

免电感滤波2×30W D类立体声音频功放

2×30W Inductor Free Class D Stereo Amplifier

■ FEATURES

- Output Power (BTL)
 - 2×20W (VDD=14.5V, RL=4Ω, THD+N=1%)
 - 2×33W (VDD=22V, RL=8Ω, THD+N=10%)
- Output Power (PBTL)
 - 50W (VDD=22V, RL=4Ω, THD+N=1%)
- Single Wide Voltage Supply: 4.5V-22V
- Selectable Work Mode: BD or 1SPW
- Efficiency > 90%
- Differential / Single-ended Analog Input, BTL or PBTL Output
- Selectable Gain: 32dB or 17.6dB
- Integrated Self-protection Circuits Including Overvoltage, Undervoltage, Overtemperature, DC-detect, and Overcurrent with Error Reporting
- LF and HF Package of ETSSOP28
- 输出功率 (BTL模式)
 - 2×20W (VDD=14.5V, RL=4Ω, THD+N=10%)
 - 2×33W (VDD=22V, RL=8Ω, THD+N=10%)
- 输出功率 (PBTL模式)
 - 50W (VDD=22V, RL=4Ω, THD+N=1%)
- 单电源系统, 4.5V-22V宽电压输入范围
- 超过90%效率, 无需散热器
- 可选输出模式: BD和1SPW
- 扩频功能, 免电感滤波
- 模拟差分/单端输入, 输出模式立体声/单声道可选
- 可选增益: 32dB/17.6dB
- 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, ETSSOP28

■ APPLICATIONS

- Sound Bars
- Wireless Speakers
- 条形音箱
- 无线智能音箱
- Consumer Audio Applications
- TVs/Monitors
- 便携式音箱
- 消费类音频应用
- 拉杆音箱
- LCD电视/监视器

■ DESCRIPTION

HT328 is a stereo efficient, Class-D audio amplifier for driving speakers up to 50W/4 Ω in mono PBTL. It can also deliver 2×33W/8Ω power in stereo BTL.

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

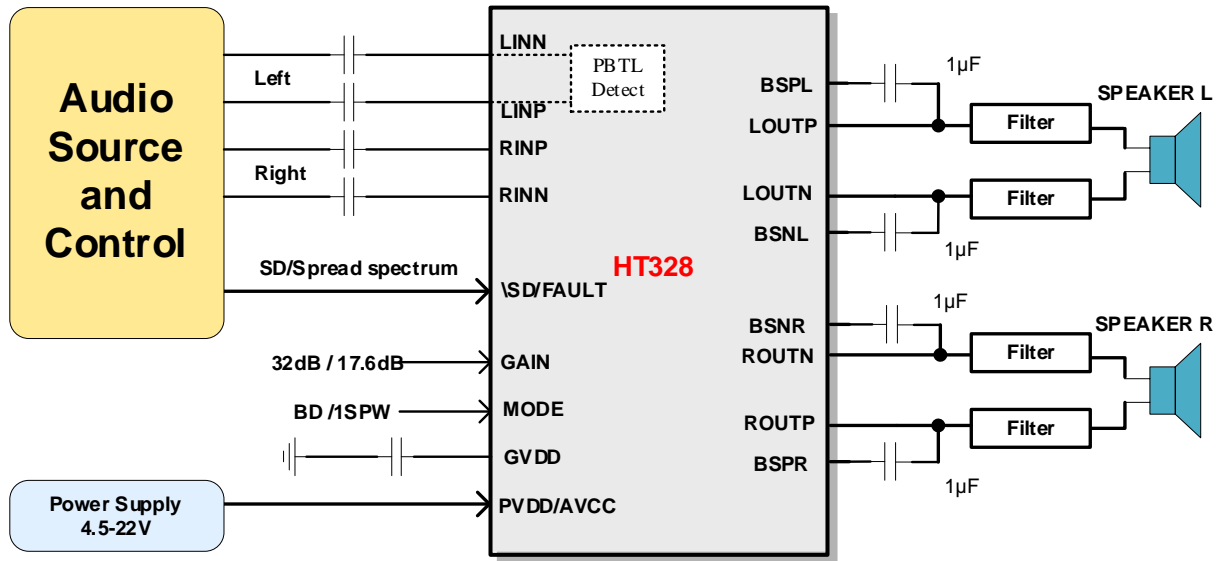
HT328 is fully protected against faults with Overvoltage, Undervoltage, Overtemperature, DC-detect, and Overcurrent protection. Faults can be reported to the processor to prevent devices from being damaged.

HT328是一款高效D类音频功率放大器。在22V供电的立体声(BTL)模式、THD+N=10%条件下,能够持续提供2×33W/8 Ω功率输出;在单声道(PBTL)、模式、THD+N=1%条件下,能够持续提供50W/4 Ω功率输出。

HT328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,HT328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。

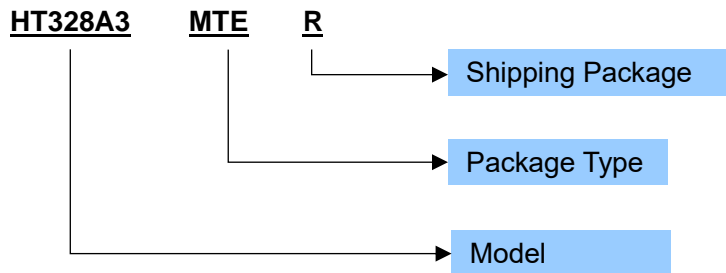
■ TYPICAL APPLICATION



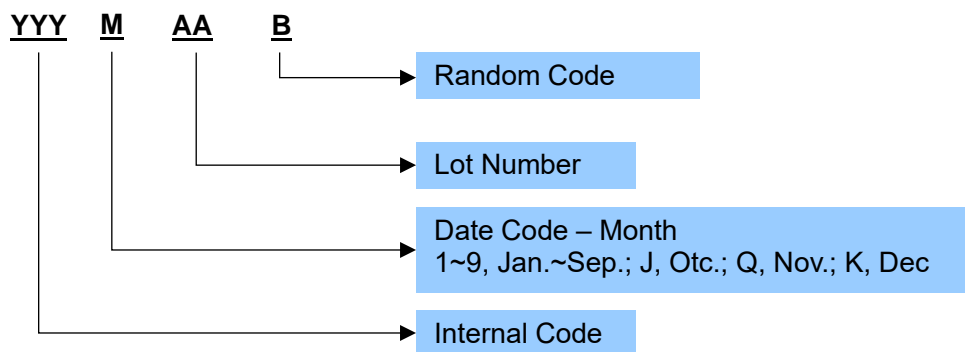
ORDERING INFORMATION

Part Number	Package Type	Marking	Operating Temperature Range	Shipping Package / MOQ
HT328A3MTER	ETSSOP28 (MTE)	HT328 YYYMAAB ¹	-40°C ~ 85°C	Tape and Reel (R) / 3000pcs

Part Number

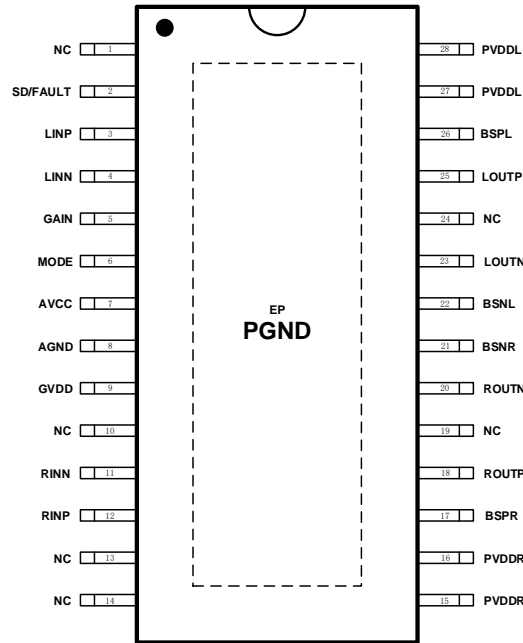


Production Tracking Code



¹ YYYMAAB is production tracking code
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■ TERMINAL CONFIGURATION



HT328 Top View

■ TERMINAL FUNCTION

Terminal No.	Name	I/O ¹	Description
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	LINP	I	Positive input terminal for L channel
4	LINN	I	Negative input terminal for L channel
5	GAIN	I	Gain select pin. Low = 17.6dB gain; High = 32dB
6	MODE	I	Mode select pin. Low = BD; High = Low-Idle-Current 1SPW
7	AVCC	P	Analog power supply.
8	AGND	G	Analog signal GND. Connect to PGND.
9	GVDD	O	Voltage regulator derived from AVDD supply, connect 1uF to GND
11	RINN	I	Negative input terminal for R channel
12	RINP	I	Positive input terminal for R channel
15/16	PVDDR	P	Power Supply for amplifier drivers of R channel
17	BSPR	BST	Connection point for the ROU TP bootstrap capacitor, which is used to create a power supply for the high-side gate drive for ROU TP
18	ROU TP	O	Positive pin for differential speaker amplifier output R
20	ROUTN	O	Negative pin for differential speaker amplifier output R
21	BSNR	BST	Connection point for the ROUTN bootstrap capacitor, which is used to create a power supply for the high-side gate drive for ROUTN
22	BSNL	BST	Connection point for the LOU TN bootstrap capacitor, which is used to create a power supply for the high-side gate drive for LOU TN
23	LOU TN	O	Negative pin for differential speaker amplifier output L
25	LOU TP	O	Positive pin for differential speaker amplifier output L
26	BSPL	BST	Connection point for the LOU TP bootstrap capacitor, which is used to create a power supply for the high-side gate drive for LOU TP
27/28	PVDDL	P	Power Supply for amplifier drivers of L channel
1/10/13/ 14/19/24	NC	-	NC, Connect to Ground for better thermal performance
EP	GND	G	Provides both electrical and thermal connection from the device to the board. A matching ground pad must be provided on the PCB and the device connected to it via solder. For proper electrical operation, this ground pad must be connected to the system ground. 既是地，又是散热PAD

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

■ SPECIFICATIONS¹
● Absolute Maximum Ratings²

PARAMETER	Symbol	MIN	MAX	UNIT
Supply voltage range (PVDD, AVCC)	PVDD	-0.3	24	V
Input voltage range (LINP, LINN, RINP, RINN, \SD, MODE, GAIN)	V _I	-0.3	5.8	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, AVCC	4.5		22	V
Operating temperature	T _a		-40	25	85	°C
High-level input voltage	V _{IH}	\SD terminal, ACF off	2.5		5.5	V
Middle-level input voltage	V _{IM}	\SD terminal, ACF on	1.7		2.1	V
Low-level input voltage	V _{IL}	\SD terminal, shutdown			0.8	V
High-level input voltage	V _{IH}	GAIN, MODE	1.5		5.5	V
Low-level input voltage	V _{IL}	GAIN, MODE			0.8	V
Low-level output voltage	V _{OL}	\SD/Fault terminal, when fault occurs, OPEN-DRAIN OUTOUT			0.5	V
Load impedance (BTL)	R _L	With output filter	4	4		Ω
Load impedance (PBTL)	R _L	With output filter		4		Ω

● Electrical Specification³

- Conditions: T_A = 25°C, PV_{DD} = 4.5-22V, 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		15		mA
Quiescent supply current in SD mode	I _{SD}	V _{DD} = 12V, With Load		12		uA
System Gain in BTL or PBTL mode	Gain	GAIN=H		32		dB
		GAIN=L		17.6		dB
Turn-on time	t _{on}	Pull \SD high or power on		80		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.

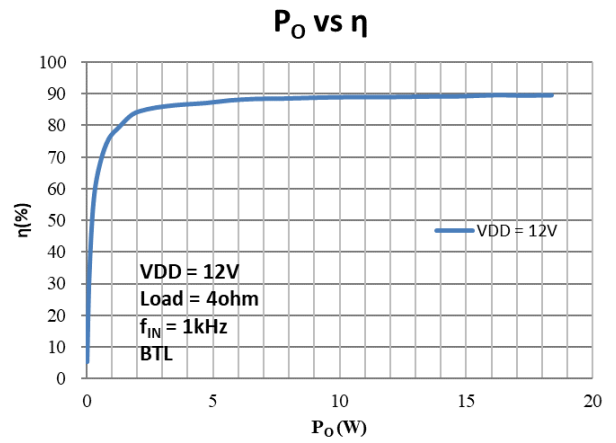
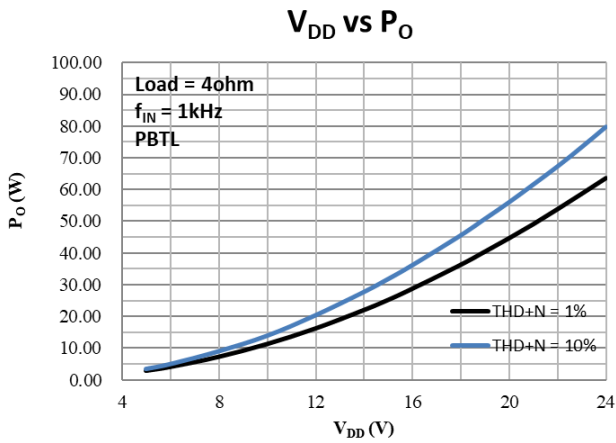
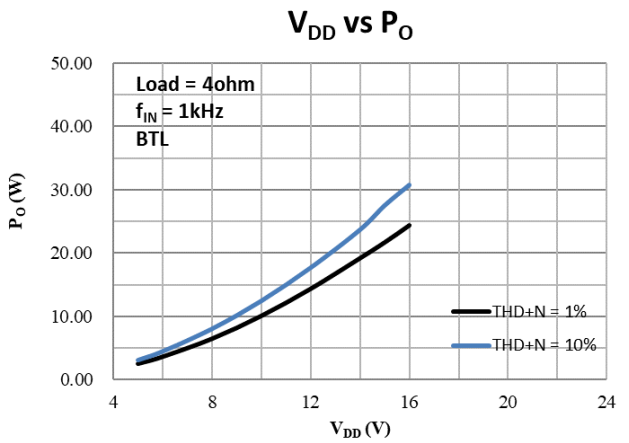
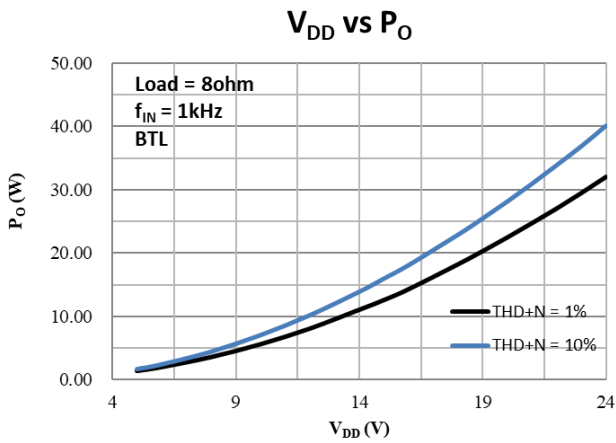
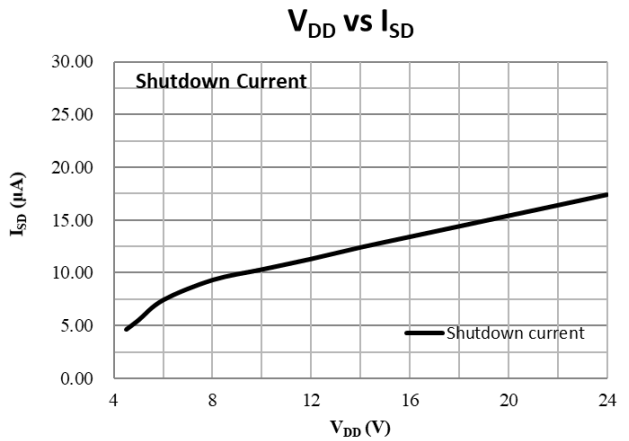
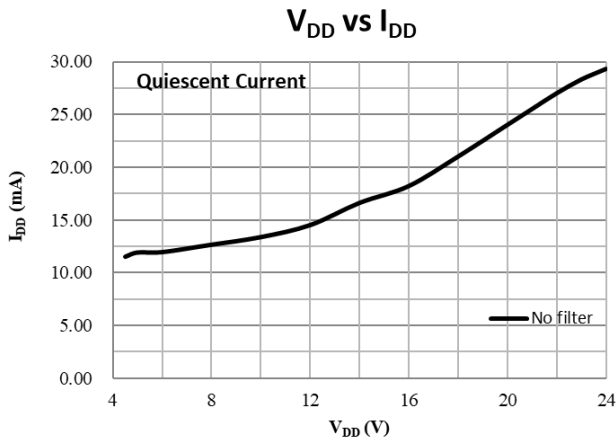
³ Depending on parts and pattern layout, characteristics may be changed.

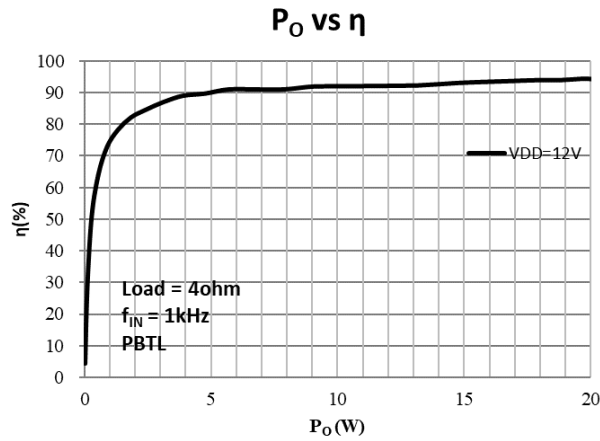
Conditions: $T_A = 25^\circ\text{C}$, $P_{VDD} = 4.5\text{-}22\text{V}$, Load = Filter + R_L , Filter = 300R Bead + 1nF, $R_L = 4\Omega + 22\mu\text{H}$, $f_{IN} = 1\text{ kHz}$, Gain = 17.6dB, $C_{IN} = 1\mu\text{F}$, 20-20kHz, unless otherwise specified.

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT	
Continuous output power	P_o	BTL, VDD = 12V, $R_L = 4\Omega$	THD +N = 1%		14		W
			THD+N = 10%		17		W
		BTL, VDD = 12V, $R_L = 8\Omega$	THD +N = 1%		8		W
			THD+N = 10%		10		W
		BTL, VDD = 22V, $R_L = 8\Omega$	THD +N = 1%		27		W
			THD+N = 10%		33		W
PBTL, VDD=22V, $R_L = 4\Omega$	THD +N = 1%		53		W		
	THD+N = 10%		67		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	VDD = 12V, THD+N = 10%	$R_L = 4\Omega$, BTL		88		%
			$R_L = 8\Omega$, BTL		93		%
Cross Talk	CT	$P_o = 1\text{W}$, Gain = 17.6dB, 1kHz		-100		dB	
Output integrated noise	V_N	A-weighted, Gain = 17.6 dB		75		μV	
Signal-to-noise ratio	SNR	A-weighted, Gain = 17.6 dB, $P_o = 1\text{W}$		88		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			150		$^\circ\text{C}$	
Over current trip point	OCP			7.5		A	

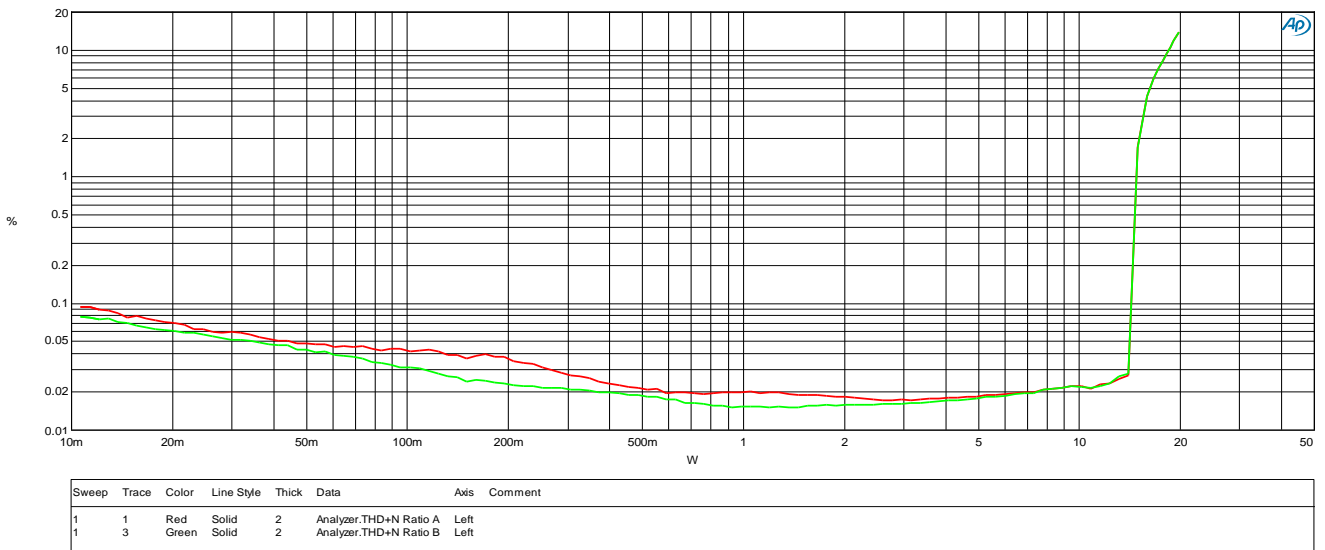
TYPICAL OPERATING CHARACTERISTICS

VDD = 12V, Load = 4ohm, BD mode, unless otherwise specified.



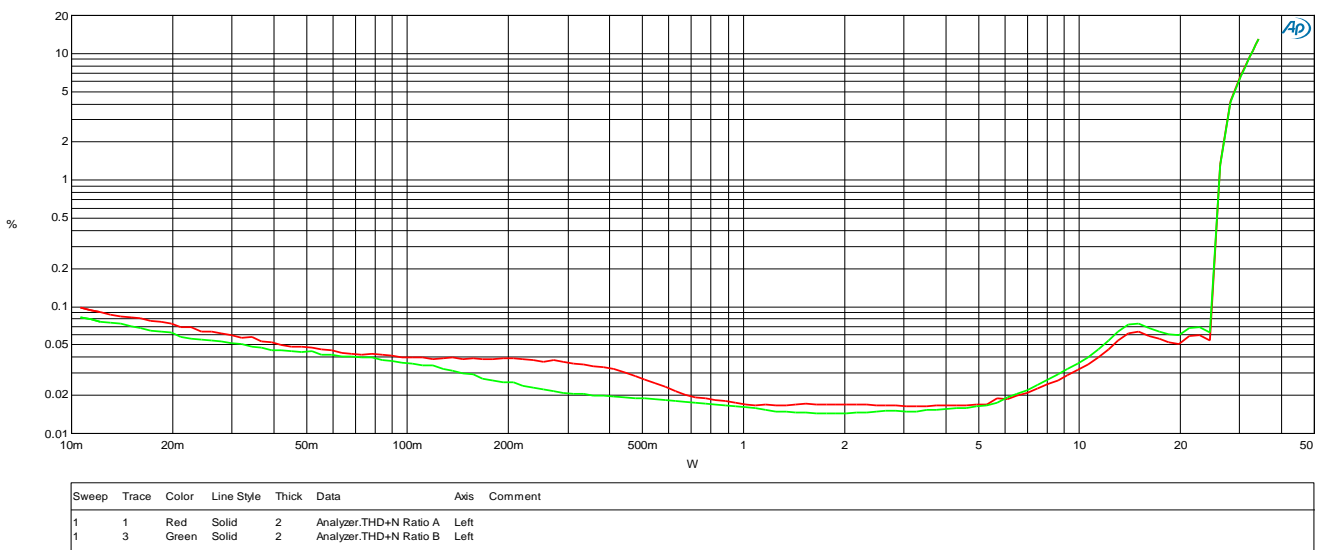


Audio Precision



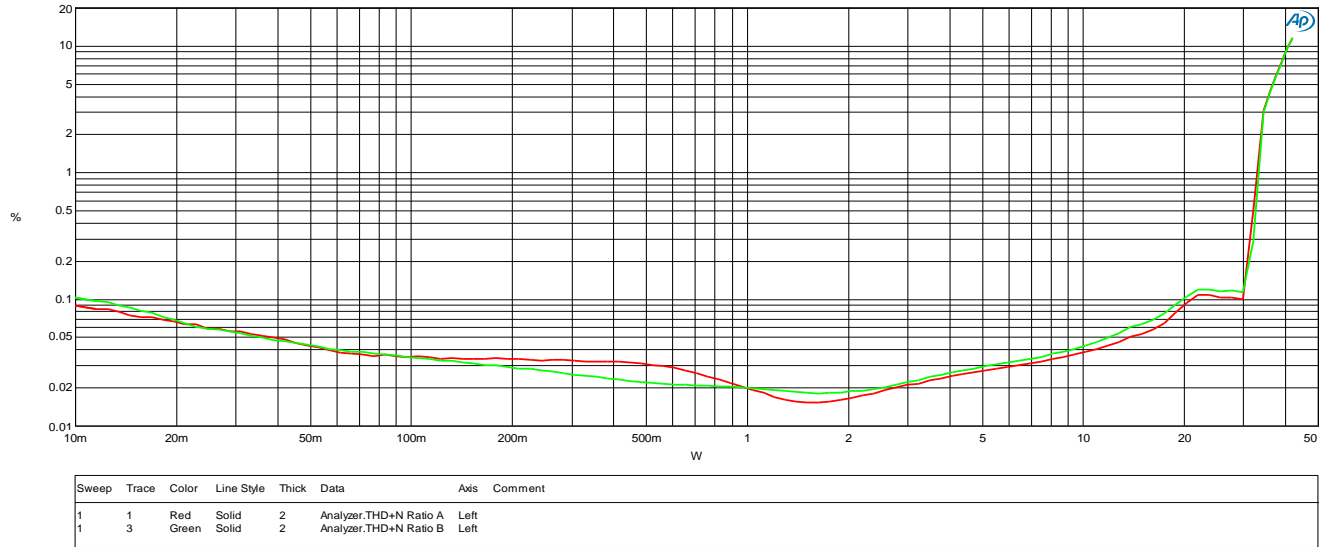
VDD = 12V, Load = 4ohm, f_{IN} = 1kHz, BTL, Spread Spectrum on,

Audio Precision



VDD = 16V, Load = 4ohm, f_{IN} = 1kHz, BTL, Spread Spectrum on,

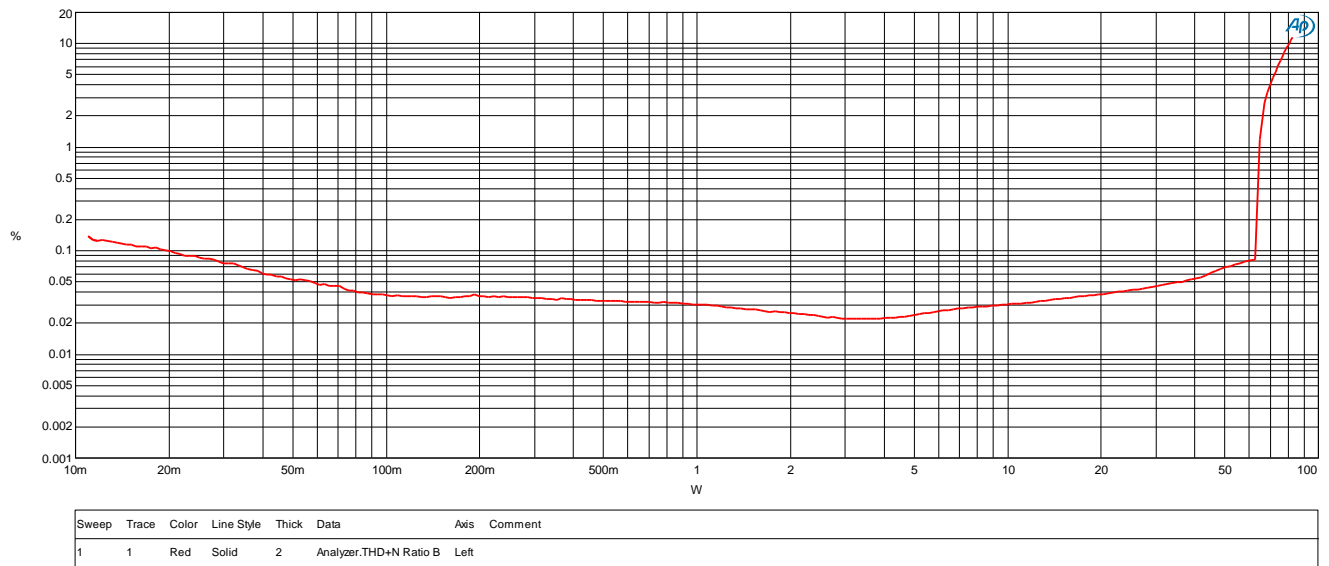
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A-AFFT.als2
VDD = 24V, Load = 8ohm, $f_{IN} = 1\text{kHz}$, BTL, Spread Spectrum on,

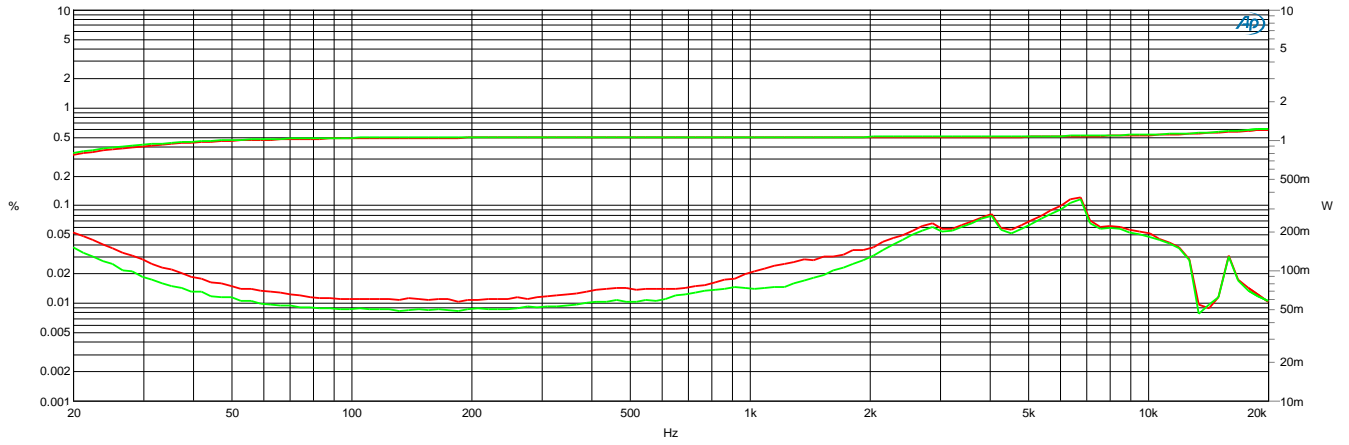
Audio Precision

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VDD = 24V, Load = 4ohm, $f_{IN} = 1\text{kHz}$, PBTL

Audio Precision



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer.THD+N Ratio A	Left	
1	2	Red	Solid	2	Analyzer.Level A	Right	
1	3	Green	Solid	2	Analyzer.THD+N Ratio B	Left	
1	4	Green	Solid	2	Analyzer.Level B	Right	

A-A FFT.ats2

VDD = 12V, Load = 4ohm, P_O = 1W, BTL, Spread Spectrum on,

APPLICATION INFORMATION

1 Power Supply

The power supply for the HT328 only require one voltage from 4.5V to 22V, which supplies the analog circuitry and the power stage

The AVDD 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 0.1uF paralleled with 10uF.

The PVDD (pin27/pin28) feeds the power stage of L channel and the PVDD (pin15/pin16) feeds the power stage of R channel. 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

HT328 is an amplifier with analog input (single-ended or differential).

For a differential operation, input signals into INP and INN pins via DC-cut capacitors (C_{IN}) and external input resistors R_{EIN} . See as figure 1. The system gain can be calculated by $Gain \approx 20 \times \log\left(\frac{R_F}{R_{IIN} + R_{EIN}}\right)$, where $R_F = 370k$, $R_{IIN} = 9.6k$. And the high pass cut-off frequency of input signal can be calculated by $f_c = \frac{1}{2\pi(R_{IIN} + R_{EIN}) \times C_{IN}}$.

For a single-ended operation, input signals to INP pin via a DC-cut capacitor (C_{IN}) and external input resistor (R_{EIN}). INN pin should be connected to ground via a DC-cut capacitor and external input resistor (with the same value of C_{IN} and R_{EIN}). See as figure 2. The Gain and high pass Cut-off frequency are

HT328 的电源只需要一个 4.5V 到 22V 的电压，用于提供模拟电路和功率电路。

AVDD 电源为内部 LDO(包括 GVDD)供电。这个 LDO 输出连接到外部引脚用于滤波，但不应该连接到外部电路。GVDD 的滤波电容建议为 0.1uF//1uF。

PVDDL (pin27/pin28)为 L 通道的功率级供电，PVDDR (pin15/pin16)为 R 通道的功率级供电。每个通道 PVDD 的 100nF//1uF//220uF 滤波电容应放置在 PVDD 引脚附近。

the same as the above case.

HT328 接受模拟差分或单端音频信号输入，产生 PWM 脉冲输出信号驱动扬声器。

对差分输入，通过隔直电容 C_{IN} 和输入电阻 R_{EIN} 分别输入到 INP 和 INN 端，见图 1。系统增益 $Gain \approx 20 \times \log\left(\frac{R_F}{R_{IIN} + R_{EIN}}\right)$, $R_F = 370k$, $R_{IIN} = 9.6k$ 。高通滤波器截止频率为 $f_c = \frac{1}{2\pi(R_{IIN} + R_{EIN}) \times C_{IN}}$ 。

对单端输入，则通过 C_{IN} 耦合到 INP 端。INN 端必须通过输入电阻和电容（与 C_{IN} 、 R_{EIN} 值相同）接地，见图 2。增益 Gain 和截止频率 f_c 与差分输入时相同。。

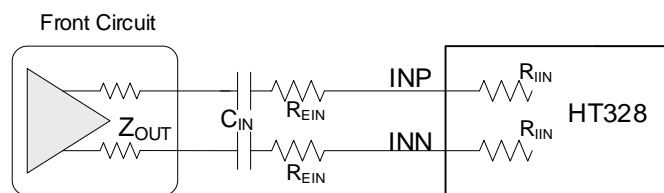


Figure 1 Differential Input configuration

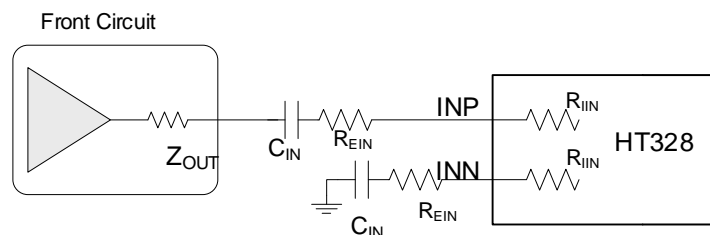


Figure 2 Single-ended Input configuration

2.2 Amplifier Output Configuration

The HT328 has been tested with a simple ferrite bead filter for a variety of applications including long speaker wires up to 10 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.

HT328 可使用简单的铁氧体珠过滤器, 在各种应用中, 包括高达 10 厘米的扬声器线和较大的功率。铁氧体珠选择的一个重要方面是铁氧体珠所用材料的类型。并不是所有的铁氧体材料都是一样的, 所以选择一种在 10 到 100 MHz 范围内有效的材料是很重要的, 这是 D 类放大器工作的关键。铁氧体珠的阻抗可与值在 1000 pF 范围内的小电容一起使用, 以将信号的频谱降低到可接受的范围。

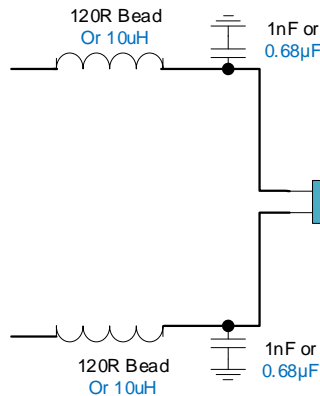


Figure 3 Output Filters Configurations

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. When $VDD < 20V$, L is recommended to be 10uH, and C is recommended to be 0.22uF; when $VDD \geq 20V$, L is recommended to be 22uH, and C is recommended to be 0.22uF.

可能在一些应用场合需要添加一个完整的 LC 滤波器, 比如附近有对噪声敏感的电, 或 EMI 难以达到标准。此时, 可以使用类似于上图所示的经典二阶巴特沃斯滤波器。当 $VDD < 20V$ 时, L 推荐 10uH, C 推荐 0.22uF; 当 $VDD \geq 20V$ 时, L 推荐 22uH, C 推荐 0.22uF。

2.3 PBTL Mode Configuration

The HT328 can be configured to drive a single speaker with the two output channels connected in parallel. This mode of operation is called Parallel Bridge Tied Load (PBTL) mode. This mode of operation effectively reduces the output impedance of the amplifier in half, which in turn reduces the power dissipated in the device due to conduction losses through the output FETs. Additionally, since the output channels are working in parallel, it also doubles the amount of current the speaker amplifier can source before hitting the over-current error threshold.

HT328 可工作在单声道输出的 PBTL 模式, 此时两个输出通道需要并联。在这种模式下, 输出线损降低了一般, 从而减小了功率损耗, 同时, 喇叭可流过的最大电流也翻倍了。

To place the HT328 into PBTL Mode, the LINP and LINN pin should be directly connected to Ground. When operated in PBTL mode, the output pins should be connected as shown in the Typical Application Circuit Diagrams.

LINP 和 LINN 直接短接至地, 可使 HT328 进入 PBTL 模式, 输出需要短接, 参见下图。此时, 信号从 R 通道进入。

In PBTL mode, the amplifier accepts its source signal from the R channel of the stereo signal.

PBTL 时，输出若使用 LC 滤波器，LC 推荐 10uH, C 推荐 0.22uF。

If LC filter is used for the output configurations, L is recommended to be 10uH, and C is recommended to be 0.22uF.

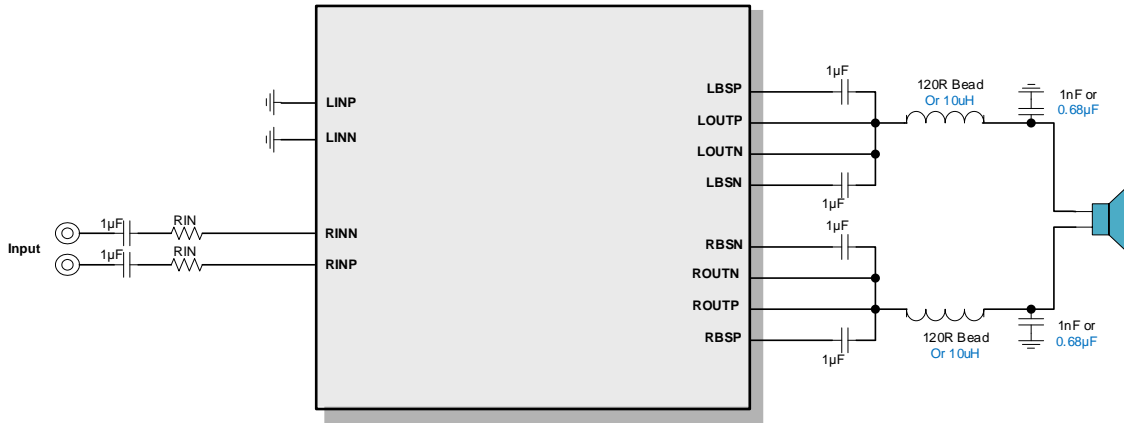


Figure 4 PBTL configuration

3 Startup, Shutdown

The HT328 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 and pull $\backslash SD$ down less than 100us, because amplifier operation would be unpredictable.

HT328 具有关断功能，以使芯片进入低功耗状态。当 $\backslash SD$ 拉高时，芯片进入工作状态；当 $\backslash SD$ 拉低时，芯片进入关断状态。

$\backslash SD$ 不建议悬空，也不建议 $\backslash SD$ 低电平的状态小于 100us，否则可能状态不定。

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.

上下电时，为减小 pop 声，在上、下电前，将功放关闭进入关断状态。

4 Spread Spectrum

The HT328 device has built-in spread spectrum control of the oscillator frequency to improve EMI performance. The spread spectrum scheme is internally fixed and by setting the \SD pin above 2.5V to turn on.

5 Device Functional Modes

MODE=L, BD modulation

This is a modulation scheme that allows operation without the classic LC reconstruction filter when the amp is driving an inductive load with short speaker wires. Each output is switching from 0 volts to the supply voltage. The OUPN and OUPN are in phase with each other with no input so that there is little or no current in the speaker. The duty cycle of OUPN is greater than 50% and OUPN is less than 50% for positive output voltages. The duty cycle of OUPN is less than 50% and OUPN is greater than 50% for negative output voltages. The voltage across the load sits at 0 V throughout most of the switching period, reducing the switching current, which reduces any I^2R losses in the load.

HT328 器件内置了扩频控制，以提高 EMI 性能。扩频方案内部固定，通过设置 2.5V 以上的 \SD 引脚打开。

BD 调制模式下，当放大器驱动带有短扬声器线的感性负载时，可以不使用 LC 滤波器。每个输出从 0V 切换到电源电压。OUPN 和 OUPN 在没有输入的情况下是相位一致的，因此扬声器中只有很少的电流或没有电流。输出正电压信号时，OUPN 占空比大于 50%，OUPN 小于 50%。输出负电压信号时，OUPN 占空比小于 50%，OUPN 大于 50%。在整个开关周期的大部分时间，负载上的电压为 0V，从而减少了开关电流，从而减少了负载中的 I^2R 损耗。

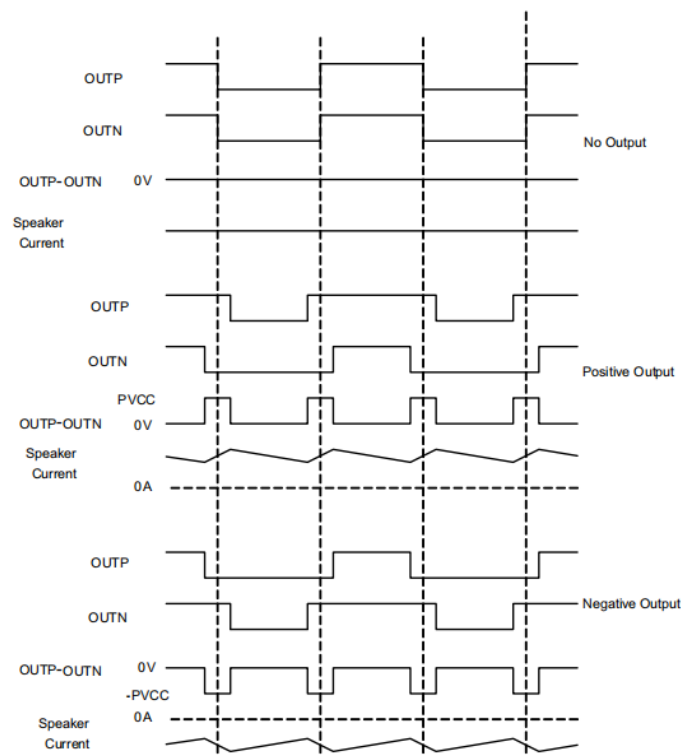


Figure 5 BD Mode Modulation

MODE=H, Hybrid modulation

Hybrid Modulation is designed to minimized power loss without compromising the THD+N performance. With Hybrid modulation enabled, HT328 will detect the input signal level and adjust PWM duty cycle dynamically based on PVDD. Hybrid modulation achieves ultra low idle current and maintains the same audio performance level as the BD Modulation..

混合调制的设计目的是在不影响 THD+N 性能的情况下最小化功耗。开启混合调制后，HT328 将检测输入信号电平，并根据 PVDD 动态调整 PWM 占空比。混合调制实现超低的空闲电流，并保持与 BD 调制相同的音频性能水平。

6 GVDD Supply

The GVDD Supply is used to power the gates of the output full bridge transistors. Decouple GVDD with a X5R ceramic 10 μ F capacitor paralleled with a 0.1 μ F capacitor to GND. The GVDD supply is not intended to be used for external supply.

7 BSP and 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 1 μ F 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.

8 Protection Function

HT328 has the protection functions such as Over-Current Protection function, Thermal Protection function, DC Detect Protection, Under-Voltage Protection and over voltage protection.

(1) Over-current Protection function (OCP)

When a short circuit occurs between one output terminal and Ground, PVDD, or the other output, the over-current protection mode starts up. In the over current protection mode, the differential output terminal becomes a high impedance state. Once the short circuit conditions are eliminated, the over current protection mode can be cancelled automatically.

(2) Thermal Protection function (OTP)

When excessive high temperature of HT328 (150 $^{\circ}$ C) is detected, the thermal protection mode starts up. In the thermal protection mode, the differential output terminal becomes Weak Low state (a state grounded through high impedance).

GVDD 电源用于为输出全桥晶体管的栅极供电。使用 X5R 陶瓷 0.1 μ F 电容器并联 10 μ F 将 GVDD 与 GND 连接。GVDD 电源不用于外部电源。

全 H 桥输出级仅使用 NMOS 晶体管。因此，它们需要引导电容器，以使每个输出的高端正确开启。必须从每个输出端将额定电压至少为 16 V、质量为 X5R 或更高的 1 μ F 陶瓷电容器连接到相应的自举输入端。连接在 BSx 引脚和相应输出之间的自举电容器，用作高端 NMOS 栅极驱动电路的电源。在每个高端开关周期中，自举电容器保持栅极至源极电压足够高，以保持高端 MOSFET 导通。

HT328 具有以下几种保护功能：输出端过流保护、片内过温保护、直流监测保护、欠压保护、过压保护。

(1) 过流保护

当检测到一输出端对电源、对地、或对另一输出端短路时，过流保护启动，输出端切换至高阻态，防止芯片烧毁损坏。短路情况消除后，通过关断、唤醒一次芯片，或重新上电均能使芯片退出保护模式。

(2) 过温保护

当检测到芯片内温度超过 150 $^{\circ}$ C 时，过温保护启动，正负输出端切换至弱低电平状态（内部通过高阻接地），防止芯片被热击穿损坏。

(3) DC Detect Protection (DCP)

The HT328 has circuitry which will protect the speakers from DC current which might occur due to an internal amplifier error. The DC Detect fault will 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. This feature protects the speaker from large DC currents or AC currents less than 2 Hz.

When OCP, OTP or DCP is activated, the SD/FAULT pin will be pulled low, and the error signal will be cleared. Therefore, after a delay time (Typ 1.3s), HT328 will try restart.

(4) Over-voltage Protection function (OVP)

The HT328 device monitors the voltage on AVDD voltage. When the voltage on AVDD pin exceeds the over-voltage threshold (28V typ), the OVP circuit puts the device into shutdown mode. The device recovers automatically once the over-voltage condition has been removed.

(5) 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} (Typ 4.2V), and the protection mode is canceled when the power supply becomes higher than the threshold voltage V_{UVLH} (Typ 4.4V). In the under-voltage protection mode, the differential output pin becomes weak low state (a stage grounded through resistivity). HT328 will start up within start-up time when the under-voltage protection mode is cancelled.

(3) 直流监测保护

HT328 具有保护扬声器免受由于内部放大器错误而产生的直流电流影响的电路。直流检测故障时，输出状态更改为 Hi-Z，致放大器关闭。

当任一通道在相同极性下的输出差占空比超过 60% 超过 420 毫秒时，就会发生 DCE 事件。此功能可保护扬声器免受大直流电流或小于 2 Hz 的交流电流的影响。

当 OCP、OTP 或 DCP 发生时，\SD/FAULT 引脚拉低，错误信号清除。因此，经过一段延迟时间(Typ 1.3s)后，HT328 将尝试重启。

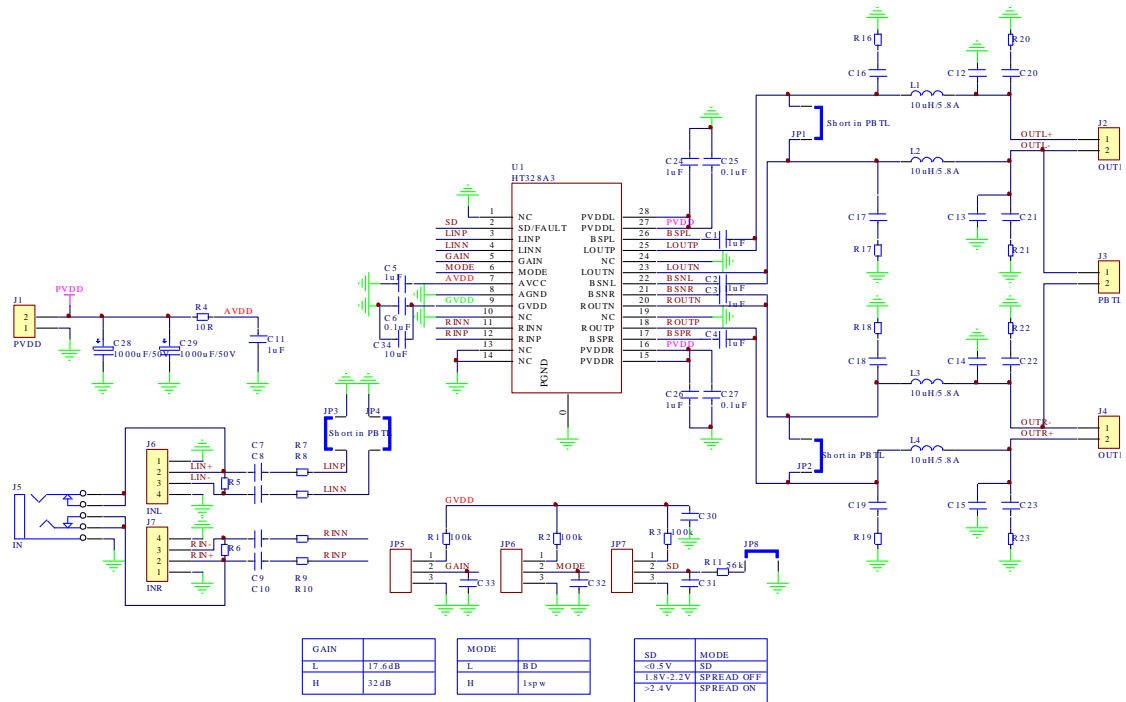
(4) 过压保护

HT328 监控 AVDD 电压上的电压。当 AVDD 引脚上的电压超过过电压阈值(28V 典型值)时，OVP 电路将 HT328 置于关机模式。一旦消除过电压情况，设备将自动恢复。

(5) 欠压保护

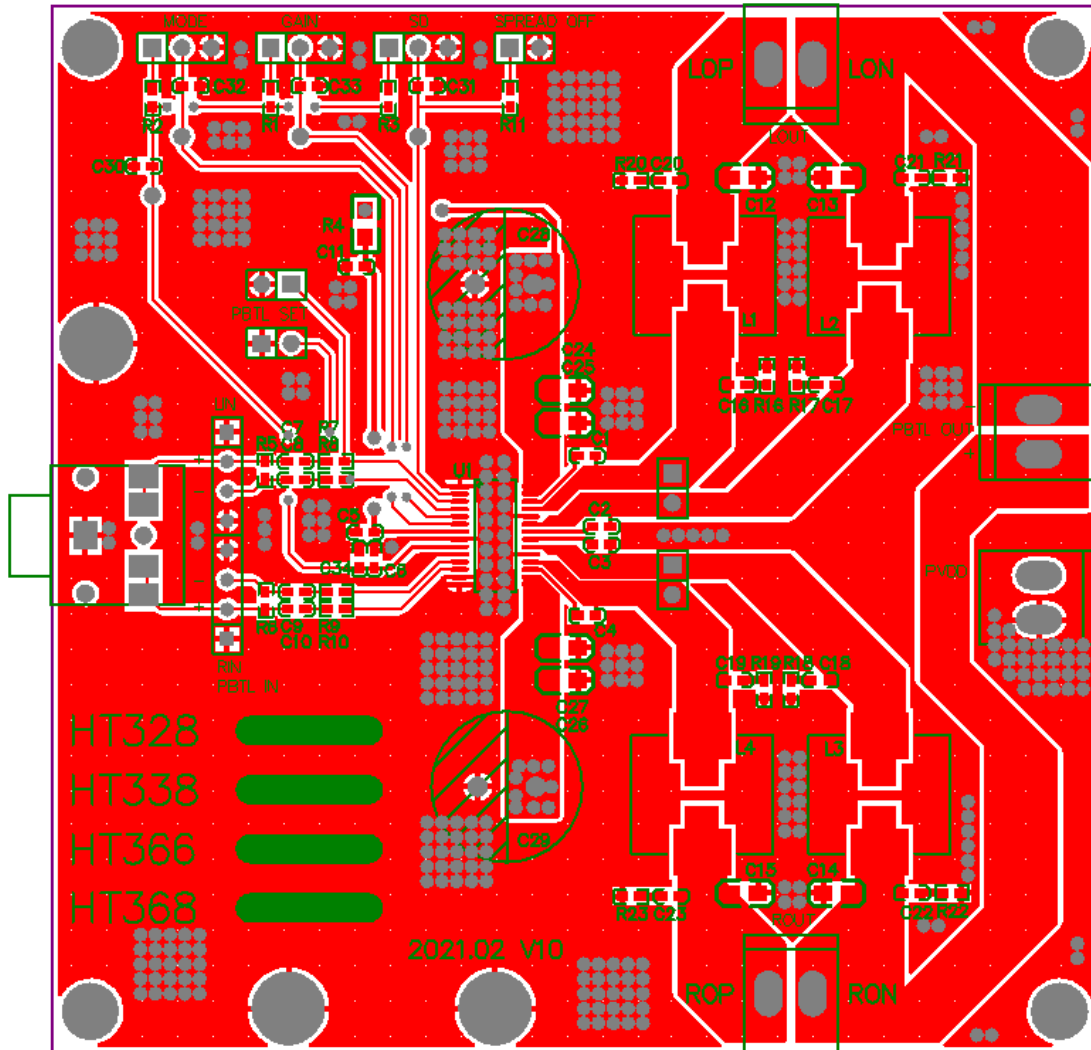
该功能是当电源低于检测电压 V_{UVLL} (Typ 4.2V)时建立欠压保护模式，当电源高于阈值电压 V_{UVLH} (Typ 4.4V)时取消保护模式。在欠压保护模式下，输出引脚变为弱下拉状态(通过电阻接地)。取消欠压保护模式后，HT328 会在启动时间内启动。

9 Typical Circuit Diagram

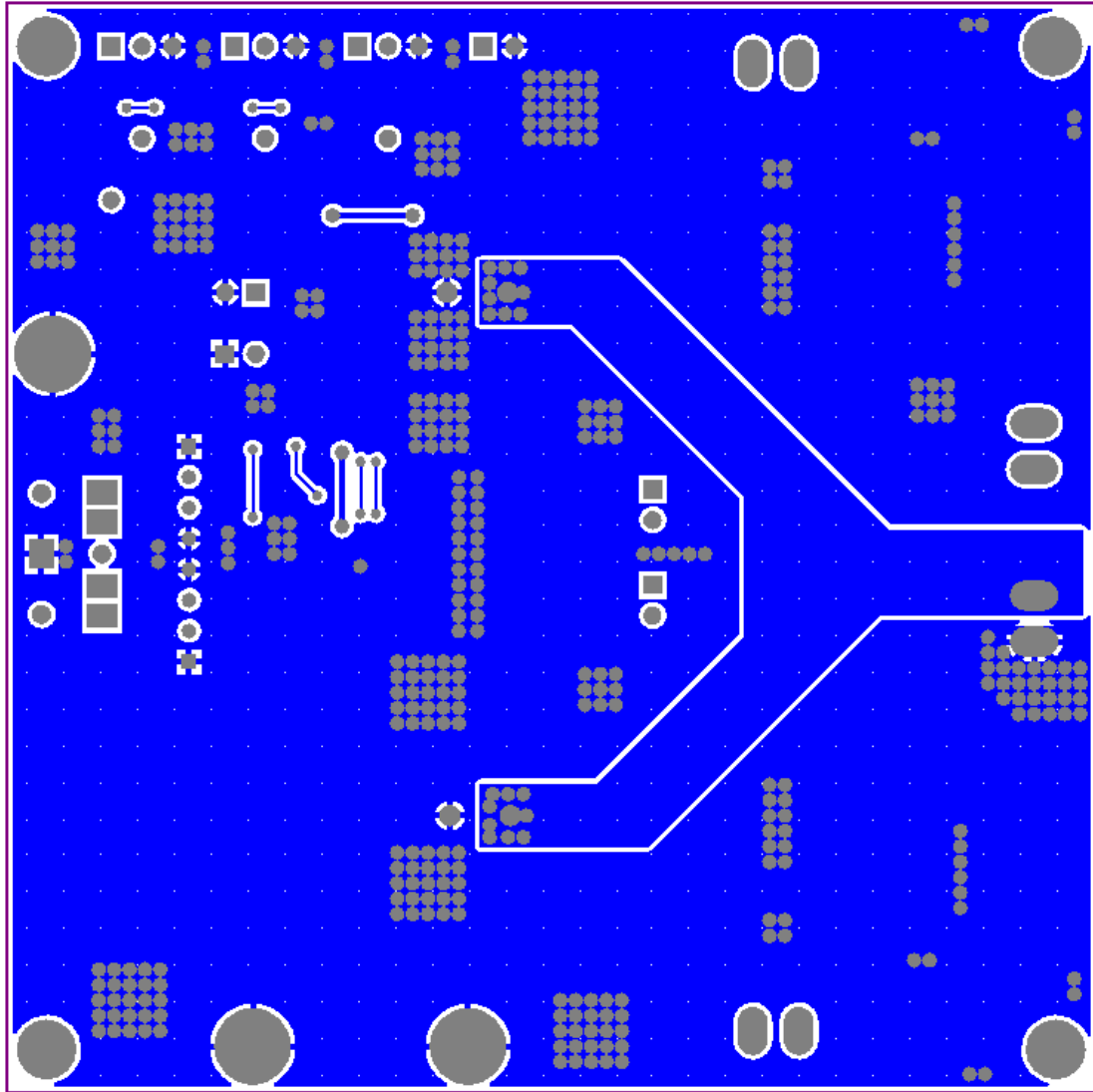


10 PCB Layout

10.1 Top Layer

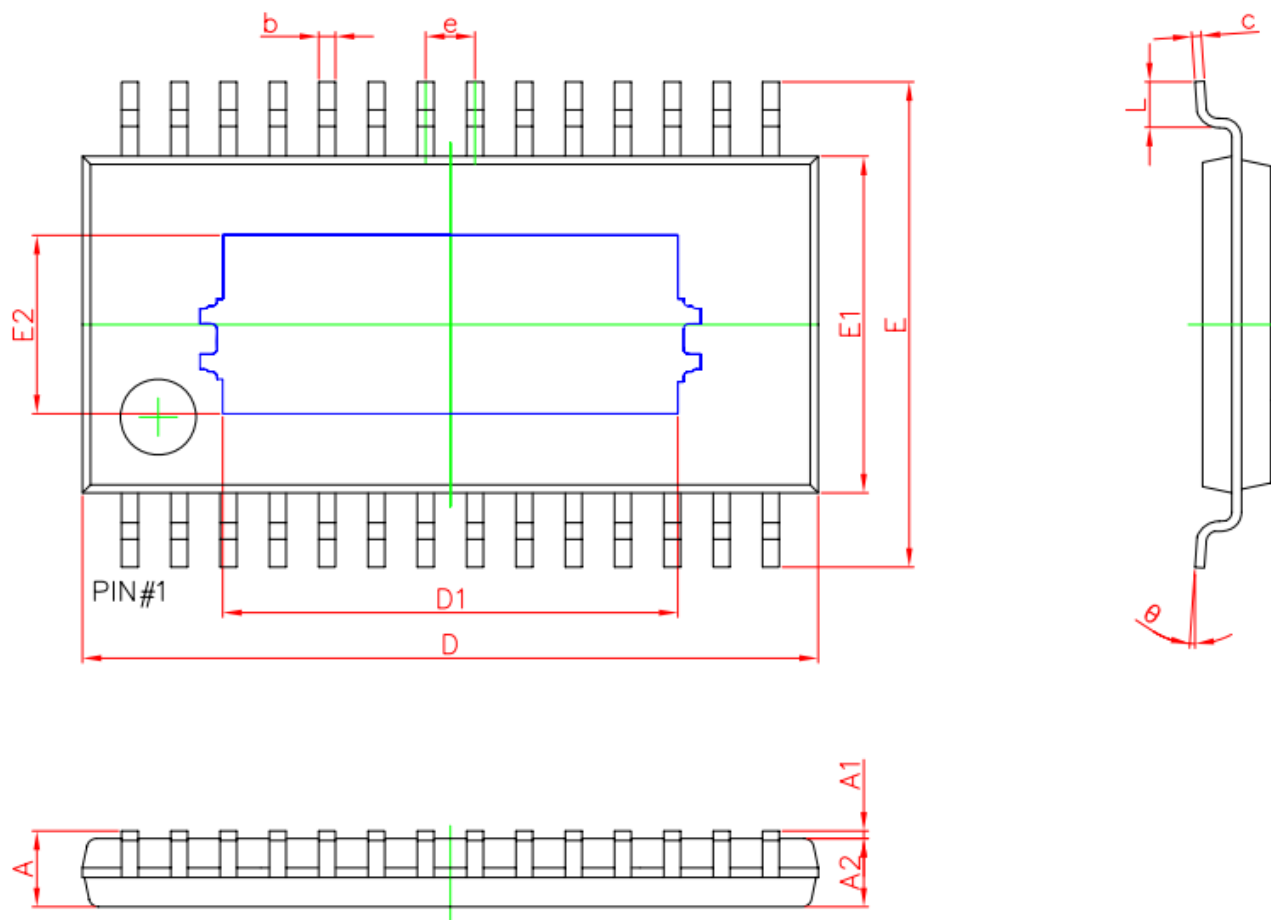


10.2 Bottom Layer



PACKAGE OUTLINE

MTE (ETSSOP28)



SYMBOL	MILLIMETER	
	MIN	MAX
A	/	1.200
A1	0	0.1
A2	0.800	1.050
b	0.190	0.300
c	0.090	0.200
D	9.600	9.800
D1	5.908	6.108
E	6.250	6.550
E1	4.300	4.500
E2	2.253	2.453
e	0.650BSC	
L	0.450	0.750
θ	0°	8°

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