION

- Mobile phone
- Portable audio product
- Portable media player
- Personal navigation device
- Video game
- Cordless phone

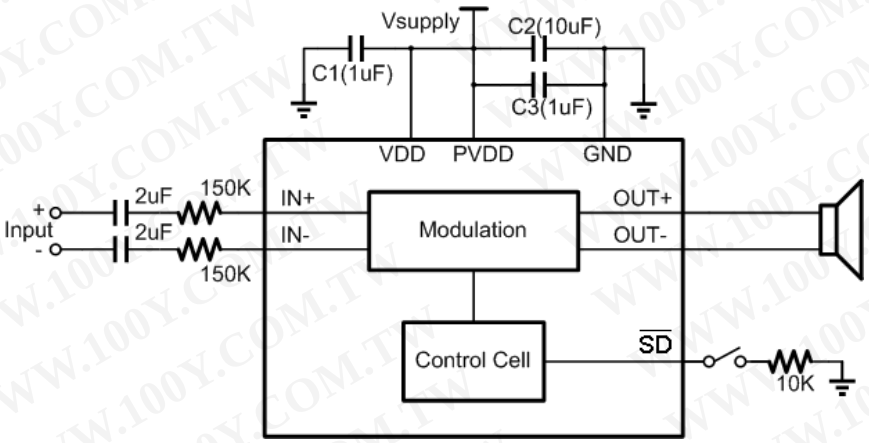
PIN CONFIGURATIONS



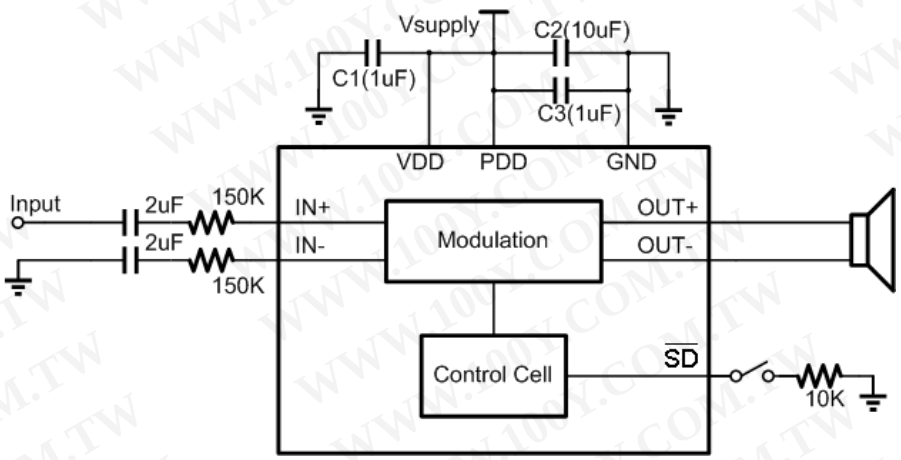
PIN DESCRIPTIONS

Pin#	Symbol	Function
1	OUT+	Positive output
2	PVDD	Power supply
3	VDD	Analog power supply
4	IN+	Positive input
5	IN-	Negative input
6	$\overline{SD}$	Shutdown pin(active low)；Internal has a 3Mohm resistor pull to VDD.
7	GND	Analog ground
8	OUT-	Negative output

TYPICAL APPLICATION CIRCUITS



MT6905: Fully-Differentially Input Application Circuit



MT6905: Single-Ended Input Application Circuit

Note: C1~C3 are ceramic capacitor and should be put as close to MT6905 as possible!

ABSOLUTE MAXMUM RATINGS

VDD	Supply voltage	In active mode	–0.3 V to 6 V
		In $\overline{SD}$ mode	–0.3 V to 7 V
VI	Input voltage		–0.3 V to VDD + 0.3 V
	Continuous total power dissipation		See Dissipation Rating Table
TJ	Operating junction temperature		–40°C to 150°C
Tstg	Storage temperature		–65°C to 150°C

THERMAL CHARACTERISTIC

Symbol	Description	Value	Units
θJA	Maximum Thermal Resistance	120	°C/W

RECOMMENTED OPERATING CONDITIONS

			MIN	MAX	UNIT
VDD	Supply voltage		2.5	5.5	V
VIH	High-level input voltage	$\overline{SD}$	1.3	VDD	VIH
VIL	Low-level input voltage	$\overline{SD}$	0	0.35	VIL
VIC	Common mode input voltage range	VDD = 2.5V - 5.5V	0.5	VDD–0.8	VIC
TA	Operating free-air temperature		–40	85	°C

ELECTRICAL CHARACTERISTICS

TA = 25℃ (unless otherwise noted)

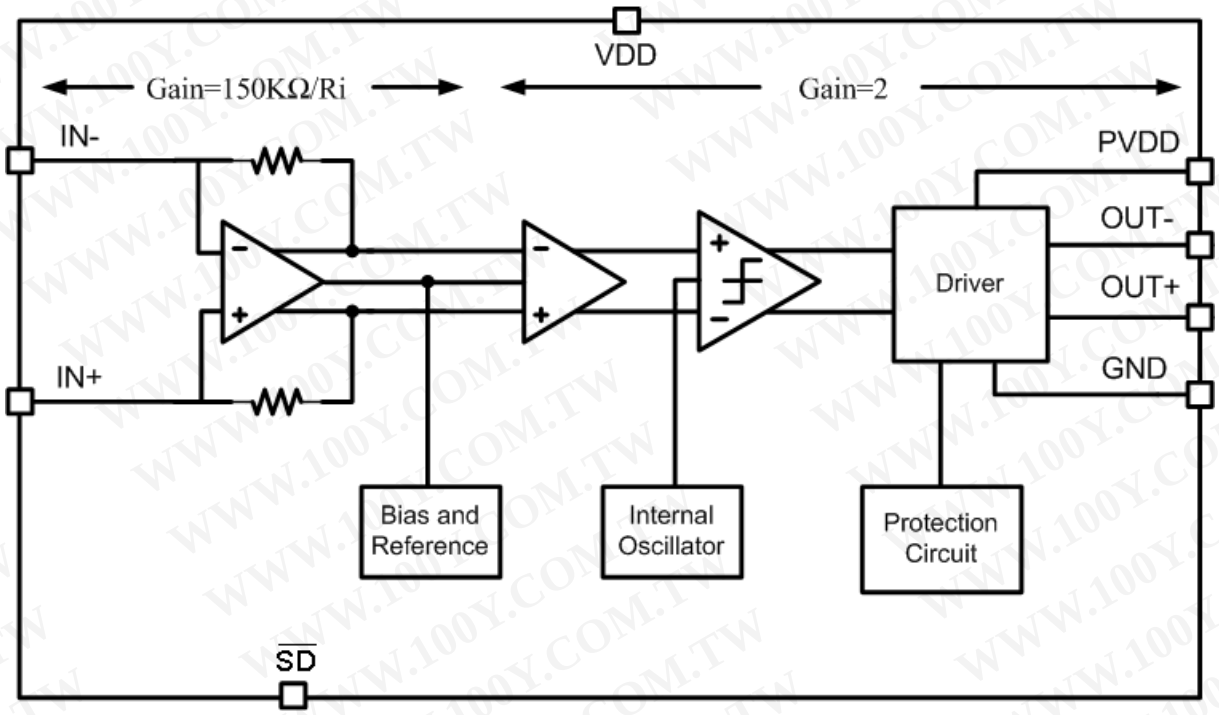
	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX
|VOS|	Output offset voltage	Inputs AC grounded, VDD = 2.5 V ~ 5.5 V		2	19	mV
|IIH|	High-level input current	VDD = 5.0V, VI = 5.3 V			50	μA
|IIL|	Low-level input current	VDD = 5.0V, VI = –0.3 V			5	μA
I(Q)	Quiescent current	VDD = 5.0 V, no load		4.2		mA
		VDD = 3.6 V, no load		3.3		
		VDD = 2.5 V, no load		2.6		
I(SD)	Shutdown current	V($\overline{SD}$)= 0.35 V, VDD = 3.6V		1.6		μA
r_{DSON}(P)	Static drain-source on-state resistance	VDD = 2.5 V		0.433		mΩ
		VDD = 3.6 V		0.365		
		VDD = 5.0V		0.346		
r_{DSON}(N)	Static drain-source on-state resistance	VDD = 2.5 V		0.195		mΩ
		VDD = 3.6 V		0.179		
		VDD = 5.0 V		0.189		
	Output impedance in SHUTDOWN mode	V($\overline{SD}$) = 0.35 V		>1		kΩ
f(sw)	Switching frequency	VDD = 2.5 V ~5.5 V		270		kHz
A_{GAIN}	Amplifier Gain	150K/Ri				
R_{UP_SD}	Resistance from $\overline{SD}$ to VDD			3		MΩ

OPERATING CHARACTERISTICS

TA = 25℃ (unless otherwise noted)

	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
PO	Output power (per channel)	THD + N = 10%, f = 1 kHz, RL = 2 Ω	VDD=5.5V		4.8		W
			VDD=3.6V		2.01		
			VDD=2.5V		0.923		
		THD + N = 1%, f = 1 kHz, RL = 2 Ω	VDD=5.5V		4		W
			VDD=3.6V		1.71		
			VDD=2.5V		0.748		
		THD + N = 10%, f = 1 kHz, RL = 4 Ω	VDD = 5 V		2.99		W
			VDD = 3.6 V		1.52		
			VDD = 2.5 V		0.695		
		THD + N = 1%, f = 1 kHz, RL = 4 Ω	VDD = 5 V		2.41		W
			VDD = 3.6 V		1.22		
			VDD = 2.5 V		0.557		
		THD + N = 10%, f = 1 kHz, RL = 8 Ω	VDD = 5 V		1.748		W
			VDD = 3.6 V		0.896		
			VDD = 2.5 V		0.419		
		THD + N = 1%, f = 1 kHz, RL = 8 Ω	VDD = 5 V		1.4		W
			VDD = 3.6 V		0.719		
			VDD = 2.5 V		0.336		
THD+N	Total harmonic distortion plus noise	VDD= 5V, PO=1W, RL=8Ω, f=1kHz			0.14%		
		VDD= 3.6V, PO=0.5 W, RL=8 Ω, f = 1kHz			0.14%		
		VDD=2.5V,PO=200mW, RL = 8 Ω, f = 1kHz			0.22%		
PSRR	Supply ripple rejection ratio	VDD = 3.6 V, Inputs ac-grounded with Ci=2μF	f=217Hz, V(ripple)=0.2Vpp		-67		dB
SNR	Signal-to-noise ratio	VDD = 5V, PO = 1W, RL = 8Ω			89		dB
	Start-up time from shutdown	VDD = 3.6V			12		ms

BLOCK DIAGRAM



TYPICAL OPERATING CHARACTERISTICS (TA=25°C)

THD+N vs. Output Power

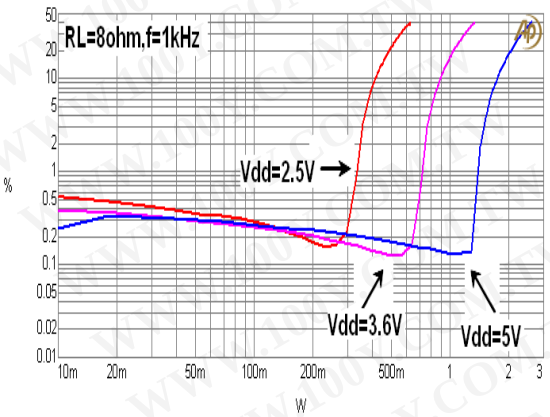


Fig.1

THD+N vs. Output Power

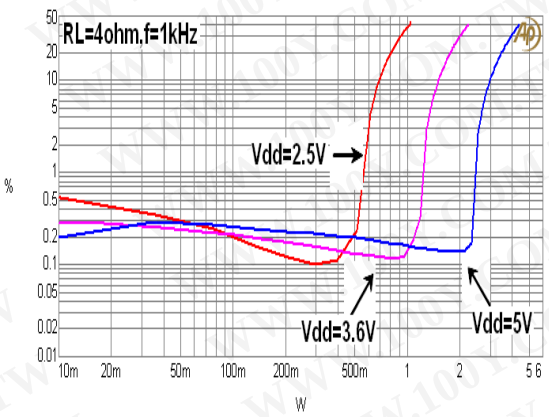


Fig. 2

THD+N vs. Output Power

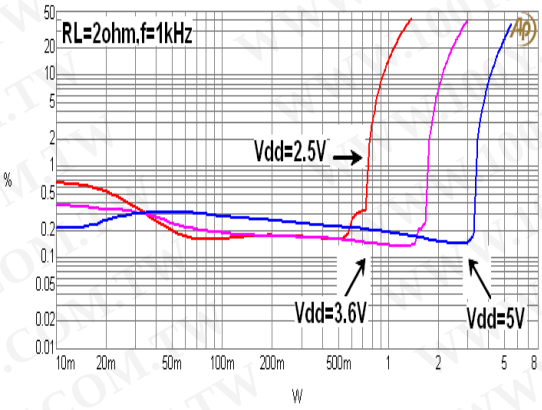


Fig. 3

THD+N vs. Frequency

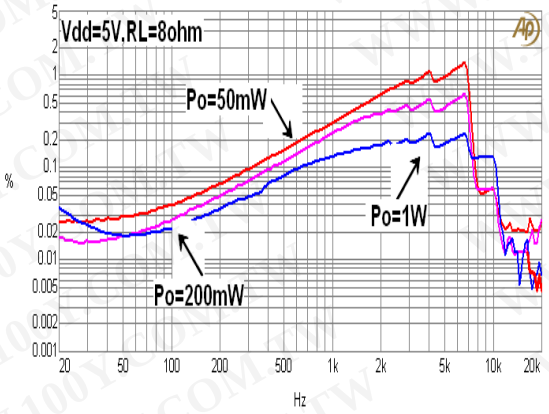


Fig. 4

THD+N vs. Frequency

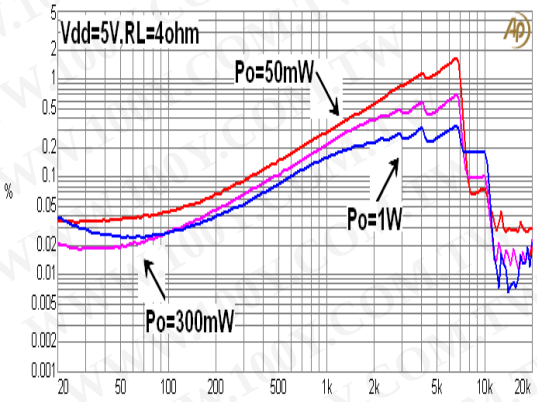


Fig. 5

THD+N vs. Frequency

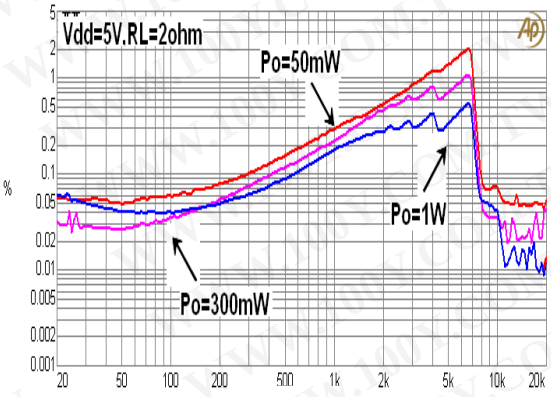


Fig. 6

THD+N vs. Frequency

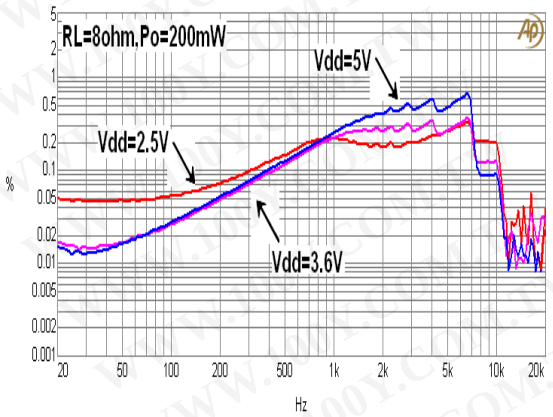


Fig. 7

THD+N vs. Frequency

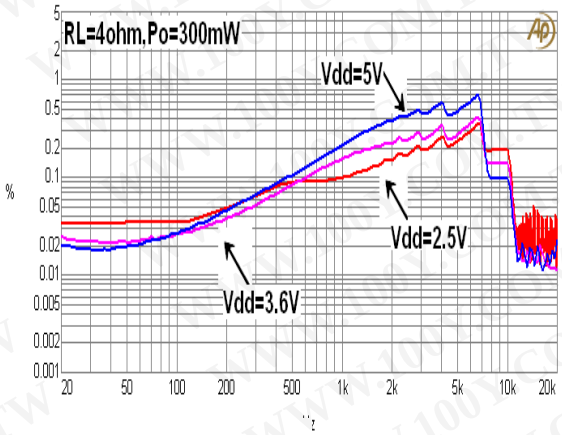


Fig. 8

THD+N vs. Frequency

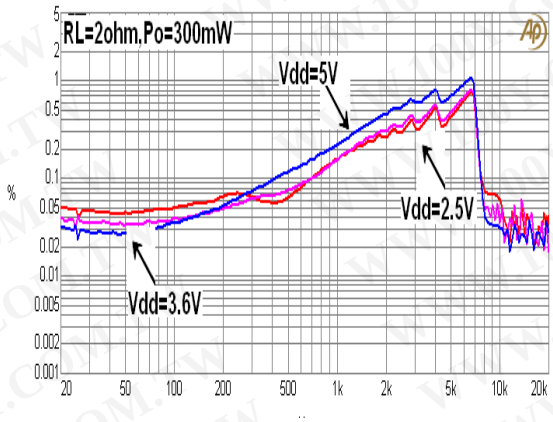


Fig. 9

Frequency Response

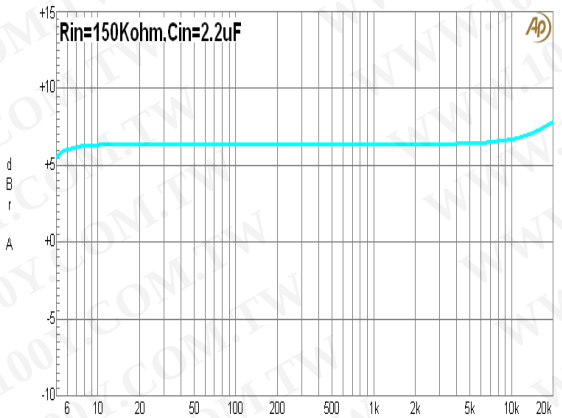


Fig. 10

Noise Floor

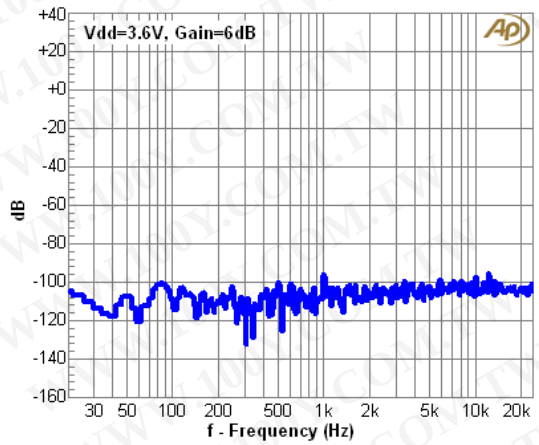


Fig. 11

Quiescent Current vs. Supply Voltage

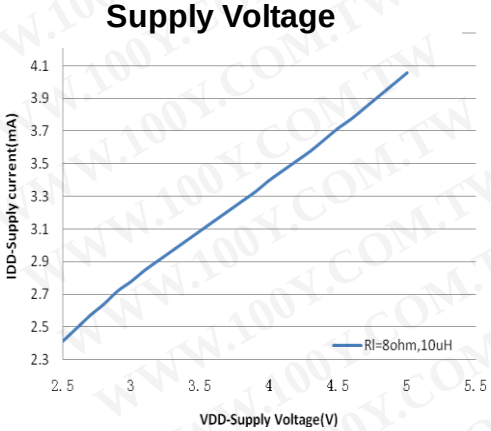


Fig. 12

PSRR vs. Frequency

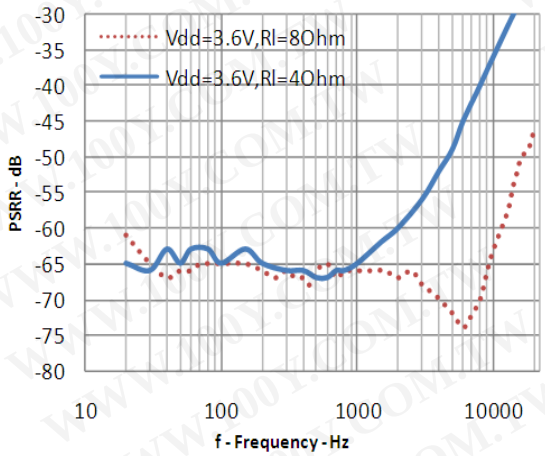


Fig. 13

CMRR vs. Frequency

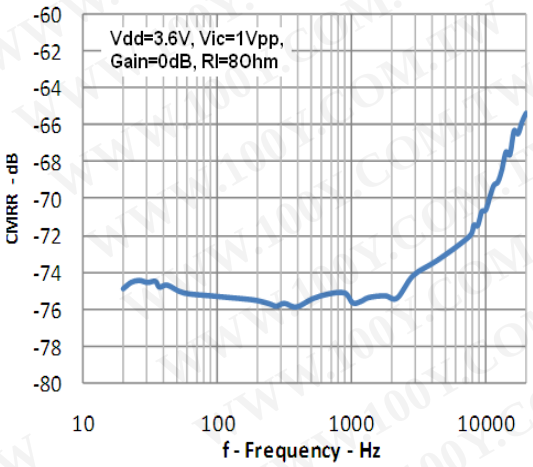


Fig. 14

Efficiency vs. Output Power

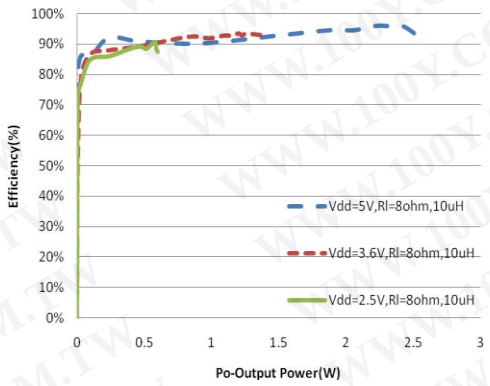


Fig. 15

Efficiency vs. Output Power

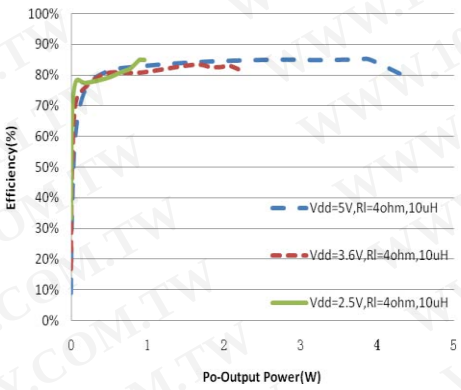


Fig. 16

Efficiency vs. Output Power

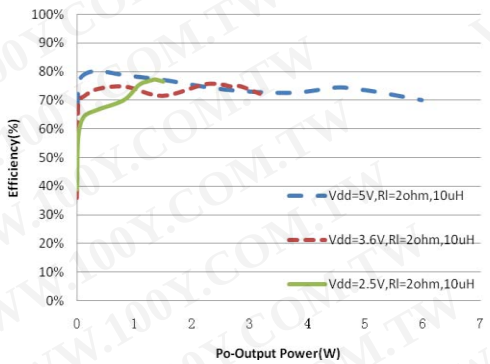


Fig. 17

Application Information

- **Inputs Setting**

MT6905: Fully differential input

The differential input stage of the amplifier cancels any noise that appears on both input lines of the channel. To use the MT6905 with a differential source, connect the positive lead of the audio source to the INL+/INR+ input through DC-cut capacitors (Ci) and the negative to the INL-/INR- input through DC-cut capacitors (Ci), as Fig.18 shows.

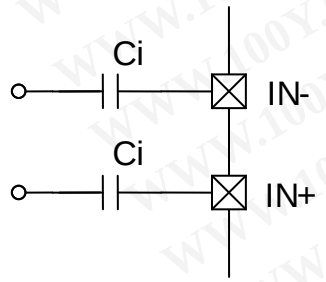


Fig.18. MT6905: Differential Input

MT6905: Single-ended input

MT6905 is also can be used for single-end operation, see Fig.19, ac ground either input through a capacitor and apply the audio signal to the remaining input, and the unused input should be ac-grounded at the audio source instead of at the device input for best noise performance.

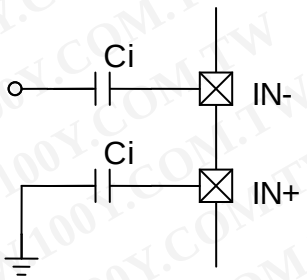


Fig.19. MT6905: Single-Ended Inputs

- **Shut down Mode**

The MT6905 provides a shutdown mode to reduce supply current to the absolute minimum level during periods of non-use for battery-power conservation. The $\overline{SD}$ input pin should be held high during normal operation when the amplifier is in use. Pulling $\overline{SD}$ low causes the outputs to mute and the amplifier to enter a low-current state. $\overline{SD}$ pin internally has a 3MΩ resistor pull up to VDD. So, this pin can be floating for normal operation.

- **Power Supply Decoupling**

The MT6905 is a high-performance CMOS audio amplifier that requires adequate power supply decoupling to ensure the output total harmonic distortion (THD) and PSRR are as low as possible. At this stage it is paramount that we acknowledge the need for separate power supplies and grounds. Noise currents in the output power stage need to be returned to output noise ground and nowhere else. Were these currents to circulate elsewhere, they may get into the power supply, the signal ground, etc, worse yet, they may form a loop and radiate noise. Any of these instances results in degraded amplifier performance. In the layout of the MT6905, the amplifier should offer separate PVDD connections and PGND connections and signal currents for the inputs, reference, etc need to be returned to quite power supply VDD and GND.

As Fig. 20 showing, optimum decoupling is achieved by using two capacitors of different types that target different types of noise on

the power supply leads. For higher frequency transients, spikes, or digital hash on the line, a good low equivalent series resistance (ESR) ceramic capacitor, typically 1.0μF, placed as close as possible to the device VDD terminal works best. For filtering lower-frequency noise signals, a larger capacitor of 10μF (ceramic) or greater placed near the audio power amplifier is recommended, this capacitor serves as local storage capacitor for supplying current during large signal transients on the amplifier outputs.

- **Over Current Protection**

The MT6905 has output short circuit protection circuitry on the outputs that prevents damage to the device during output-to-output short, output-to-GND short, and output-to-VDD short. MT6905 enters the shutdown state and the outputs are disabled when detects output short. This is a latched fault and must be reset by cycling the voltage on $\overline{SD}$ pin to a logic low and back to the logic high, or by cycling the power off and then back on. This clears the short circuit flag and allows for normal operation if the short was removed. If the short was not removed, the protection circuitry actives again.

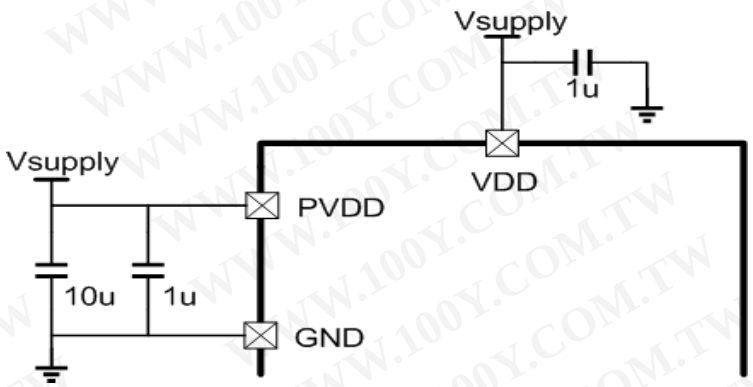
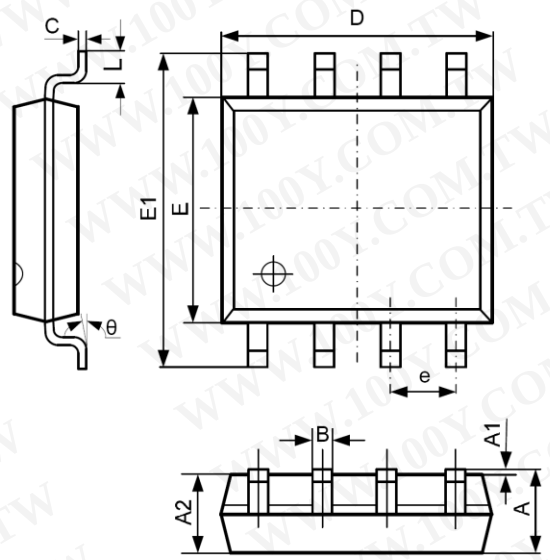


Fig.20. Power Supply Decoupling

PACKAGE DIMENSION

SOP-8 PACKAGE OUTLINE AND DIMENSIONS



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°