

免电感滤波30W D类音频功放

■ 特点

- 输出功率
24W ($V_{DD}=15V, R_L=4\Omega, THD+N=1\%$)
30W ($V_{DD}=15V, R_L=4\Omega, THD+N=10\%$)
- 单电源系统, 4.5V-16V宽电压输入范围
- 超过90%效率, 无需散热器
- 扩频功能, 免电感滤波
- 模拟差分/单端输入
- 保护功能: 过压/过流/过热/欠压异常, 直流检测和短路保护
- 无铅无卤封装, SSOP10-PP

■ 应用

- 条形音箱
- 便携式音箱
- 拉杆音箱
- 无线智能音箱
- 消费类音频应用
- LCD电视/监视器

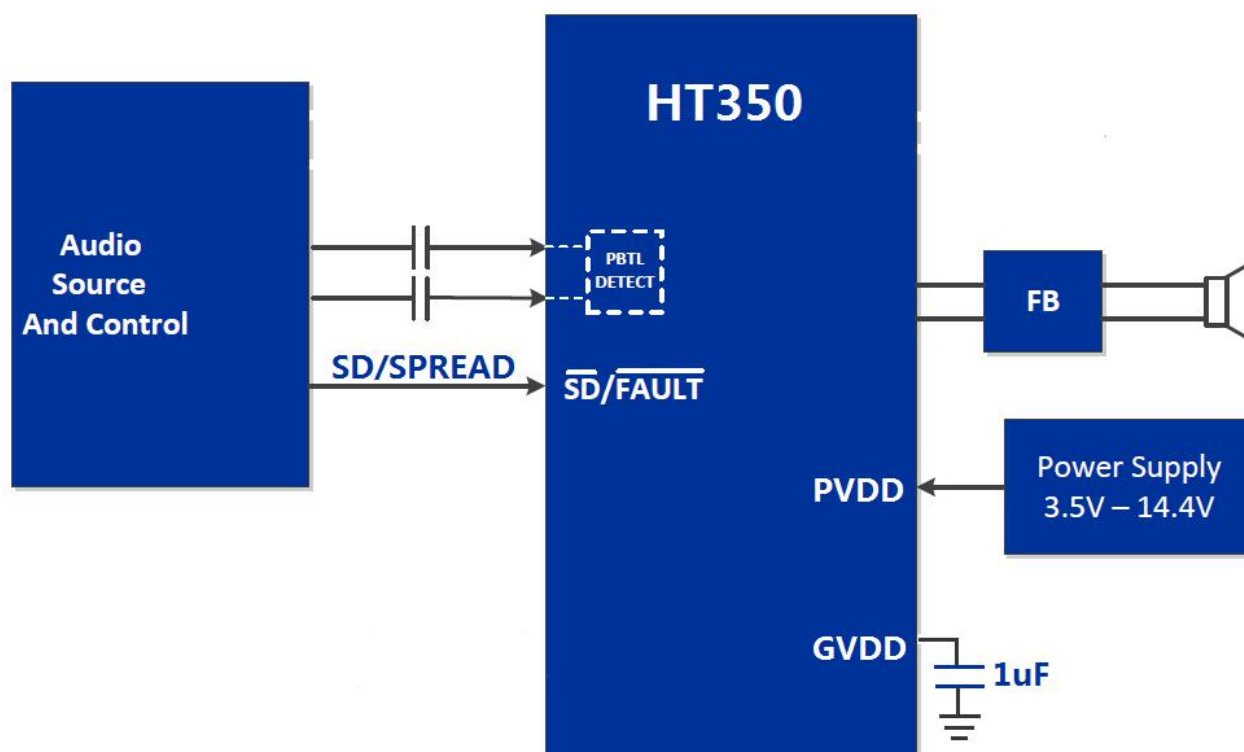
■ 概述

HT350是一款高效D类音频功率放大器。在15V供电的单声道(PBTL)模式下,能够持续提供30W/4Ω功率输出。

HT350具有先进的扩频功能来抑制EMI,使用价格低廉且小体积铁氧体磁珠可满足EMC要求。

此外,HT350内置关断功能使待机电流最小化,还集成了过压保护、直流保护、短路保护、热保护和电源欠压异常保护等功能,可全面防止出现故障。

■ 简化应用图



30W Inductor Free Class D Mono Amplifier

■ FEATURE

- Output Power
24W ($V_{DD}=15V$, $R_L=4\Omega$, THD+N=1%)
30W ($V_{DD}=15V$, $R_L=4\Omega$, THD+N=10%)
- Single Wide Voltage Supply: 4.5V-16V
- Efficiency > 90%
- Differential / Single-ended Analog Input
- Spread Switching Frequency For Inductor Free
- Integrated Self-protection Circuits Including Overvoltage, Undervoltage, Overtemperature, DC-detect, and Overcurrent with Error Reporting
- LF and HF Package of SSOP10-PP

■ APPLICATIONS

- Sound Bars · Wireless Speakers
- Consumer Audio Applications · TVs/Monitors

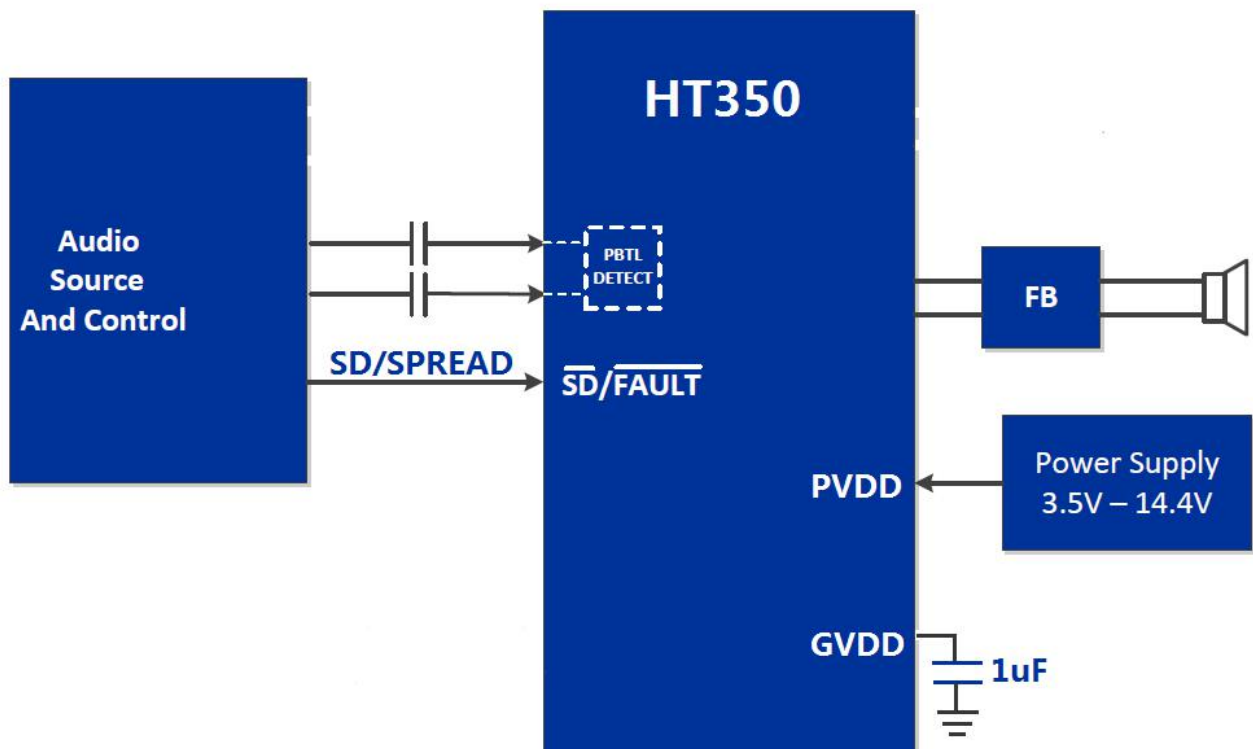
■ GENERAL DESCRIPTION

HT350 is a mono efficient, Class-D audio amplifier for driving speakers up to 30W/4 Ω in mono PBTL.

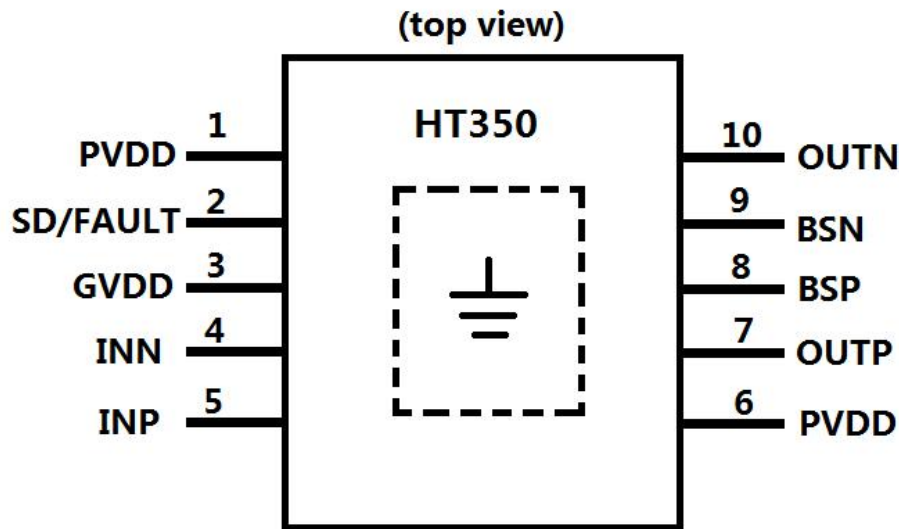
Advanced EMI Suppression with Spread Spectrum Control enables the use of inexpensive ferrite bead filters while meeting EMC requirements for system cost reduction.

HT350 is fully protected against faults with Overvoltage, Undervoltage, Overtemperature, DC-detect, and Overcurrent protection. Faults can be reported to the processor to prevent devices from being damaged

■ TYPICAL APPLICATION



■ TERMINAL CONFIGURATION



Pin No.	Name	I/O ¹	Description
1	PVDD	P	Power Supply for amplifier drivers
2	\SD/FAULT	I	SD/FAULT, multi function pin. When pulled down, place the speaker amplifier in shutdown mode. General fault reporting including Over-Temp, Over-Current, DC Detect.
3	GVDD	O	Voltage regulator derived from PVDD supply, connect 1uF to GND (NOTE: This pin is provided as a connection point for filtering capacitors for this supply and must not be used to power any external circuitry)
4	INN	I	Negative input terminal
5	INP	I	Positive input terminal
6	PVDD	P	Power Supply for amplifier drivers
7	OUTP	O	Positive pin for differential speaker amplifier output
8	BSP	BST	Connection point for the OUTP bootstrap capacitor, which is used to create a power supply for the high-side gate drive for OUTP
9	BSN	BST	Connection point for the OUTN bootstrap capacitor, which is used to create a power supply for the high-side gate drive for OUTN
10	OUTN	O	Negative pin for differential speaker amplifier output
PAD	PGND	G	Power ground, make sure connect it to the system ground

¹ I: Input; O: Output; G: Ground; P: Power; BST: Boot Strap

ORDERING INFORMATION

Part Number	Package Type	Marking	Operating Temperature Range	MOQ/Shipping Package
HT350SPET	SSOP10L-PP	HT350 ^{SPE} UVWXYZ ¹	-40°C ~ 85°C	100PCS / Tube
HT350SPER	SSOP10L-PP	HT350 ^{SPE} UVWXYZ ¹	-40°C ~ 85°C	2500PCS / Tape

¹ UVWXYZ is production tracking code

■ SPECIFICATIONS¹

● Absolute Maximum Ratings²

PARAMETER	Symbol	MIN	MAX	UNIT
Supply voltage range (PVDD)	PVDD	-0.3	18	V
Input voltage range (INP, INN)	V _I	-0.3	5.8	V
Input voltage range (\SD)	V _I	-0.3	PVDD	V
Operating temperature range	T _A	-40	85	°C
Operating junction temperature range	T _J	-40	150	°C
Storage temperature range	T _{STG}	-50	150	°C

● Recommended Operating Conditions

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Supply voltage range	V _{DD}	PVDD	4.5		16	V
Operating temperature	T _a		-40	25	85	°C
High-level input voltage	V _{IH}	\SD, Spread on	2.5		PVDD	V
Middle-level input voltage	V _{IM}	\SD, Spread off	1.5		2.2	V
Low-level input voltage	V _{IL}	\SD			0.8	V
High-level input current	I _{IH}	\SD (V _I = 2V, V _{DD} = 12V)			1	uA
Low-level output voltage	V _{OL}	FAULT, OPEN-DRAIN OUTOUT			0.5	V
Load impedance (BTL)	R _L	With output filter	3.2	4		Ω
Load impedance (PBTL)	R _L	With output filter	1.6	2		Ω

● DC Electrical Characteristics

Conditions: T_A = 25°C, PV_{DD} = 4.5-16V, Load = 4ohm, unless otherwise specified.

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Class Output Offset Voltage	V _{OS}	V _I = 0V, Gain = 32dB		1.5		mV
Quiescent supply current	I _{DD}	V _{DD} = 12V, No Load		12		mA
Quiescent supply current in SD mode	I _{SD}	V _{DD} = 12V, With Load		12		uA
System Gain in BTL or PBTL mode	Gain	R _{in} = 0kΩ		32		dB
		R _{in} = 8.2kΩ		26		dB
Turn-on time	t _{on}	Pull \SD high or power on		90		ms
Turn-off time	t _{off}	Pull \SD low		5		us
Gate drive supply	GVDD			5		V

¹ Depending on parts and PCB layout, characteristics may be changed.

² 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.

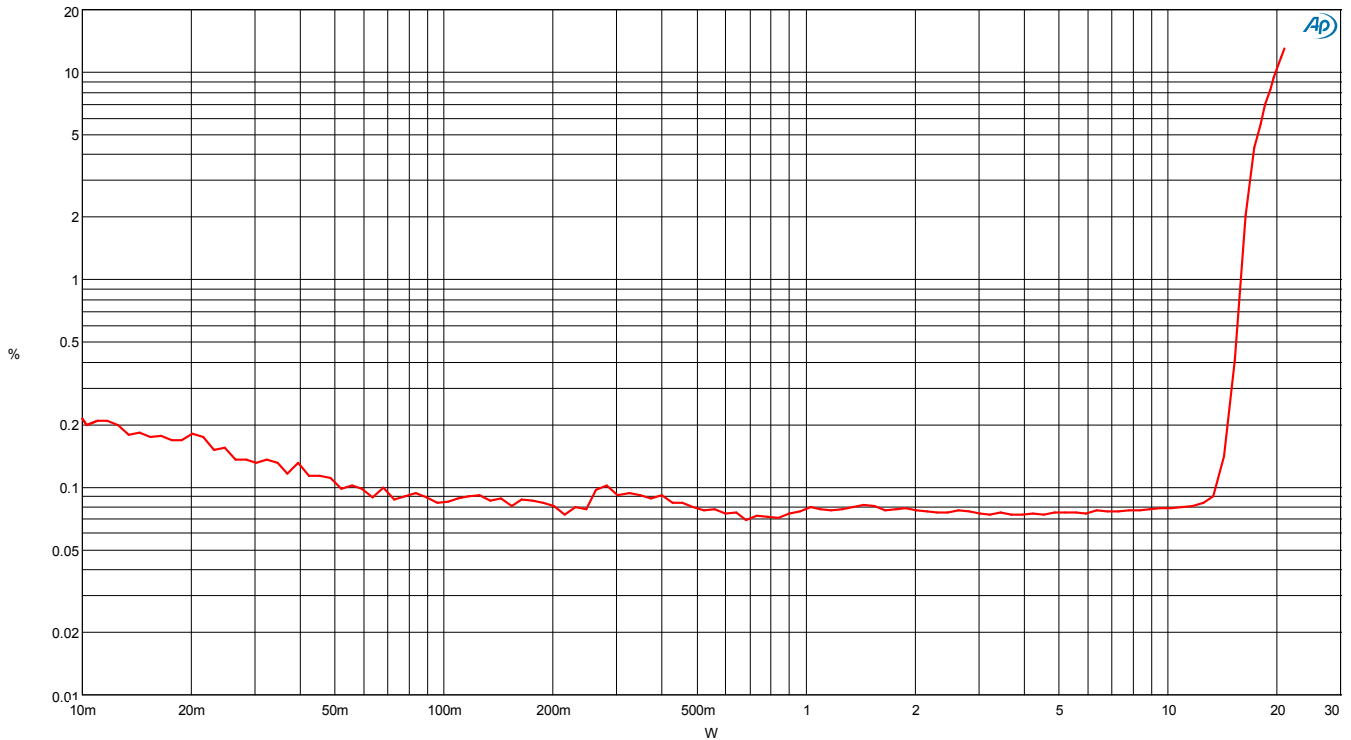
● **AC Electrical Characteristics**

Conditions: $T_A = 25^\circ\text{C}$, $V_{DD} = 4.5\text{-}16\text{V}$, Load = Filter + R_L , Filter = 300R Bead + 1nF, $R_L = 4\Omega + 22\mu\text{H}$, $f_{IN} = 1\text{ kHz}$, Gain = 26dB, $C_{IN} = 1\mu\text{F}$, 20-20kHz, unless otherwise specified.

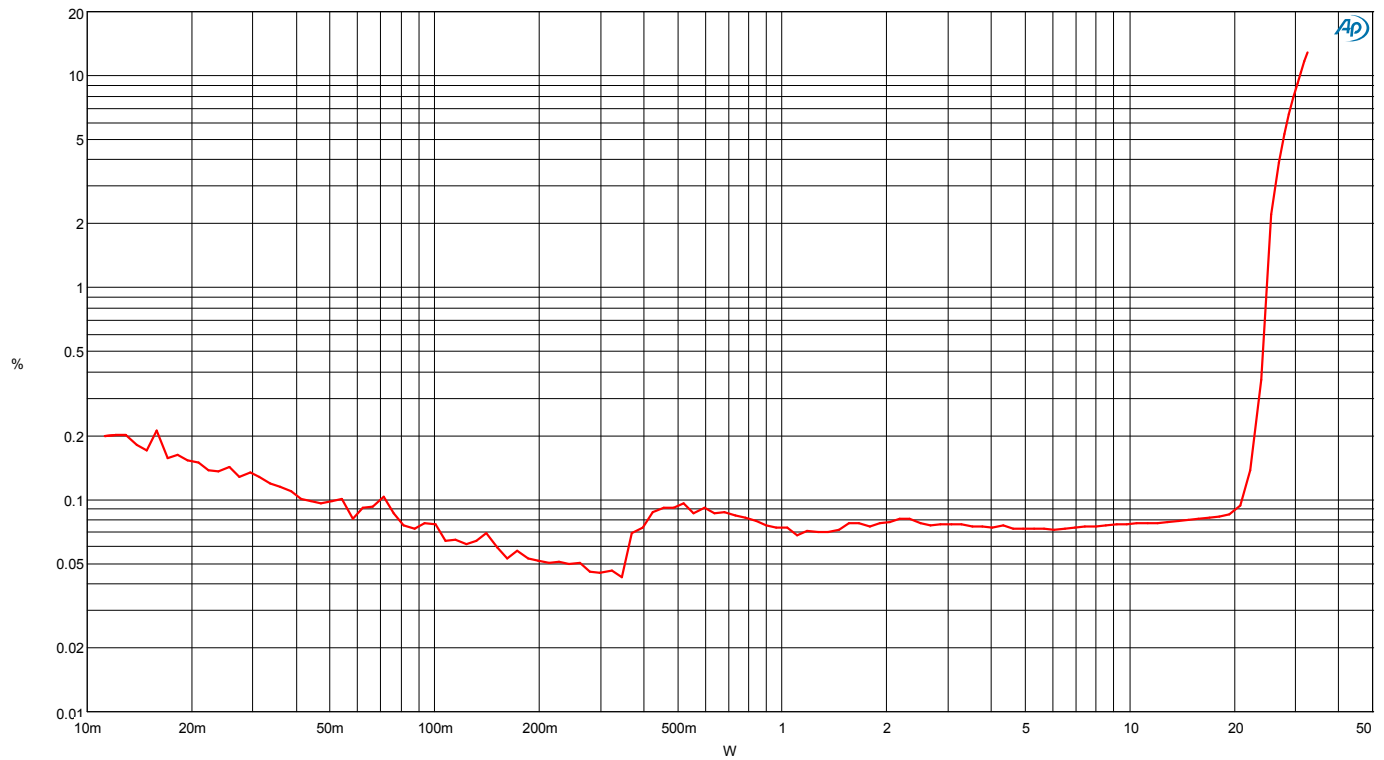
PARAMETER	Symbol	CONDITION		MIN	TYP	MAX	UNIT
Continuous output power	P_o	$V_{DD} = 16\text{V}$, $R_L = 3\Omega + 22\mu\text{H}$, PBTL	THD +N = 1%		35		W
			THD+N = 10%		44		W
		$V_{DD} = 16\text{V}$, $R_L = 4\Omega + 22\mu\text{H}$, PBTL	THD +N = 1%		28		W
			THD+N = 10%		35		W
Total harmonic distortion + noise	THD+N	$P_o = 1\text{W}$, $V_{DD} = 12\text{V}$, $R_L = 4\Omega$			0.05		%
Efficiency	η	$V_{DD} = 12\text{V}$, THD+N = 10%	$R_L = 4\Omega$		92		%
Output integrated noise	V_N	A-weighted, Gain = 20 dB			120		μV
Signal-to-noise ratio	SNR	A-weighted, Gain = 20 dB, $P_o = 1\text{W}$			82		dB
Power supply rejection ratio	PSRR	200mVpp 1kHz, Input grounded			-75		dB
Oscillator frequency	f_{osc}				360		kHz
Spread frequency range					± 15		kHz
Over temperature protection trigger point	OTP				160		$^\circ\text{C}$
Thermal holdback trigger point	TFB				150		$^\circ\text{C}$
Over current trip point	OCP				12		A

TYPICAL OPERATING CHARACTERISTICS

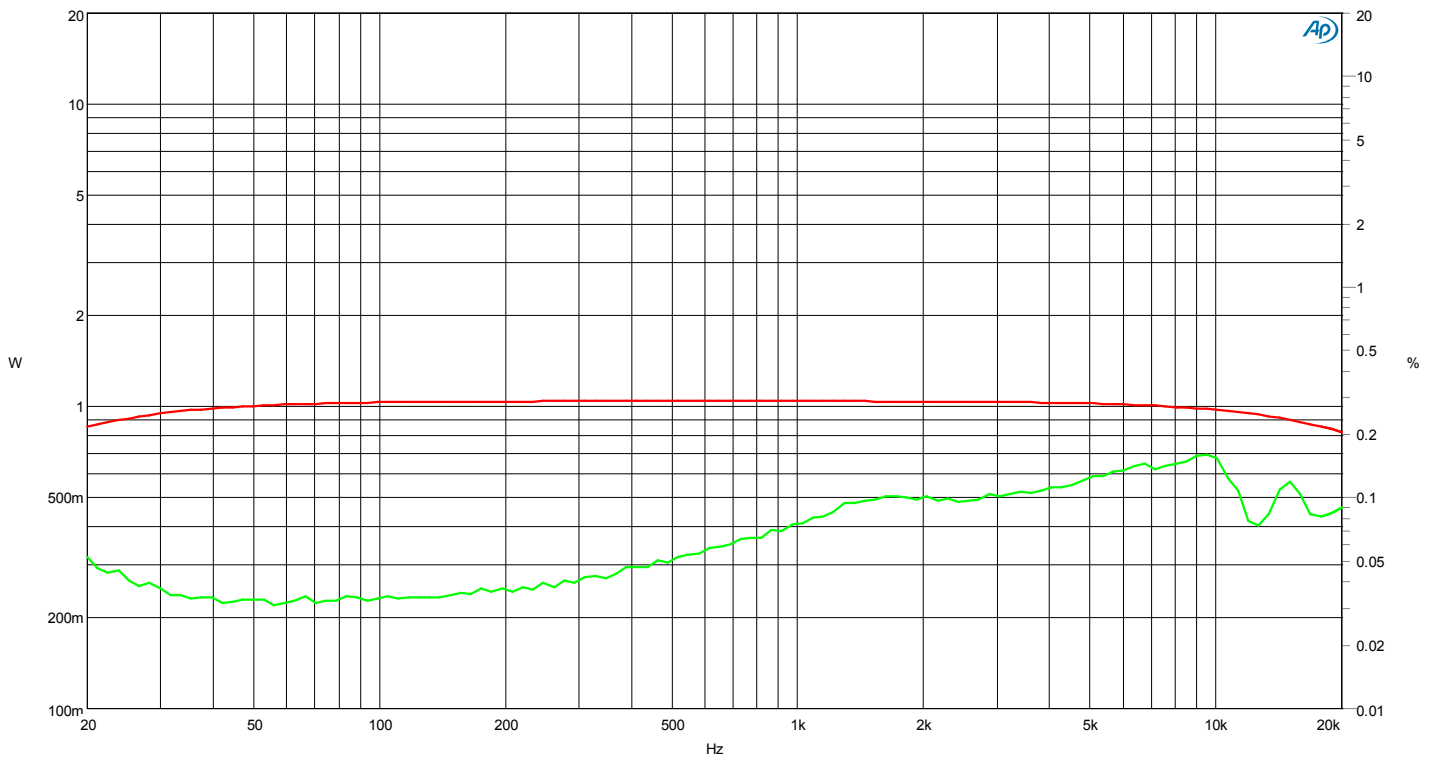
Condition: PVDD = 12V, f_{IN} = 1kHz, C_{IN} = 1uF, external R_{IN} = 8.2kohm, $R_L=4R$, unless otherwise specified



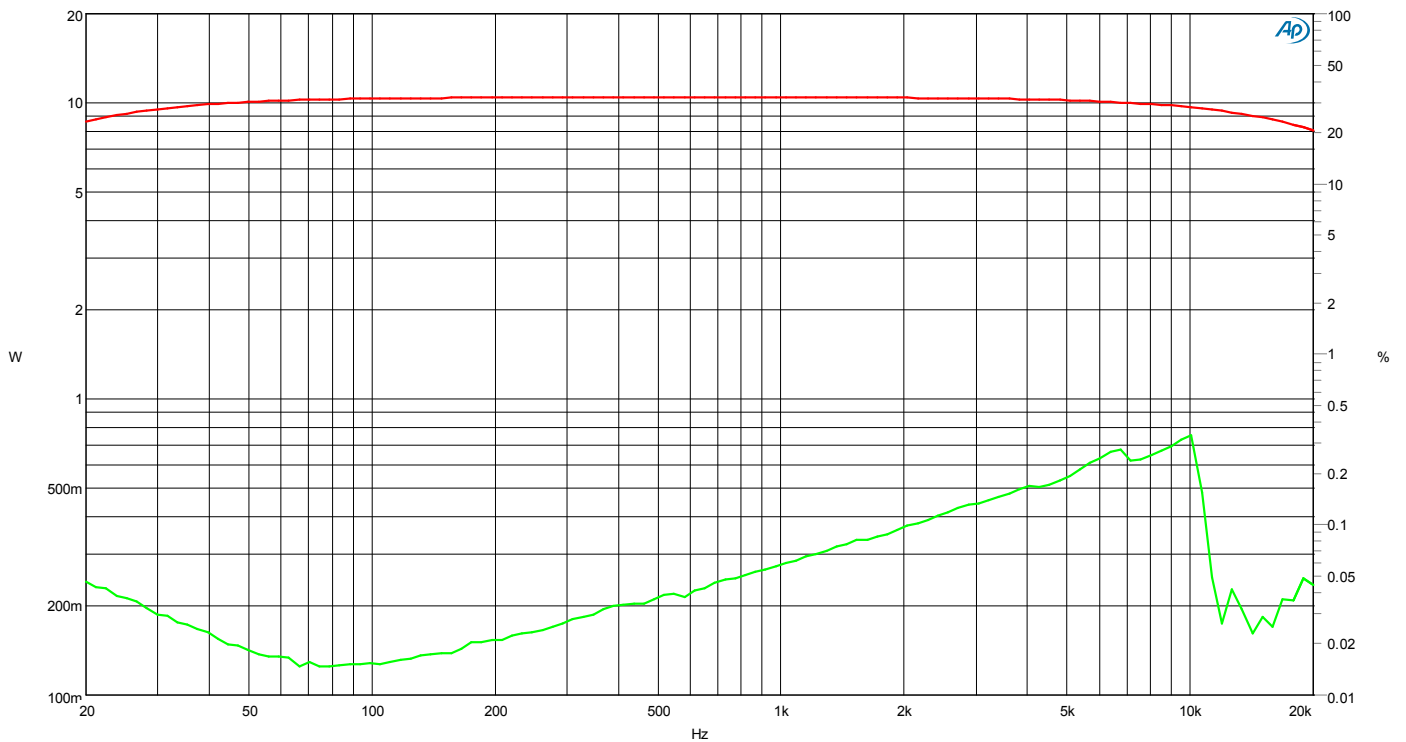
Output Power vs THD+N(PVDD=12V)



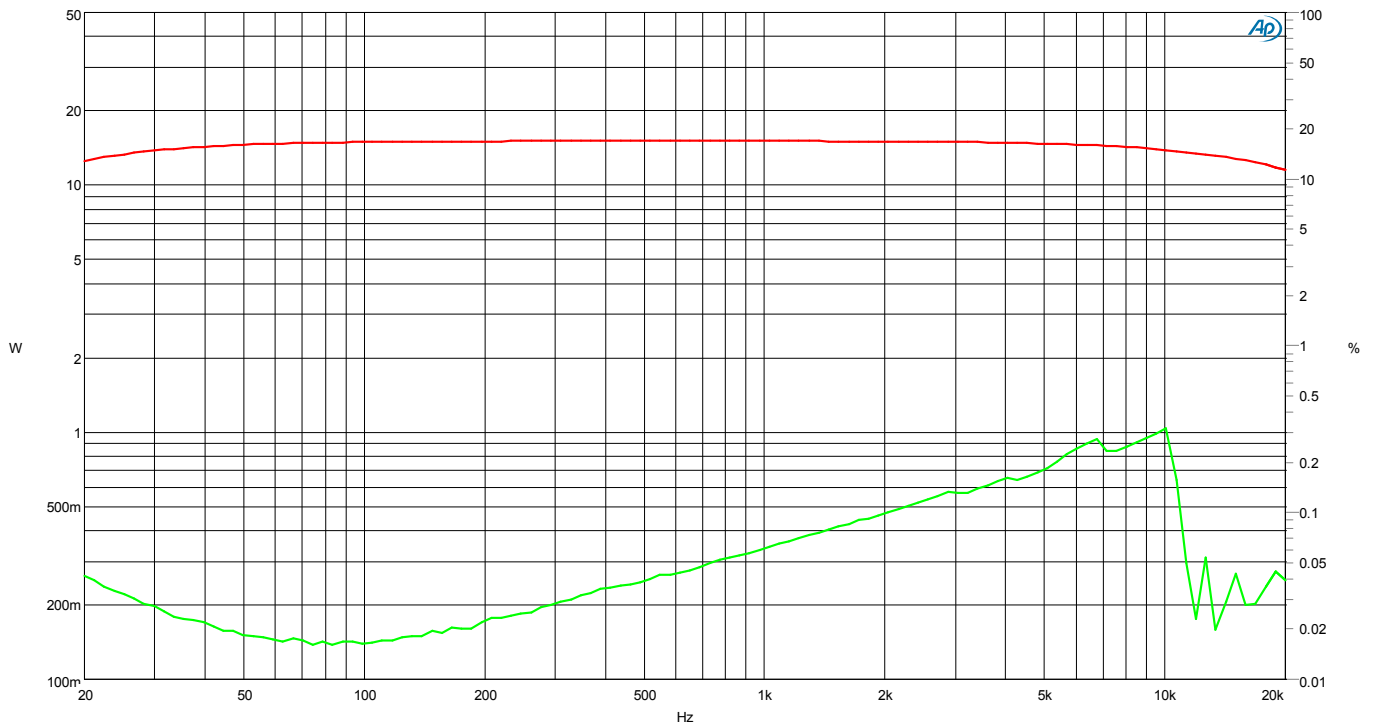
Output Power vs THD+N(PVDD=15V)



f_{IN} vs THD+N($P_o=1W$)

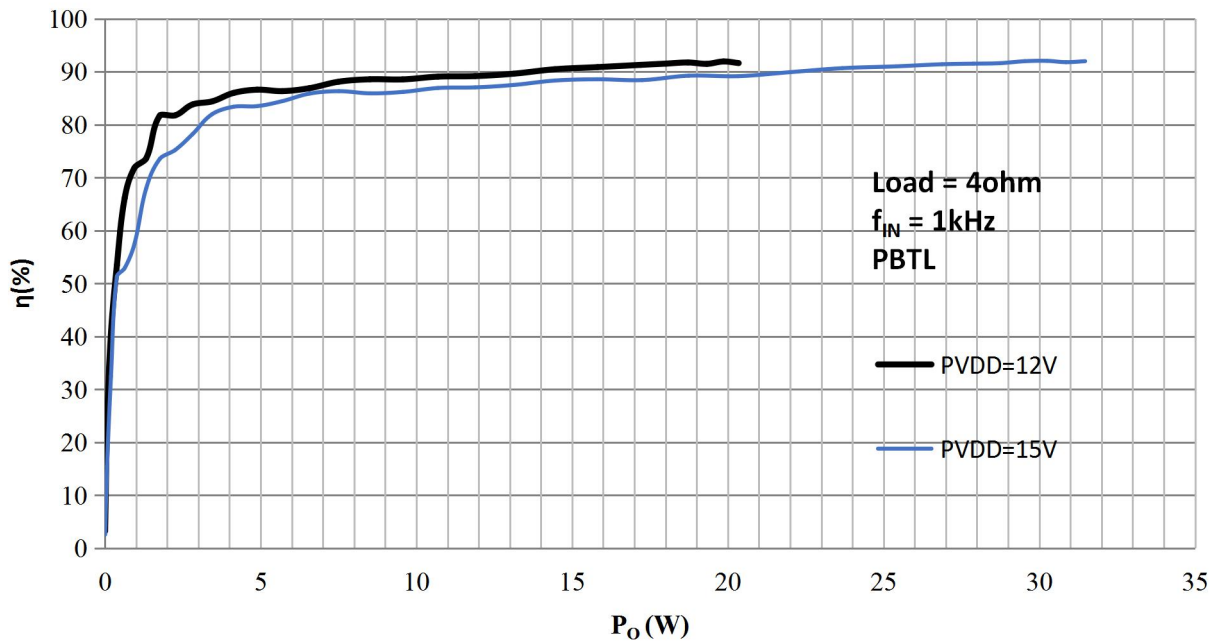


f_{IN} vs THD+N($P_o=10W$)

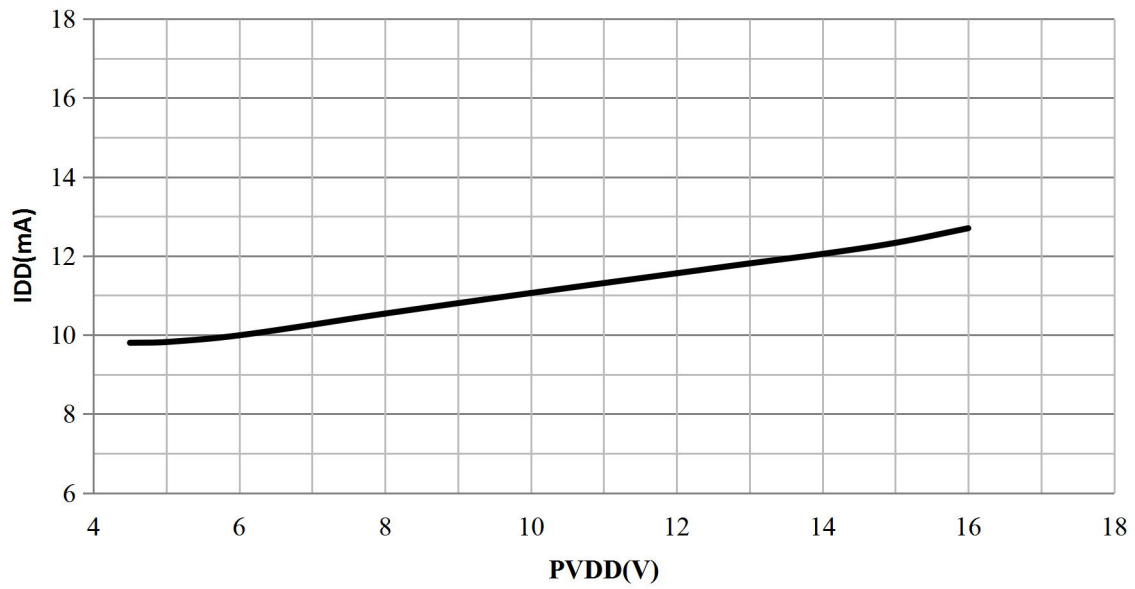


f_{IN} vs THD+N(PVDD=15V, $P_o=10W$)

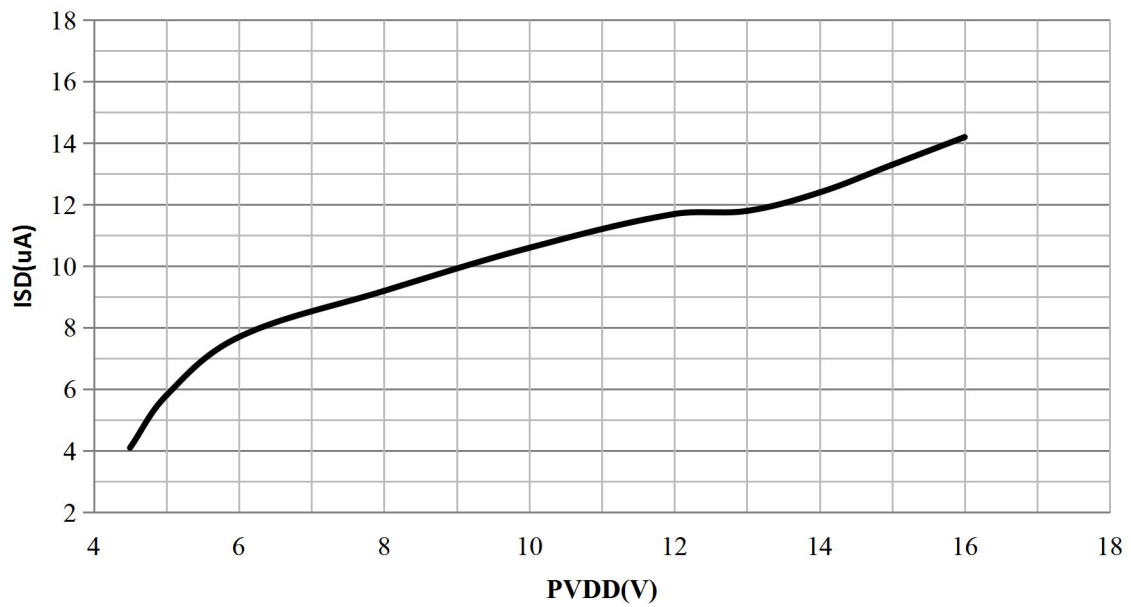
P_o vs η



IDD vs PVDD



ISD vs PVDD



APPLICATION INFORMATION

1. Power Supply

The power supply for the HT350 only require one voltage from 4.5V to 16V, which supplies the analog circuitry and the power stage

The PVDD supply feeds internal LDO including GVDD. This LDO output is connected to external pins for filtering purposes, but should not be connected to external circuits. The filtering capacitor for GVDD is recommended to be 1uF.

Filtering capacitors of 100nF//1uF//220uF for PVDD of each channel should be placed close to the PVDD pin.

2. Amplifier Input and Output

2.1 Amplifier Input Configuration

HT350 is an amplifier with analog input (single-ended or differential). For a differential operation, input signals into IN+ and IN- pins via DC-cut capacitors (C_{IN}). The high pass cut-off frequency of input signal can be calculated by

$$f_c = \frac{1}{2\pi(\text{External } R_{IN} + \text{Internal } R_{IN}) \times C_{IN}}$$

The input signal gain is calculated by $\text{Gain} \approx R_F / (\text{External } R_{IN} + \text{Internal } R_{IN})$. The inter RF=400k, inter Rin=10k.

For a single-ended operation, input signals to IN+ pin via a DC-cut capacitor (C_{IN}). IN- pin should be connected to ground via a DC-cut capacitor (with the same value of C_{IN}).

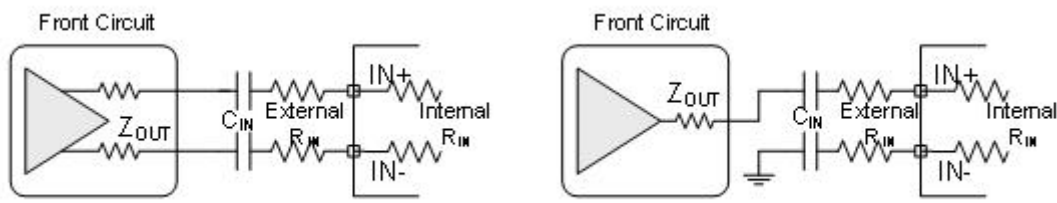


Figure 1 (1) Differential Input;

(2) Single-ended Input

2.2 Amplifier Output Configuration

The HT350 has been tested with a simple ferrite bead filter for a variety of applications including long speaker wires up to 20 cm and high power. One important aspect of the ferrite bead selection is the type of material used in the ferrite bead. Not all ferrite material is alike, so it is important to select a material that is effective in the 10 to 100 MHz range which is key to the operation of the class-D amplifier. The impedance of the ferrite bead can be used along with a small capacitor with a value in the range of 1000 pF to reduce the frequency spectrum of the signal to an acceptable level. For best performance, the resonant frequency of the ferrite bead/ capacitor filter should be less than 10 MHz. Also, the filter capacitor can be increased if necessary, with some impact on efficiency.

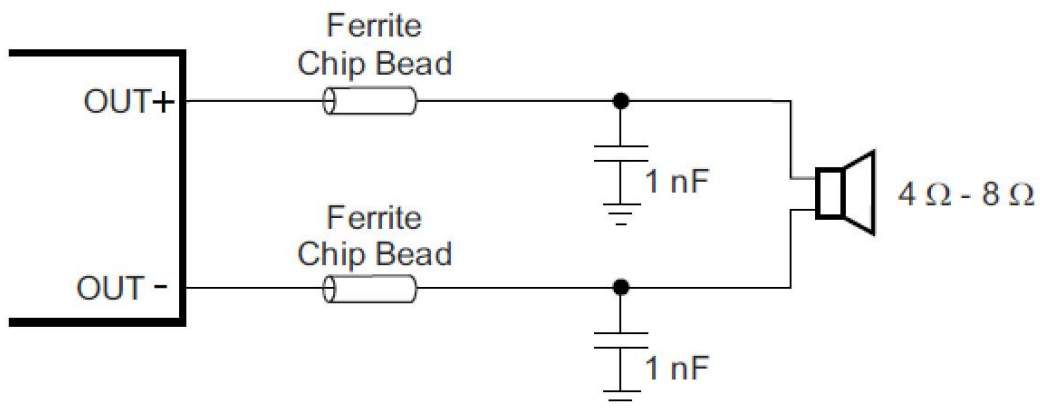


Figure 2 Output Filters with Ferrite Beads

There may be a few circuit instances where it is necessary to add a complete LC reconstruction filter. These circumstances

might occur if there are nearby circuits which are sensitive to noise. In these cases, a classic second order Butterworth filter similar to those shown in the figures below can be used.

Some systems have little power supply decoupling from the AC line but are also subject to line conducted interference (LCI) regulations. These include systems powered by "wall warts" and "power bricks." In these cases, LC reconstruction filters can be the lowest cost means to pass LCI tests. Common mode chokes using low frequency ferrite material can also be effective at preventing line conducted interference.

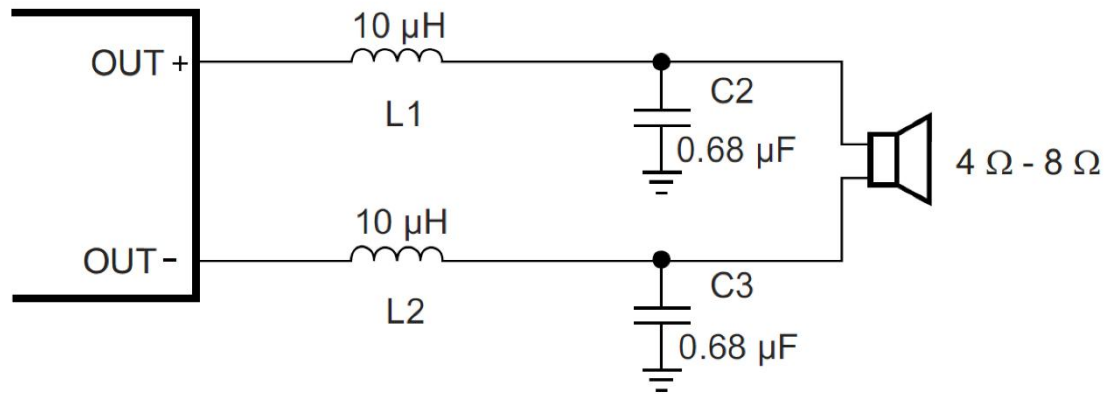


Figure 3 Output Filters with LC

3. Startup, Shutdown

The HT350 employs a shutdown mode of operation designed to reduce supply current (I_{DD}) to the absolute minimum level during periods of nonuse for power conservation. The $\backslash SD$ input terminal should be held high during normal operation when the amplifier is in use. Pulling $\backslash SD$ low will put the outputs to mute and the amplifier to enter a low-current state. It is not recommended to leave $\backslash SD$ unconnected, because amplifier operation would be unpredictable.

For a better power on and power-off pop performance, place the amplifier in the shutdown mode prior to delivering or removing the power supply.

4. Other Functions and Terminals

4.1 GVDD Supply

The GVDD Supply is used to power the gates of the output full bridge transistors. Decouple GVDD with a X5R ceramic 1 μF capacitor to GND. The GVDD supply is not intended to be used for external supply.

4.2 BSP和BSN Capacitors

The full H-bridge output stages use only NMOS transistors. Therefore, they require bootstrap capacitors for the high side of each output to turn on correctly. A 220nF ceramic capacitor of quality X5R or better, rated for at least 16 V, must be connected from each output to its corresponding bootstrap input. The bootstrap capacitors connected between the BSx pins and corresponding output function as a floating power supply for the high-side N-channel power MOSFET gate drive circuitry. During each high-side switching cycle, the bootstrap capacitors hold the gate-to-source voltage high enough to keep the high-side MOSFETs turned on.

5. Protection Functions

The HT350 contains a complete set of protection circuits carefully designed to make system design efficient as well as to protect the device against any kind of permanent failures due to short circuits, overload, over temperature, under-voltage, and over-voltage.

5.1 Over Temperature Protection (OTP)

This is the function to establish the over temperature protection mode when detecting excessive high temperature of HT350. When the on-die temperature of HT350 is higher than TOP, the OTP mode is activated, the differential output pin becomes weak low state (a state grounded through resistivity), and the SD/FAULT pin is pulled low.

5.2 DC Detect Protection (DCP)

The HT350 has circuitry which will protect the speakers from DC current which might occur due to an internal amplifier error. A DC detect fault will be reported on the SD/FAULT pin as a low state. The DC Detect fault will also cause the amplifier to shutdown by changing the state of the outputs to Hi-Z.

A DCE event occurs when the output differential duty-cycle of either channel exceeds 60% for more than 420 msec at the same polarity. The table below shows some examples of the typical DCE Protection threshold for several values of the supply voltage. This feature protects the speaker from large DC currents or AC currents less than 2 Hz.

5.3 Short-Circuit Protection (OCP) and Automatic Recovery

The HT350 has protection from over current conditions caused by a short circuit on the output stage. The amplifier outputs are switched to a high impedance state when the short circuit protection latch is engaged. The short circuit protection fault is reported on the SD/FAULT pin as a low state.

When OCP or OTP or DC error is detected, the SD/FAULT pin will be pulled low. Because the SD input is low, it clear the error signal. Delay a ton time(normal 1.3s), HT350 will try restart.

5.4 Under-Voltage Protection (UVP)

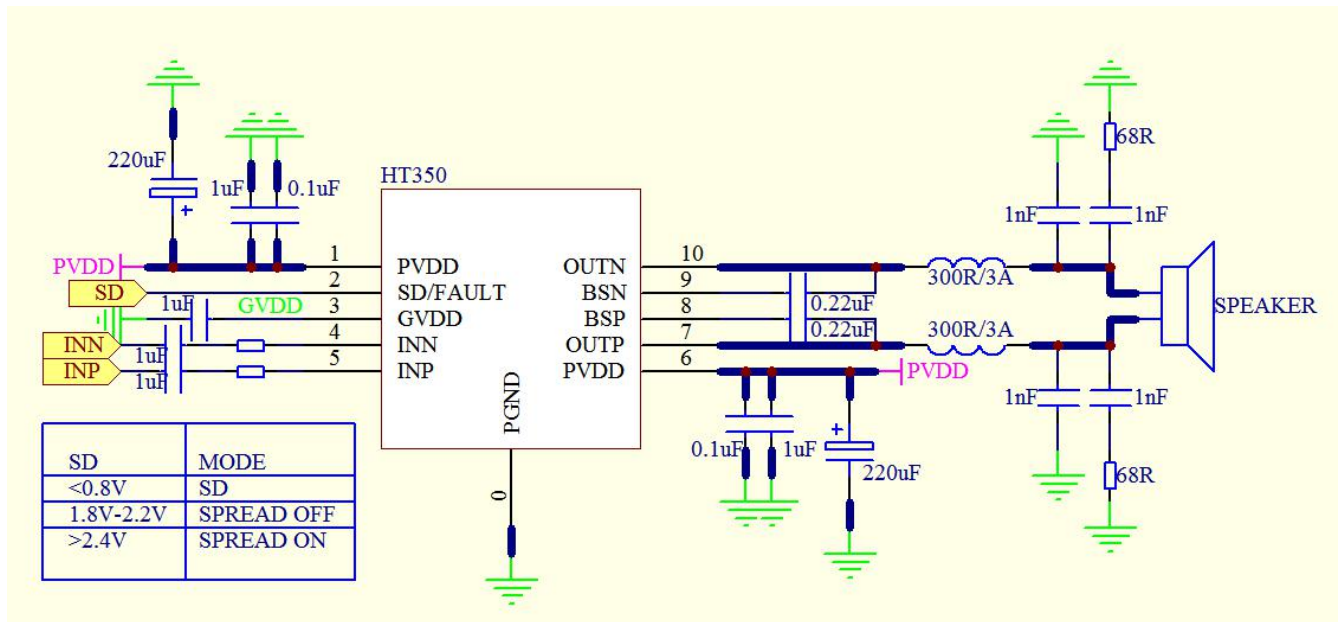
This is the function to establish the under-voltage protection mode when power supply becomes lower than the detection voltage V_{UVLL} , and the protection mode is canceled when the power supply becomes higher than the threshold voltage V_{UVLH} . In the under-voltage protection mode, the differential output pin becomes weak low state (a stage grounded through resistivity). HT350 will start up within start-up time when the under-voltage protection mode is cancelled.

5.5 Uver-Voltage Protection (OVP)

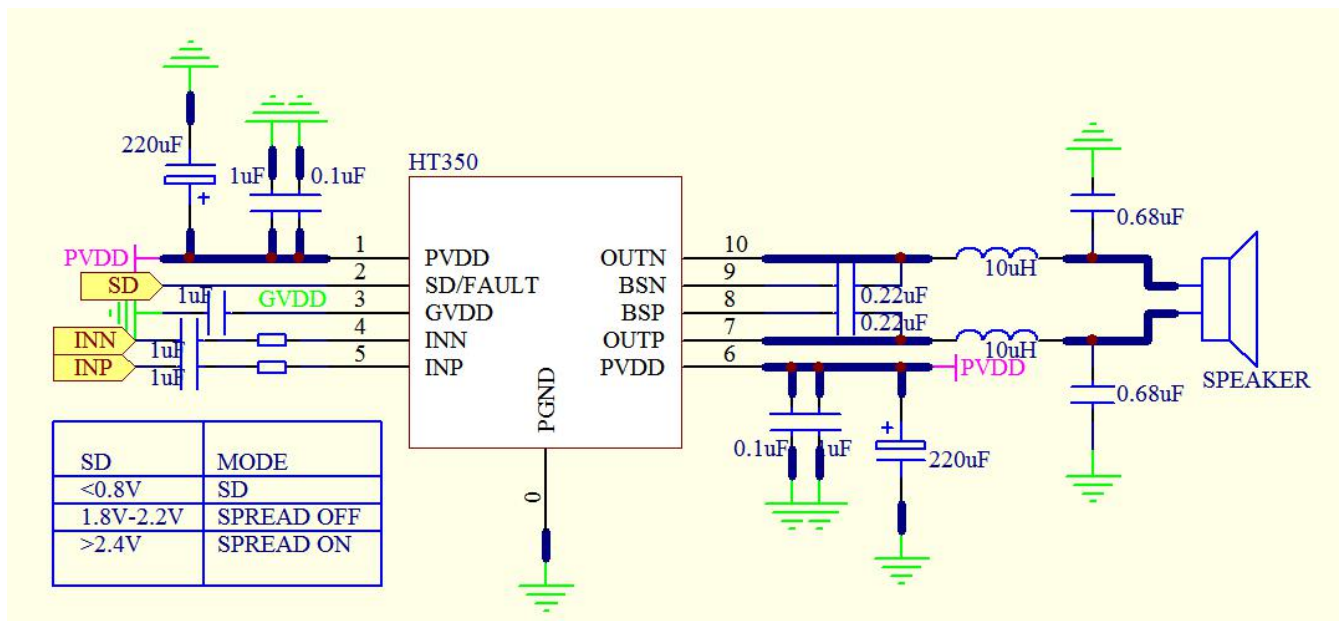
The HT350 device monitors the voltage on PVDD voltage threshold. When the voltage on PVDD pin exceeds the over-voltage threshold (18V typ), the OVP circuit puts the device into shutdown mode. The device recovers automatically once the over-voltage condition has been removed.

6. Typical Applications

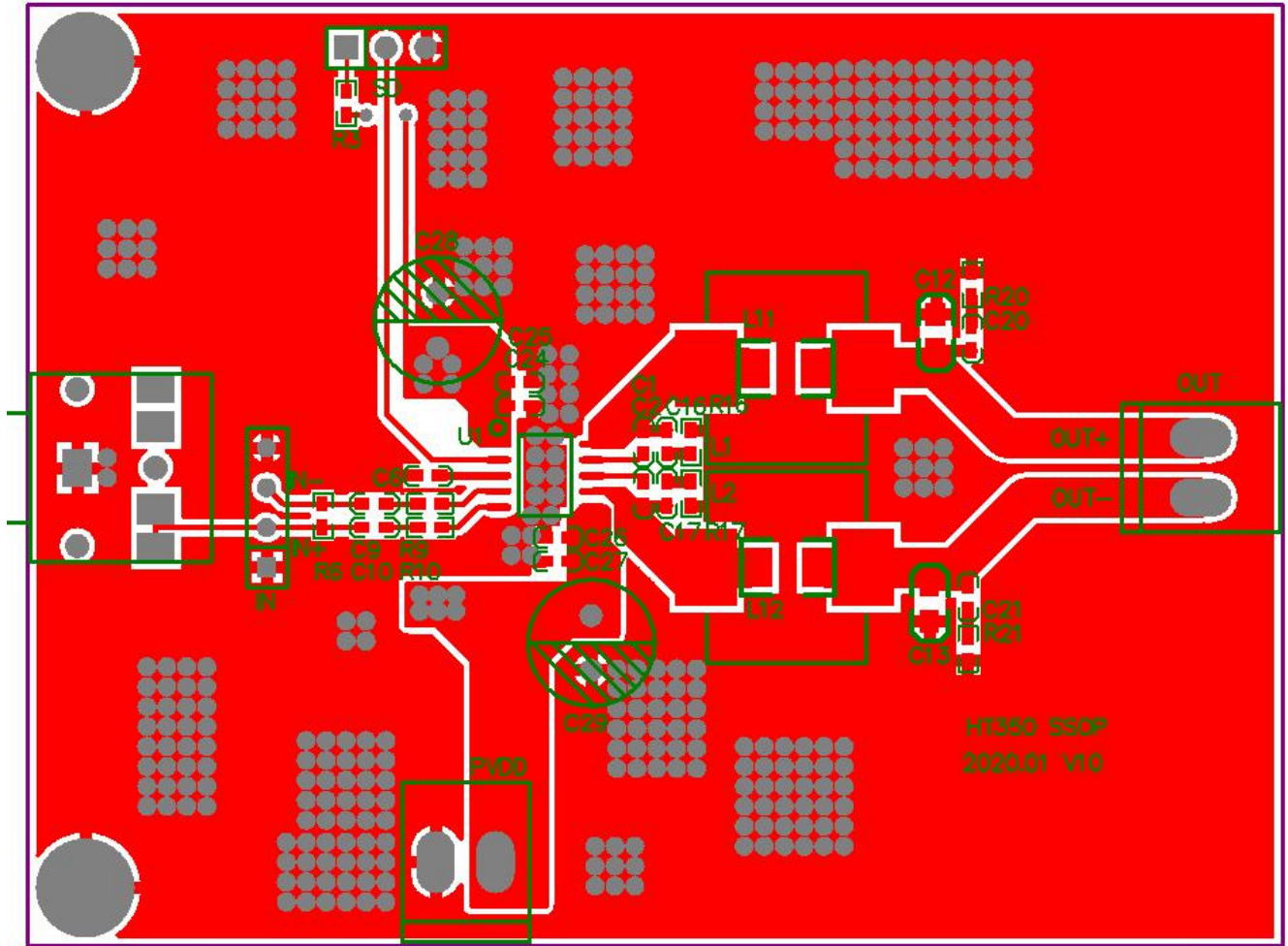
6.1 INDUCTOR FREE

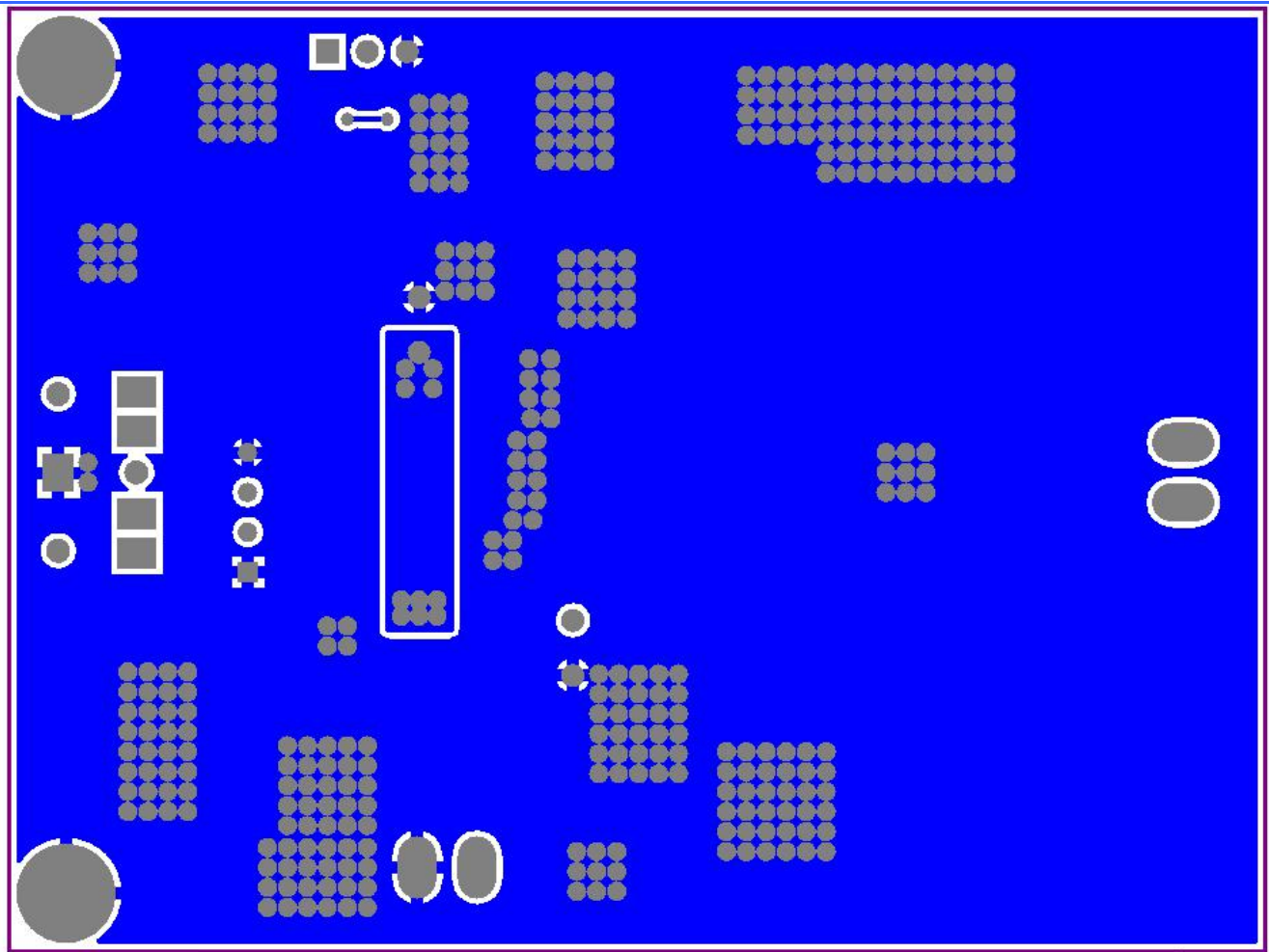


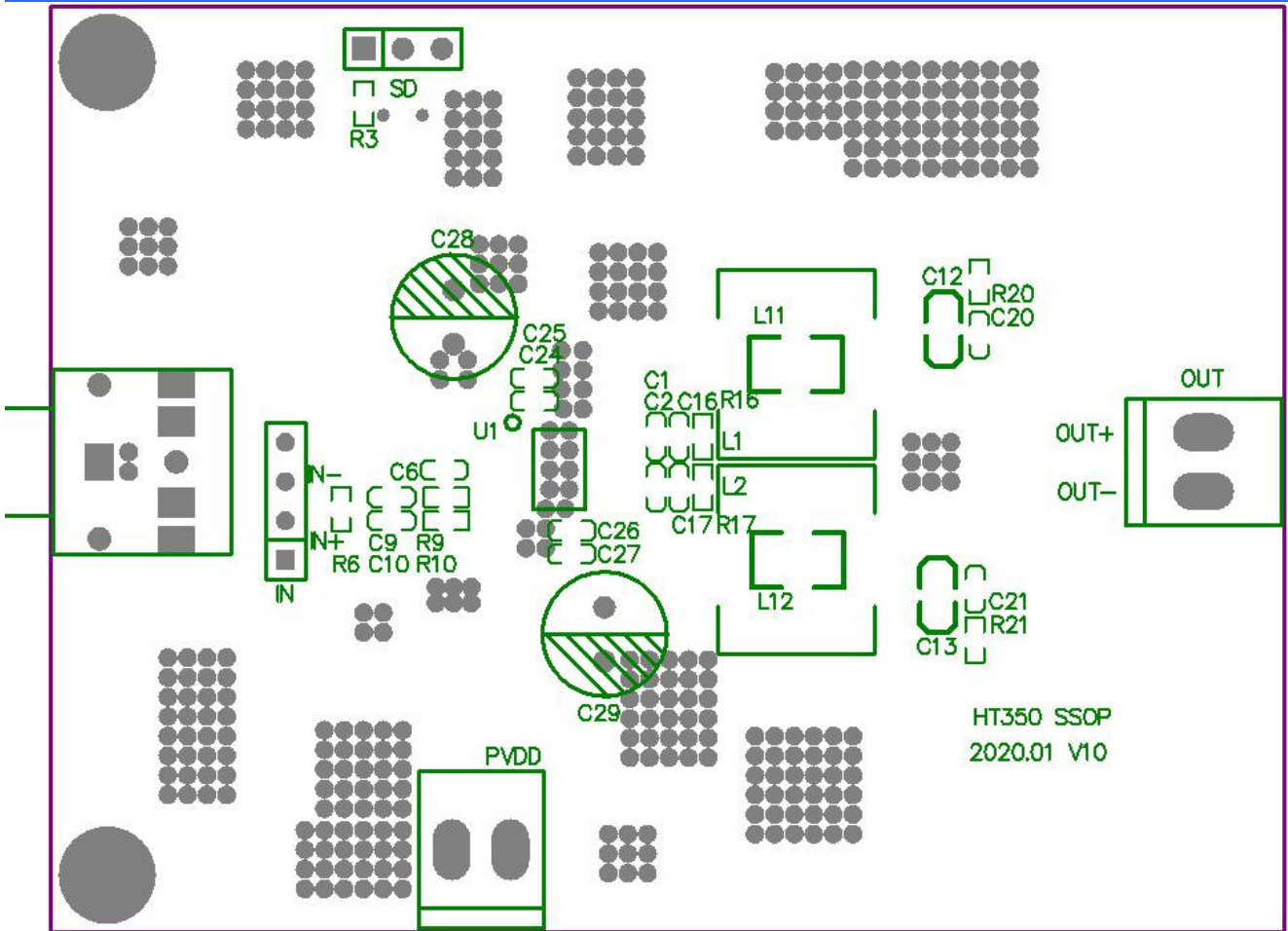
6.2



7. PCB Layout



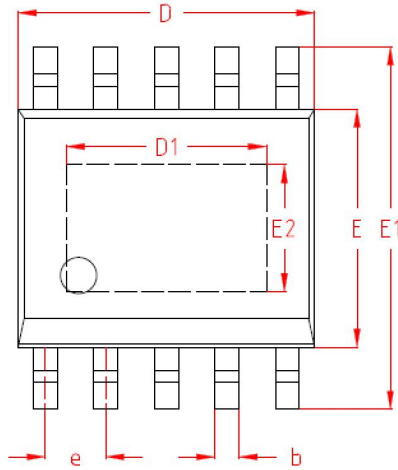




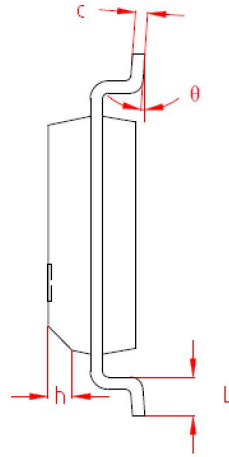
■ PACKAGE OUTLINE

SOP10L-PP

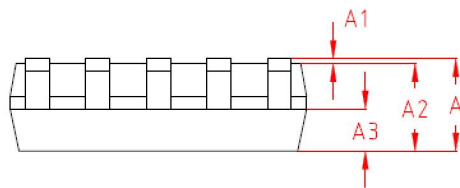
TOP VIEW
正视图



SIDE VIEW
侧视图



SIDE VIEW
侧视图



机械尺寸/mm Dimensions			
字符 SYMBOL	最小值 MIN	典型值 NOMINAL	最大值 MAX
A	1.50	1.60	1.70
A1	0.04	-	0.12
A2	1.35	1.45	1.55
A3	0.65	0.70	0.75
b	0.35	-	0.50
c	0.19	-	0.25
D	4.80	4.90	5.00
D1	3.20	3.30	3.40
E	3.80	3.90	4.00
E1	5.80	6.00	6.20
E2	2.00	2.10	2.20
e	1.00 BSC		
h	0.30	-	0.50
L	0.50	-	0.80
θ	0°	-	8°

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嘉兴禾润电子科技有限公司**Jiaxing Heroic Electronic Technology Co., Ltd.**

地址：浙江省嘉兴市凌公塘路3339号JRC大厦A座三层

Add: A 3rd floor, JRC Building, No. 3339, LingGongTang Road, Jiaxing, Zhejiang Province

Sales: 0573-82585539, sales@heroic.com.cn

Support: 0573-82586151, support@heroic.com.cn

Fax: 0573-82585078

Website: www.heroic.com.cn; wap.heroic.com.cn

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