

TPA3128D2 静态功耗较低的 2x30W D 类放大器

1 特性

- 支持多路输出配置
 - 24V 电压、8Ω BTL 负载条件下的功率为 $2 \times 30\text{W}$ (TPA3128D2)
- 宽电压范围：4.5V 至 26V
- 高效 D 类运行
 - 采用推荐的 LC 滤波器配置时静态电流超低： $<23\text{mA}$
 - 功率效率达 90% 以上且静态损耗低，因此无需散热器
 - 基于输出功率的自适应调制机制
 - 智能放大器驱动器可降低对 RC 缓冲器的要求
- 多重开关频率
 - AM 抑制
 - 主从模式同步
 - 300kHz 至 1.2MHz 开关频率
- 采用具有高 PSRR 的反馈功率级架构，降低了 PSU 需求
- 可编程功率限制
- 支持并联 BTL 模式和单通道模式
- 支持单电源和双电源供电模式
- 集成了具有错误报告功能的自保护电路，其中包括过压、欠压、过热、直流检测和短路等保护
- 耐热增强型封装
 - DAP (TPA3128D2 采用 32 引脚 HTSSOP 封装，焊盘朝下)

2 应用

- 蓝牙/无线扬声器
- 条形音箱
- 迷你组件，接口盒
- 液晶显示屏 (LCD)/发光二极管 (LED) 电视 (TV)
- 家庭影院

3 说明

TPA3128D2 器件是用于驱动扬声器的高效立体声数字放大器功率级，并行桥接负载 (PBTL) 模式下高达 $60\text{W}/2\Omega$ 。TPA3128D2 具有低静态功率损耗特性，这有助于延长蓝牙/无线扬声器和其他电池供电音频系统的电池使用寿命。TPA3128D2 器件的效率非常高，无需在双层 PCB 上使用外部散热器即可提供 $2 \times 30\text{W}$ 的功率。该器件建议用于高效升压模式，这样能够动态减小外部 LC 滤波器的电流纹波和空闲电流。

TPA3128D2 高级振荡器/PLL 电路采用多开关频率选项来避免 AM 干扰；搭配使用主/从模式选项时，还可使多个器件实现同步。

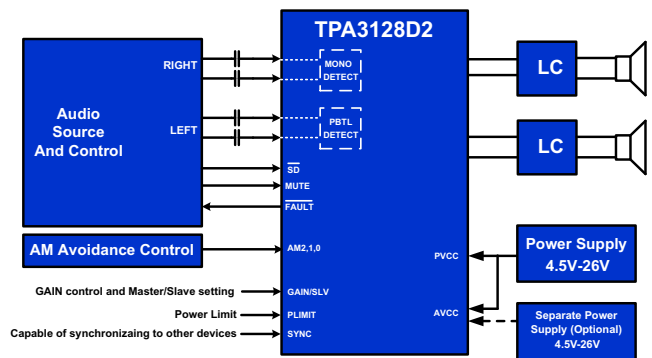
TPA3128D2 器件通过短路保护、过热保护、过压保护、欠压保护和直流保护实现全面的故障保护。在过载情况下，器件会将故障情况报告给处理器，从而避免自身遭到损坏。

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
TPA3128D2	DAP (32)	11.00mm x 6.20mm

(1) 如需了解所有可用封装，请见数据表末尾的可订购产品附录。

简化应用电路



Copyright © 2016, Texas Instruments Incorporated



目录

1	特性	1	7.4	Device Functional Modes	21
2	应用	1	8	Applications and Implementation	22
3	说明	1	8.1	Application Information	22
4	修订历史记录	2	8.2	Typical Application	22
5	Pin Configuration and Functions	3	9	Power Supply Recommendations	25
6	Specifications	5	9.1	Power Supply Mode	25
6.1	Absolute Maximum Ratings	5	10	Layout	25
6.2	ESD Ratings	5	10.1	Layout Guidelines	25
6.3	Recommended Operating Conditions	5	10.2	Layout Example	26
6.4	Thermal Information	5	11	器件和文档支持	28
6.5	DC Electrical Characteristics	6	11.1	文档支持	28
6.6	AC Electrical Characteristics	6	11.2	社区资源	28
6.7	Typical Characteristics	7	11.3	商标	28
7	Detailed Description	11	11.4	静电放电警告	28
7.1	Overview	11	11.5	Glossary	28
7.2	Functional Block Diagram	11	12	机械、封装和可订购信息	29
7.3	Feature Description	12			

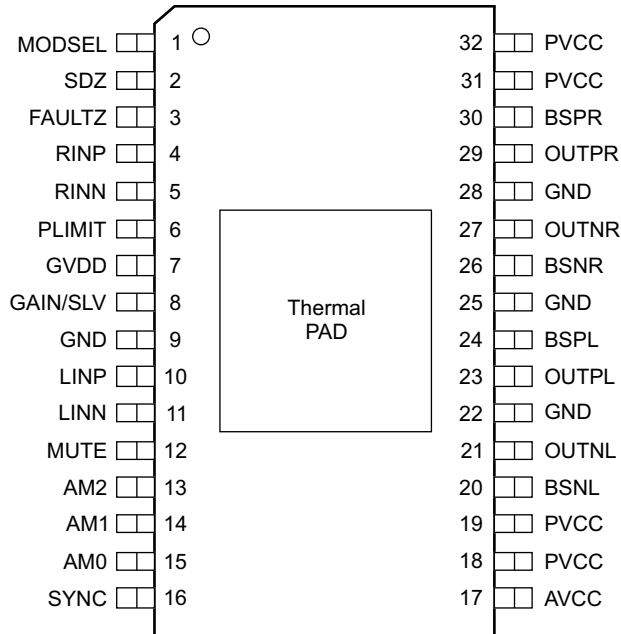
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Original (May 2016) to Revision A	Page
• 将完整数据表作为量产数据发布	1

5 Pin Configuration and Functions

DAP Package
32-Pin HTSSOP With PowerPAD Down
TPA3128D2, Top View



Pin Functions

NO.	PIN	TYPE ⁽¹⁾	DESCRIPTION
	NAME		
1	MODSEL	I	Mode selection logic input (LOW = Ultra Low Idle Loss Mode, HIGH = BD Mode). TTL logic levels with compliance to AVCC.
2	SDZ	I	Shutdown logic input for audio amp (LOW = outputs Hi-Z, HIGH = outputs enabled). TTL logic levels with compliance to AVCC.
3	FAULTZ	DO	General fault reporting including Over-temp, DC Detect. Open drain. FAULTZ = High, normal operation FAULTZ = Low, fault condition
4	RINP	I	Positive audio input for right channel. Connect to GND for MONO mode.
5	RINN	I	Negative audio input for right channel. Connect to GND for MONO mode.
6	PLIMIT	I	Power limit level adjust. Connect a resistor divider from GVDD to GND to set power limit. Connect directly to GVDD for no power limit.
7	GVDD	PO	Internally generated gate voltage supply. Not to be used as a supply or connected to any component other than a 1 µF X7R ceramic decoupling capacitor and the PLIMIT and GAIN/SLV resistor dividers.
8	GAIN/SLV	I	Selects Gain and selects between Master and Slave mode depending on pin voltage divider.
9	GND	G	Ground
10	LINP	I	Positive audio input for left channel. Connect to GND for PBTTL mode.
11	LINN	I	Negative audio input for left channel. Connect to GND for PBTTL mode.
12	MUTE	I	Mute signal for fast disable/enable of outputs (HIGH = outputs Hi-Z, LOW = outputs enabled). TTL logic levels with compliance to AVCC.
13	AM2	I	AM Avoidance Frequency Selection
14	AM1	I	AM Avoidance Frequency Selection
15	AM0	I	AM Avoidance Frequency Selection
16	SYNC	DIO	Clock input/output for synchronizing multiple class-D devices. Direction determined by GAIN/SLV terminal.
17	AVCC	P	Analog Supply

(1) **TYPE:** DO = Digital Output, I = Analog Input, G = General Ground, PO = Power Output, BST = Boot Strap.

TPA3128D2

ZHCSFV8A – MAY 2016 – REVISED DECEMBER 2016

www.ti.com.cn
Pin Functions (continued)

PIN		TYPE ⁽¹⁾	DESCRIPTION
NO.	NAME		
18	PVCC	P	Power supply
19	PVCC	P	Power supply
20	BSNL	BST	Boot strap for negative left channel output, connect to 220 nF X5R, or better ceramic cap to OUTPL
21	OUTNL	PO	Negative left channel output
22	GND	G	Ground
23	OUTPL	PO	Positive left channel output
24	BSPL	BST	Boot strap for positive left channel output, connect to 220 nF X5R, or better ceramic cap to OUTNL
25	GND	G	Ground
26	BSNR	BST	Boot strap for negative right channel output, connect to 220 nF X5R, or better ceramic cap to OUTNR
27	OUTNR	PO	Negative right channel output
28	GND	G	Ground
29	OUTPR	PO	Positive right channel output
30	BSPR	BST	Boot strap for positive right channel output, connect to 220 nF X5R or better ceramic cap to OUTPR
31	PVCC	P	Power supply
32	PVCC	P	Power supply
33	PowerPAD	G	Connect to GND for best system performance. If not connected to GND, leave floating.

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Supply voltage, V_{CC}	PV_{CC} , AV_{CC}	−0.3	30	V
Input voltage, V_I	INPL, INNPL, INPR, INNR	−0.3	6.3	V
	PLIMIT, GAIN / SLV, SYNC	−0.3	GVDD+0.3	V
	AM0, AM1, AM2, MUTE, SDZ, MODSEL	−0.3	PVCC+0.3	V
Slew rate, maximum ⁽²⁾	AM0, AM1, AM2, MUTE, SDZ, MODSEL		10	V/ms
Operating free-air temperature, T_A		−40	85	°C
Operating junction temperature, T_J		−40	150	°C
Storage temperature, T_{stg}		−40	125	°C

(1) Stresses beyond those listed under absolute maximum ratings can 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 can affect device reliability.

(2) 100-k Ω series resistor is required if maximum slew rate is exceeded.

6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	PV_{CC} , AV_{CC}	4.5		26	V
V_{IH}	High-level input voltage	AM0, AM1, AM2, MUTE, SDZ, SYNC, MODSEL	2			V
V_{IL}	Low-level input voltage	AM0, AM1, AM2, MUTE, SDZ, SYNC, MODSEL			0.8	V
V_{OL}	Low-level output voltage	FAULTZ, $R_{PULL-UP} = 100\text{ k}\Omega$, $PV_{CC} = 26\text{ V}$			0.8	V
I_{IH}	High-level input current	AM0, AM1, AM2, MUTE, SDZ, MODSEL ($V_I = 2\text{ V}$, $V_{CC} = 18\text{ V}$)			50	μA
$R_L(BTL)$	Minimum load Impedance	Output filter: $L = 10\text{ }\mu\text{H}$, $C = 680\text{ nF}$	3.2	4		Ω
$R_L(PBTL)$		Output filter: $L = 10\text{ }\mu\text{H}$, $C = 1\text{ }\mu\text{F}$	1.6			
L_o	Output-filter Inductance	Minimum output filter inductance under short-circuit condition	1			μH

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TPA3128D2	UNIT
		DAP ⁽²⁾	
		32 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	22	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	0.3	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	4.8	°C/W

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

(2) For the PCB layout please see the TPA3128D2EVM user guide.

TPA3128D2

ZHCSFV8A – MAY 2016 – REVISED DECEMBER 2016

www.ti.com.cn

6.5 DC Electrical Characteristics

 $T_A = 25^\circ\text{C}$, $AV_{CC} = PV_{CC} = 12\text{ V to }24\text{ V}$, $R_L = 4\ \Omega$, $f_s = 400\text{ kHz}$, low idle-loss mode(unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$ V_{OS} $	Class-D output offset voltage (measured differentially)	$V_I = 0\text{ V}$		1.5	5	mV
I_{CC}	Quiescent supply current	SDZ = 2 V, With load and filter, $PV_{CC} = 12\text{ V}$		17		
		SDZ = 2 V, With load and filter, $PV_{CC} = 24\text{ V}$		23		
$I_{CC(SD)}$	Quiescent supply current in shutdown mode	SDZ = 0.8 V, With load and filter, $PV_{CC} = 12\text{ V}$		20		μA
		SDZ = 0.8 V, With load and filter, $PV_{CC} = 24\text{ V}$		30		
$r_{DS(on)}$	Drain-source on-state resistance, measured pin to pin	$PV_{CC} = 21\text{ V}$, $I_{out} = 500\text{ mA}$, $T_J = 25^\circ\text{C}$		90		m Ω
G	Gain (BTL)	R1 = 5.6 k Ω , R2 = Open	19	20	21	dB
		R1 = 20 k Ω , R2 = 100 k Ω	25	26	27	
		R1 = 39 k Ω , R2 = 100 k Ω	31	32	33	dB
		R1 = 47 k Ω , R2 = 75 k Ω	35	36	37	
G	Gain (SLV)	R1 = 51 k Ω , R2 = 51 k Ω	19	20	21	dB
		R1 = 75 k Ω , R2 = 47 k Ω	25	26	27	
		R1 = 100 k Ω , R2 = 39 k Ω	31	32	33	dB
		R1 = 100 k Ω , R2 = 16 k Ω	35	36	37	
t_{on}	Turn-on time	SDZ = 2 V		40		ms
t_{OFF}	Turn-off time	SDZ = 0.8 V		2		μs
GVDD	Gate drive supply	IGVDD < 200 μA	5.1	5.6	6.1	V
V_O	Output voltage maximum under PLIMIT control	$V(\text{PLIMIT}) = 2\text{ V}$; $V_I = 1\text{ V}_{rms}$	6.75	8.2	8.75	V

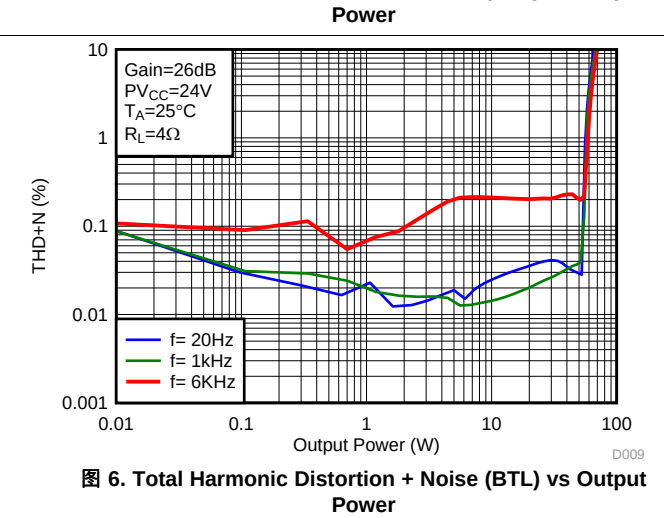
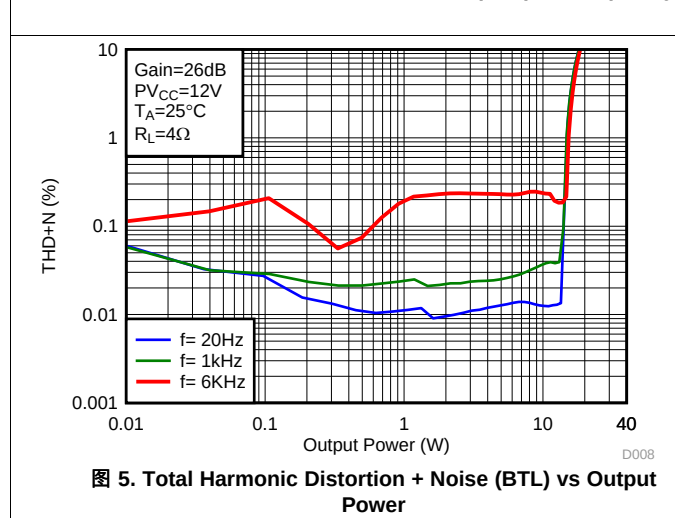
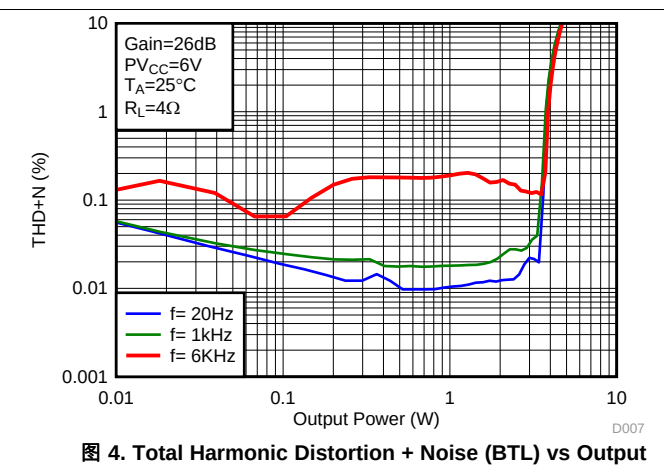
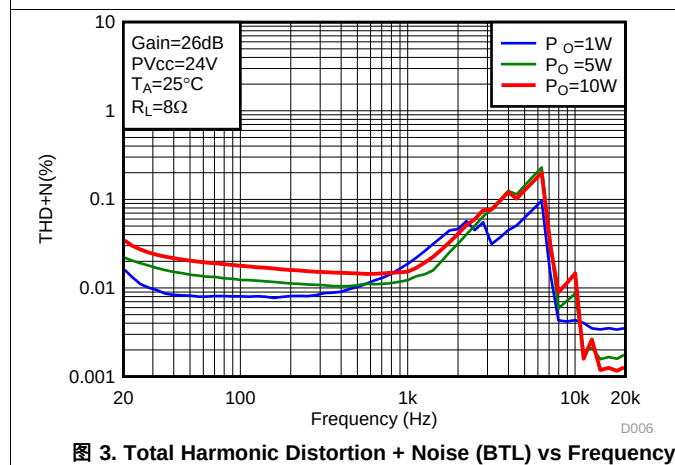
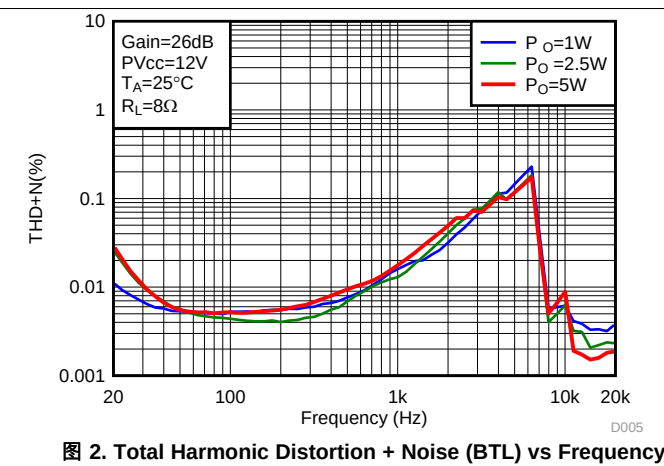
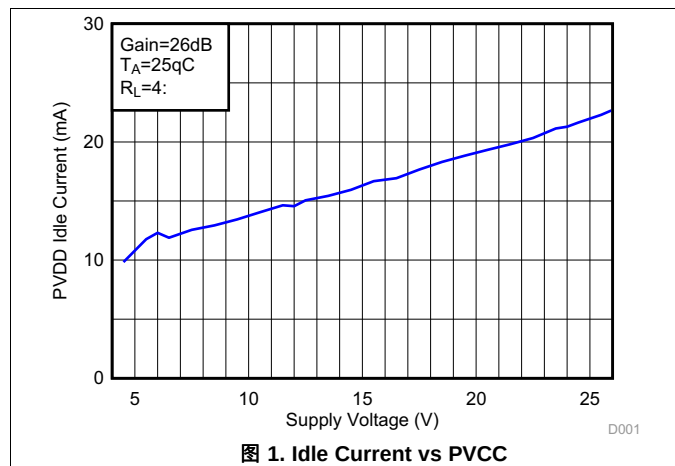
6.6 AC Electrical Characteristics

 $T_A = 25^\circ\text{C}$, $AV_{CC} = PV_{CC} = 12\text{ V to }24\text{ V}$, $R_L = 4\ \Omega$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
KSVR	Power supply ripple rejection	200 mV _{PP} ripple at 1 kHz, Gain = 20 dB, Inputs AC-coupled to GND		−70		dB
P _O	Continuous output power	THD+N = 10%, f = 1 kHz, PV _{CC} = 14.4 V		25		W
		THD+N = 10%, f = 1 kHz, PV _{CC} = 21 V		30		
THD+N	Total harmonic distortion + noise	V _{CC} = 21 V, f = 1 kHz, P _O = 15 W (half-power)		0.1%		
V _n	Output integrated noise	20 Hz to 22 kHz, A-weighted filter, Gain = 20 dB		65		μV
				−80		dBV
	Crosstalk	V _O = 1 V _{rms} , Gain = 20 dB, f = 1 kHz		−100		dB
SNR	Signal-to-noise ratio	Maximum output at THD+N < 1%, f = 1 kHz, Gain = 20 dB, A-weighted		102		dB
f _{osc}	Oscillator frequency	AM2=0, AM1=0, AM0=0	376	400	424	kHz
		AM2=0, AM1=0, AM0=1	470	500	530	
		AM2=0, AM1=1, AM0=0	564	600	636	
		AM2=0, AM1=1, AM0=1	940	1000	1060	
		AM2=1, AM1=0, AM0=0	1128	1200	1278	
		AM2=1, AM1=0, AM0=1	282	300	318	
		AM2=1, AM1=1, AM0=0	Reserved			
		AM2=1, AM1=1, AM0=1				
	Thermal trip point		≥150		°C	
	Thermal hysteresis		15		°C	
	Over current trip point	TPA3128D2		7.5		A

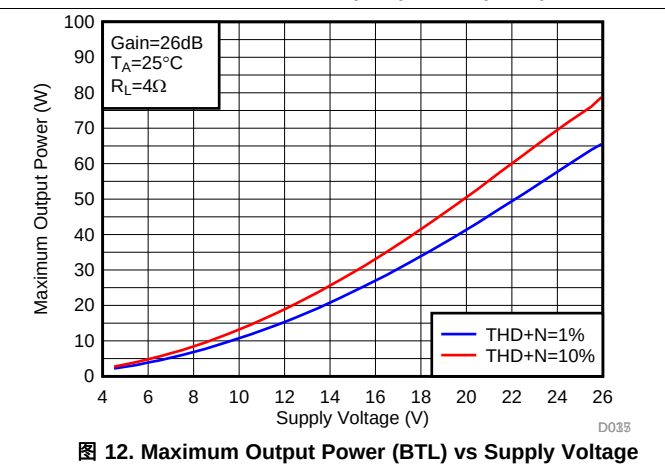
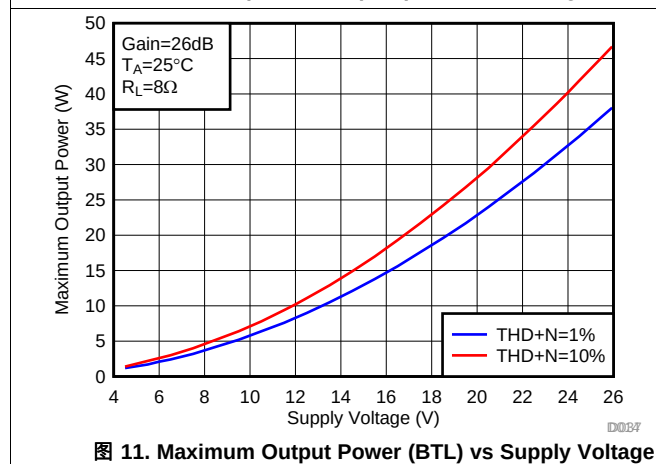
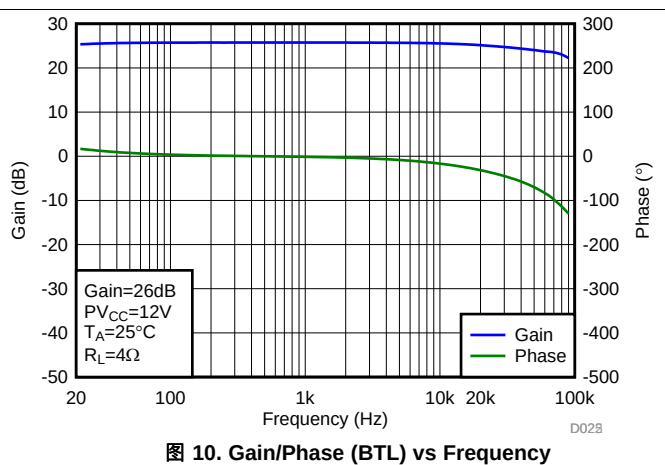
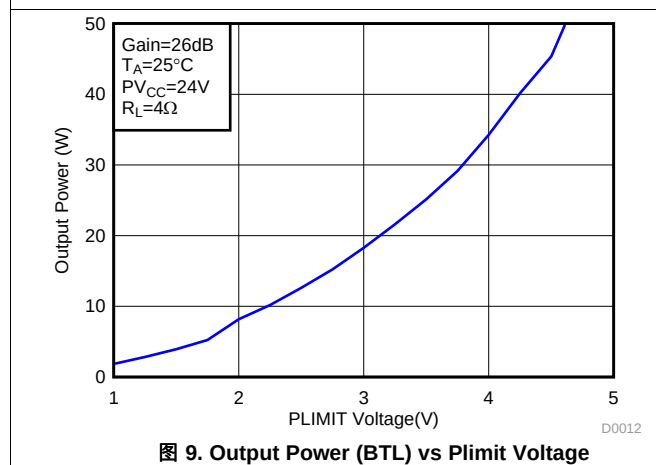
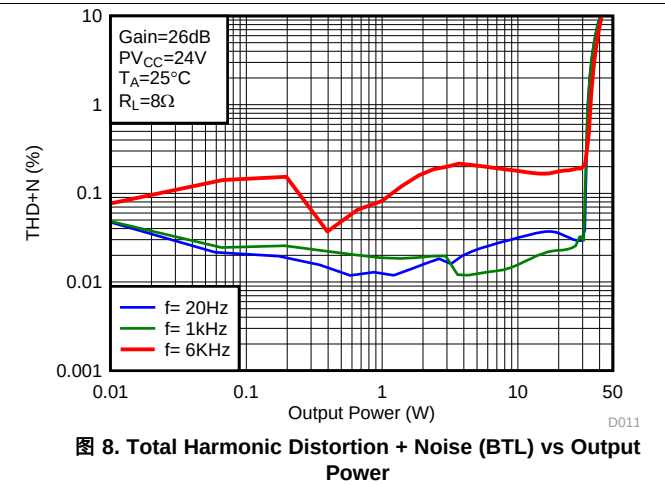
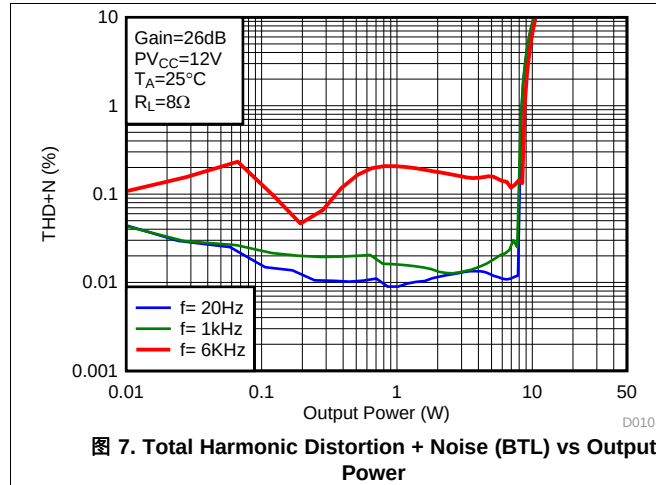
6.7 Typical Characteristics

$f_s = 400$ kHz, Ultra Low Idle Loss Mode, TPA3128D2EVM Tested With AP2722. (unless otherwise noted)



Typical Characteristics (接下页)

$f_s = 400$ kHz, Ultra Low Idle Loss Mode, TPA3128D2EVM Tested With AP2722. (unless otherwise noted)



Typical Characteristics (接下页)

$f_s = 400$ kHz, Ultra Low Idle Loss Mode, TPA3128D2EVM Tested With AP2722. (unless otherwise noted)

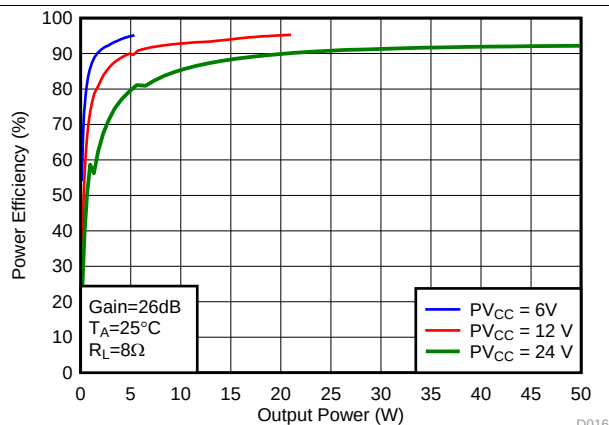


图 13. Power Efficiency (BTL) vs Output Power

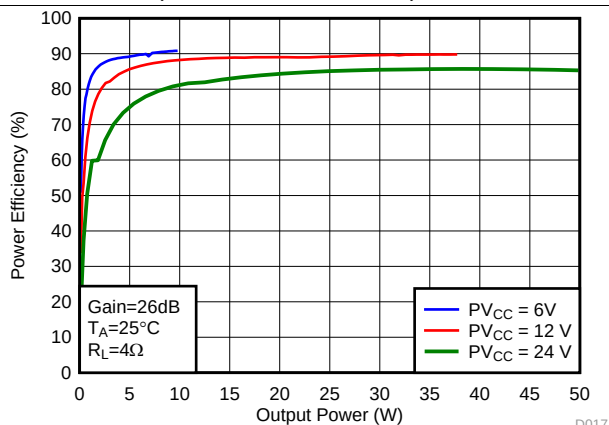


图 14. Power Efficiency (BTL) vs Output Power

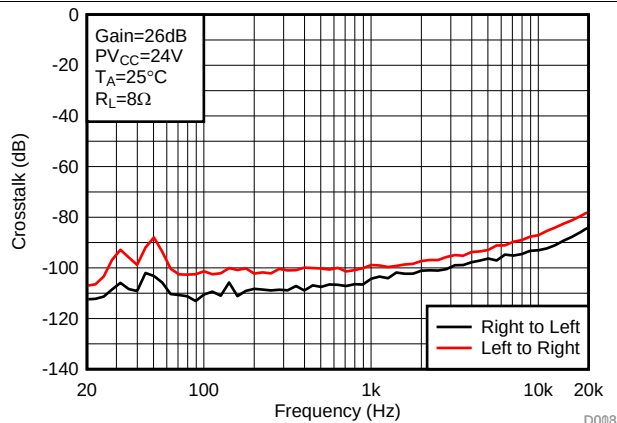


图 15. Crosstalk vs Frequency

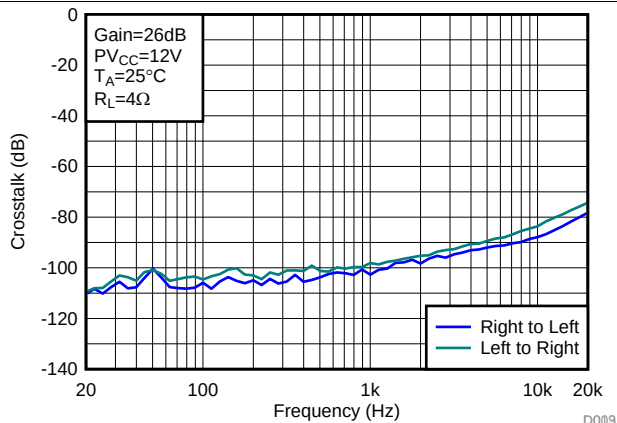


图 16. Crosstalk vs Frequency

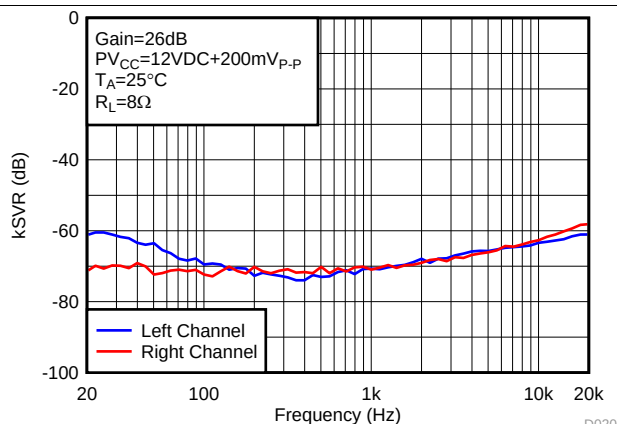


图 17. Supply Ripple Rejection Ratio (BTL) vs Frequency

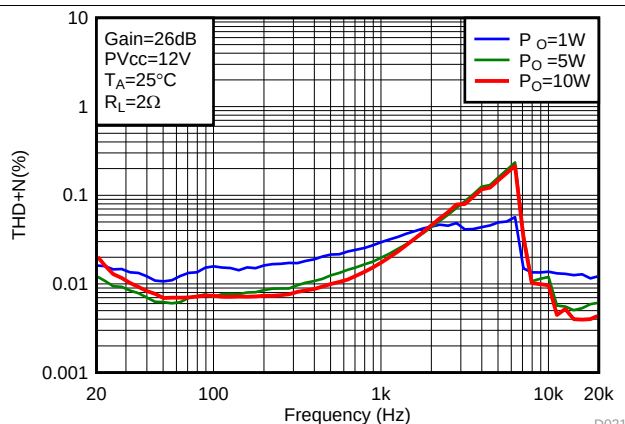


图 18. Total Harmonic Distortion + Noise (PBTL) vs Frequency

Typical Characteristics (接下页)

$f_s = 400$ kHz, Ultra Low Idle Loss Mode, TPA3128D2EVM Tested With AP2722. (unless otherwise noted)

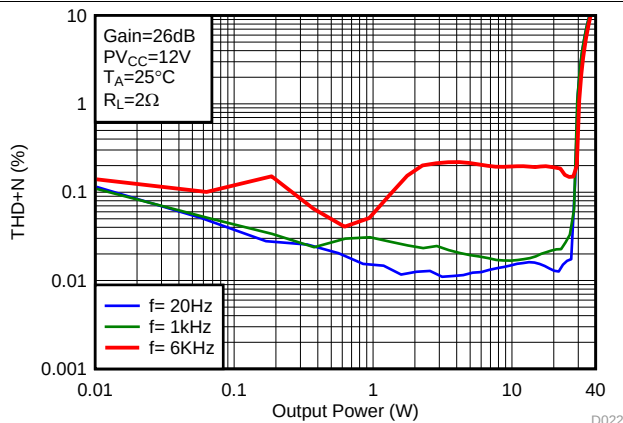


图 19. Total Harmonic Distortion + Noise (PBTL) vs Output Power

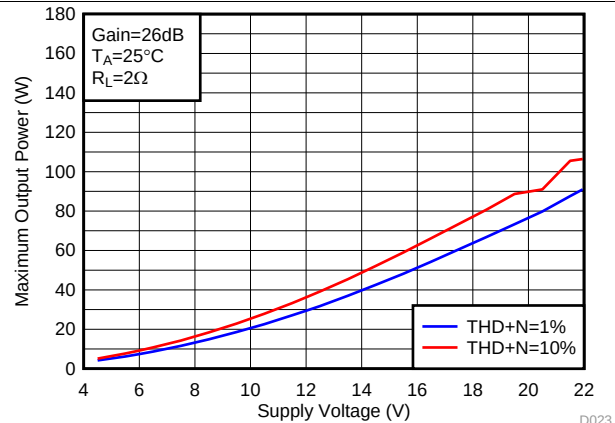


图 20. Maximum Output Power (PBTL) vs Supply Voltage

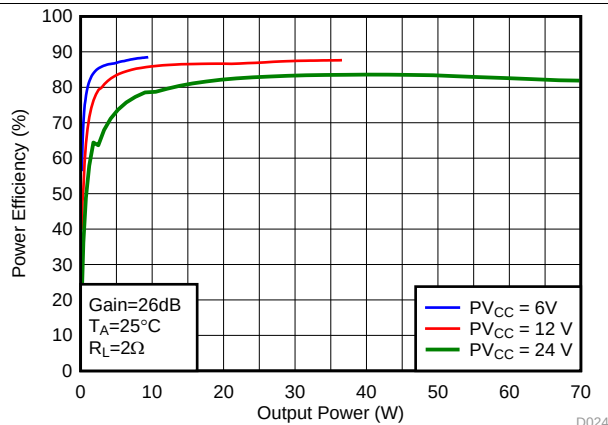


图 21. Power Efficiency (PBTL) vs Output Power

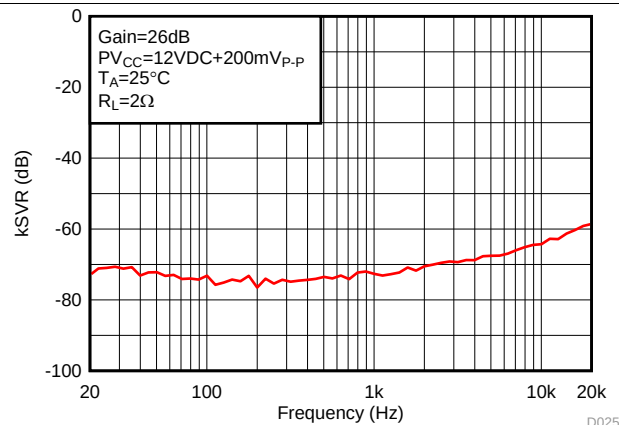


图 22. Supply Ripple Rejection Ratio (PBTL) vs Frequency

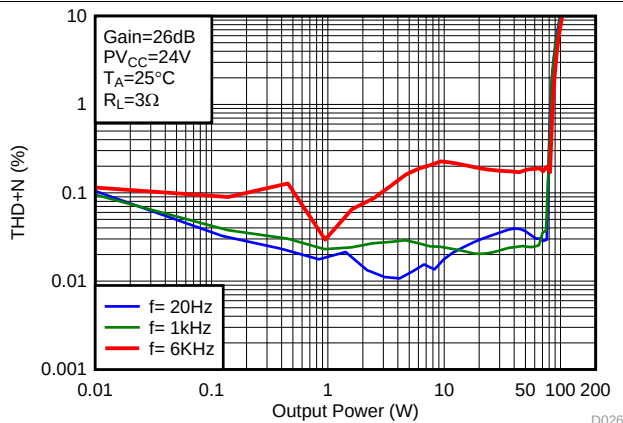


图 23. Total Harmonic Distortion + Noise (PBTL) vs Output Power

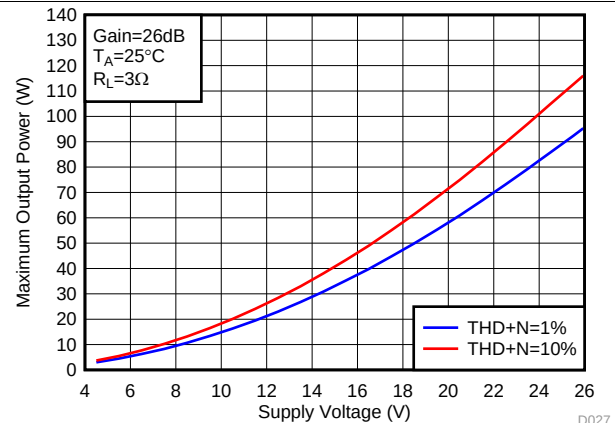


图 24. Maximum Output Power (PBTL) vs Supply Voltage

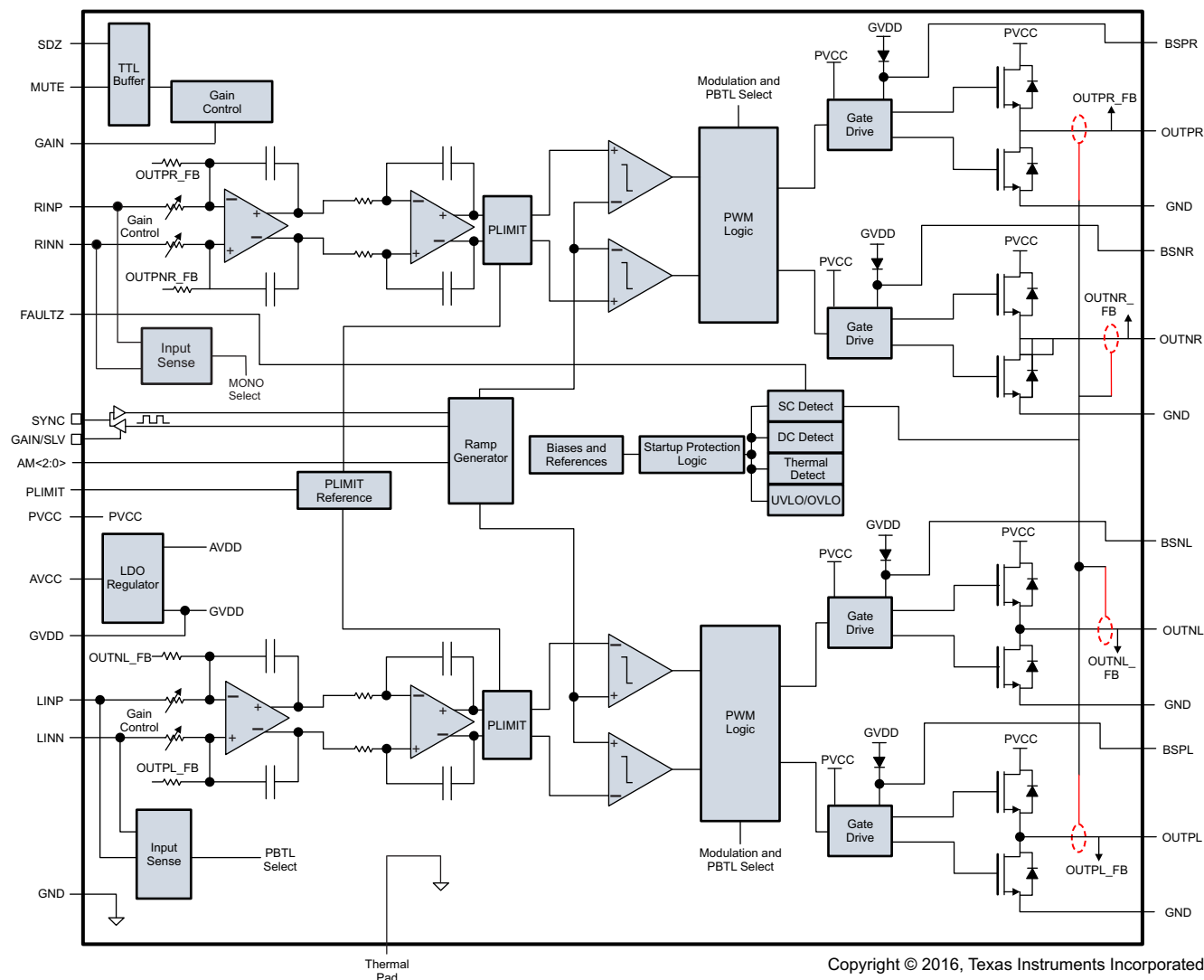
7 Detailed Description

7.1 Overview

The TPA3128D2 device is a highly efficient Class D audio amplifier with extreme low idle power dissipation. It can support as low as 23mA idle loss current using standard LC filter configurations. It is integrated with 90-mΩ MOSFET that allows output currents up to 7.5 A. The high efficiency allows the amplifier to provide an excellent audio performance without the requirement for a bulky heat sink.

The device can be configured for either master or slave operation by using the SYNC pin. Configuring using the SYNC pin helps to prevent audible beats noise.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Gain Setting and Master and Slave

The gain of the TPA3128D2 is set by the voltage divider connected to the GAIN/SLV control pin. Master or Slave mode is also controlled by the same pin. An internal ADC is used to detect the 8 input states. The first four stages sets the GAIN in Master mode in gains of 20, 26, 32, 36 dB respectively, while the next four stages sets the GAIN in Slave mode in gains of 20, 26, 32, 36 dB respectively. The gain setting is latched during power-up and cannot be changed while device is powered. 表 1 lists the recommended resistor values and the state and gain:

表 1. Gain and Master/Slave

MASTER / SLAVE MODE	GAIN	R1 (to GND) ⁽¹⁾	R2 (to GVDD) ⁽¹⁾	INPUT IMPEDANCE
Master	20 dB	5.6 kΩ	OPEN	60 kΩ
Master	26 dB	20 kΩ	100 kΩ	30 kΩ
Master	32 dB	39 kΩ	100 kΩ	15 kΩ
Master	36 dB	47 kΩ	75 kΩ	9 kΩ
Slave	20 dB	51 kΩ	51 kΩ	60 kΩ
Slave	26 dB	75 kΩ	47 kΩ	30 kΩ
Slave	32 dB	100 kΩ	39 kΩ	15 kΩ
Slave	36 dB	100 kΩ	16 kΩ	9 kΩ

(1) Resistor tolerance should be 5% or better.

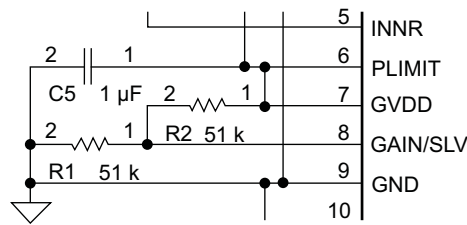


图 25. Gain, Master/Slave

In Master mode, SYNC terminal is an output, in Slave mode, SYNC terminal is an input for a clock input. TTL logic levels with compliance to GVDD.

7.3.2 Input Impedance

The TPA3128D2 input stage is a fully differential input stage and the input impedance changes with the gain setting from 9 kΩ at 36 dB gain to 60 kΩ at 20 dB gain. 表 1 lists the values from min to max gain. The tolerance of the input resistor value is ±20% so the minimum value will be higher than 7.2 kΩ. The inputs must be AC-coupled to minimize the output dc-offset and ensure correct ramping of the output voltages during power-ON and power-OFF. The input ac-coupling capacitor together with the input impedance forms a high-pass filter with the following cut-off frequency:

$$f = \frac{1}{2\pi Z_i C_i} \quad (1)$$

If a flat bass response is required down to 20 Hz the recommended cut-off frequency is a tenth of that, 2 Hz. 表 2 lists the recommended ac-couplings capacitors for each gain step. If a –3-dB capacitor is accepted at 20 Hz 10 times lower capacitors can be used – for example, a 1-μF capacitor can be used.

表 2. Recommended Input AC-Coupling Capacitors

GAIN	INPUT IMPEDANCE	INPUT CAPACITANCE	HIGH-PASS FILTER
20 dB	60 k Ω	1.5 μ F	1.8 Hz
26 dB	30 k Ω	3.3 μ F	1.6 Hz
32 dB	15 k Ω	5.6 μ F	2.3 Hz
36 dB	9 k Ω	10 μ F	1.8 Hz

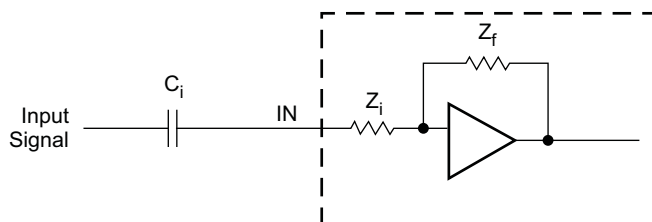


图 26. Input Impedance

The input capacitors used should be a type with low leakage, such as quality electrolytic, tantalum, or ceramic capacitors. If a polarized type is used the positive connection should face the input pins which are biased to 3 Vdc.

7.3.3 Startup and Shutdown Operation

The TPA3128D2 employs a shutdown mode of operation designed to reduce supply current (I_{cc}) to the absolute minimum level during periods of nonuse for power conservation. The SDZ input terminal should be held high (see specification table for trip point) during normal operation when the amplifier is in use. Pulling SDZ low will put the outputs to mute and the amplifier to enter a low-current state. Do not leave SDZ unconnected, because amplifier operation would be unpredictable.

For the best power-off pop performance, place the amplifier in the shutdown mode prior to removing the power supply. The gain setting is selected at the end of the start-up cycle. At the end of the start-up cycle, the gain is selected and cannot be changed until the next power-up.

7.3.4 PLIMIT Operation

The TPA3128D2 has a built-in voltage limiter that can be used to limit the output voltage level below the supply rail, the amplifier operates as if it was powered by a lower supply voltage, and thereby limits the output power. Add a resistor divider from GVDD to ground to set the voltage at the PLIMIT pin. An external reference may also be used if tighter tolerance is required. Add a 1- μ F capacitor from pin PLIMIT to ground to ensure stability.

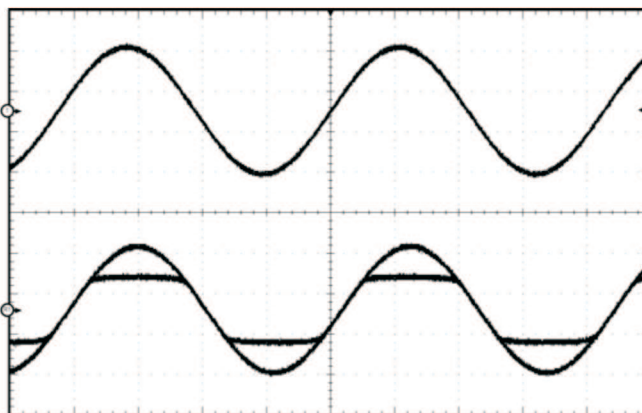


图 27. Power Limit Example

TPA3128D2

ZHCSFV8A – MAY 2016 – REVISED DECEMBER 2016

www.ti.com.cn

The PLIMIT circuit sets a limit on the output peak-to-peak voltage. The limiting is done by limiting the duty cycle to a fixed maximum value. The limit can be thought of as a "virtual" voltage rail which is lower than the supply connected to PVCC. The "virtual" rail is approximately four times the voltage at the PLIMIT pin. The output voltage can be used to calculate the maximum output power for a given maximum input voltage and speaker impedance.

$$P_{OUT} = \frac{\left(\left(\frac{R_L}{R_L + 2 \times R_S} \right) \times V_P \right)^2}{2 \times R_L} \quad \text{for unclipped power}$$

where

- $P_{OUT} (10\%THD) = 1.25 \times P_{OUT} (\text{unclipped})$
- R_L is the load resistance.
- R_S is the total series resistance including $R_{DS(on)}$, and output filter resistance.
- V_P is the peak amplitude, which is limited by "virtual" voltage rail.

(2)

表 3. Power Limit Example

PV _{CC} (V)	PLIMIT VOLTAGE (V) ⁽¹⁾	R to GND	R to GVDD	OUTPUT VOLTAGE (V _{rms})
24 V	GVDD	Open	Short	17.9
24 V	3.3	45 kΩ	51 kΩ	12.67
24 V	2.25	24 kΩ	51 kΩ	9
12 V	GVDD	Open	Short	10.33
12 V	2.25	24 kΩ	51 kΩ	9
12 V	1.5	18 kΩ	68 kΩ	6.3

(1) PLIMIT measurements taken with EVM gain set to 26 dB and input voltage set to 1 V_{rms}.

7.3.5 GVDD Supply

The GVDD Supply is used to power the gates of the output full bridge transistors. The GVDD Supply can also be used to supply the PLIMIT and GAIN/SLV voltage dividers. Decouple GVDD with a X5R ceramic 1-μF capacitor to GND. The GVDD supply is not intended to be used for external supply. The current consumption should be limited by using resistor voltage dividers for GAIN/SLV and PLIMIT of 100 kΩ or more.

7.3.6 BSPx AND BSNx 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 220-nF ceramic capacitor of quality X5R or better, rated for at least 16 V, must be connected from each output to the corresponding bootstrap input. (See the application circuit diagram in [图 36](#).) The bootstrap capacitors connected between the BSxx 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.

7.3.7 Differential Inputs

The differential input stage of the amplifier cancels any noise that appears on both input lines of the channel. To use the TPA3128D2 with a differential source, connect the positive lead of the audio source to the RINP or LINP input and the negative lead from the audio source to the RINN or LINN input. To use the TPA3128D2 with a single-ended source, ac ground the negative input through a capacitor equal in value to the input capacitor on positive and apply the audio source to either input. In a single-ended input application, the unused input should be ac grounded at the audio source instead of at the device input for best noise performance. For good transient performance, the impedance seen at each of the two differential inputs should be the same.

The impedance seen at the inputs should be limited to an RC time constant of 1 ms or less if possible to allow the input dc blocking capacitors to become completely charged during the 40-ms power-up time. If the input capacitors are not allowed to completely charge, there will be some additional sensitivity to component matching which can result in pop if the input components are not well matched.

7.3.8 Device Protection System

The TPA3128D2 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, and under-voltage. The FAULTZ pin will signal if an error is detected according to [表 4](#):

表 4. Fault Reporting

FAULT	TRIGGERING CONDITION (typical value)	FAULTZ	ACTION	LATCHED/SELF-CLEARING
Over Current	Output short or short to PVCC or GND	Low	Output high impedance	Latched
Over Temperature	$T_j > 150^{\circ}\text{C}$	Low	Output high impedance	Latched
Too High DC Offset	DC output voltage	Low	Output high impedance	Latched
Under Voltage on PVCC	$\text{PVCC} < 4.5\text{V}$	–	Output high impedance	Self-clearing
Over Voltage on PVCC	$\text{PVCC} > 27\text{V}$	–	Output high impedance	Self-clearing

7.3.9 DC Detect Protection

The TPA3128D2 has circuitry which will protect the speakers from DC current which might occur due to defective capacitors on the input or shorts on the printed circuit board at the inputs. A DC detect fault will be reported on the 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.

If automatic recovery from the short circuit protection latch is desired, connect the FAULTZ pin directly to the SDZ pin. Connecting the FAULTZ and SDZ pins allows the FAULTZ pin function to automatically drive the SDZ pin low which clears the DC Detect protection latch.

A DC Detect Fault is issued when the output differential voltage of either channel exceeds DC protection threshold level for more than 640 ms at the same polarity. 表 5 below shows some examples of the typical DC Detect Protection threshold for several values of the supply voltage. The Detect Protection Threshold feature protects the speaker from large DC currents or AC currents less than 2 Hz. To avoid nuisance faults due to the DC detect circuit, hold the SD pin low at power-up until the signals at the inputs are stable. Also, take care to match the impedance seen at the positive and negative inputs to avoid nuisance DC detect faults.

表 5 lists the minimum output offset voltages required to trigger the DC detect. The outputs must remain at or above the voltage listed in the table for more than 640 ms to trigger the DC detect.

表 5. DC Detect Threshold

PV _{CC} (V)	V _{OS} - OUTPUT OFFSET VOLTAGE (V)
4.5	1.35
6	1.8
12	3.6
18	5.4

7.3.10 Short-Circuit Protection and Automatic Recovery Feature

The TPA3128D2 has protection from over current conditions caused by a short circuit on the output stage. The short circuit protection fault is reported on the FAULTZ pin as a low state. The amplifier outputs are switched to a high impedance state when the short circuit protection latch is engaged. The latch can be cleared by cycling the SDZ pin through the low state.

If automatic recovery from the short circuit protection latch is desired, connect the FAULTZ pin directly to the SDZ pin. Connecting the FAULTZ and SDZ pins allows the FAULTZ pin function to automatically drive the SDZ pin low which clears the short-circuit protection latch.

In systems where a possibility of a permanent short from the output to PVDD or to a high voltage battery like a car battery can occur, pull the MUTE pin low with the FAULTZ signal with a inverting transistor to ensure a high-Z restart, like shown in the 图 28 below:

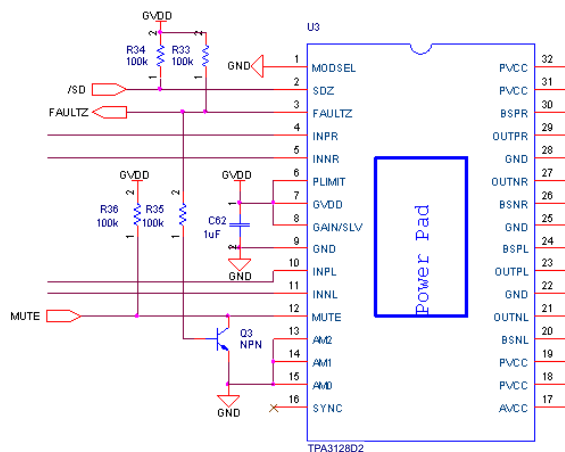


图 28. MUTE Driven by Inverted FAULTZ

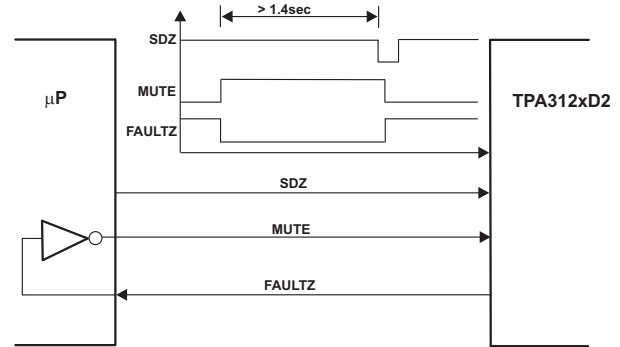


图 29. Timing Requirement for SDZ

7.3.11 Thermal Protection

Thermal protection on the TPA3128D2 prevents damage to the device when the internal die temperature exceeds 150°C. This trip point has a ±15°C tolerance from device to device. Once the die temperature exceeds the thermal trip point, the device enters into the shutdown state and the outputs are disabled. This is a latched fault.

Thermal protection faults are reported on the FAULTZ terminal as a low state.

If automatic recovery from the thermal protection latch is desired, connect the FAULTZ pin directly to the SDZ pin. This allows the FAULTZ pin function to automatically drive the SDZ pin low which clears the thermal protection latch.

7.3.12 Device Modulation Scheme

The TPA3128D2 has the option of running in either BD modulation or low idle-loss mode.

7.3.12.1 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 OUTPx and OUTNx are in phase with each other with no input so that there is little or no current in the speaker. The duty cycle of OUTPx is greater than 50% and OUTNx is less than 50% for positive output voltages. The duty cycle of OUTPx is less than 50% and OUTNx is greater than 50% for negative output voltages. The voltage across the load sits at 0V throughout most of the switching period, reducing the switching current, which reduces any I^2R losses in the load.

TPA3128D2

ZHCSFV8A – MAY 2016 – REVISED DECEMBER 2016

www.ti.com.cn

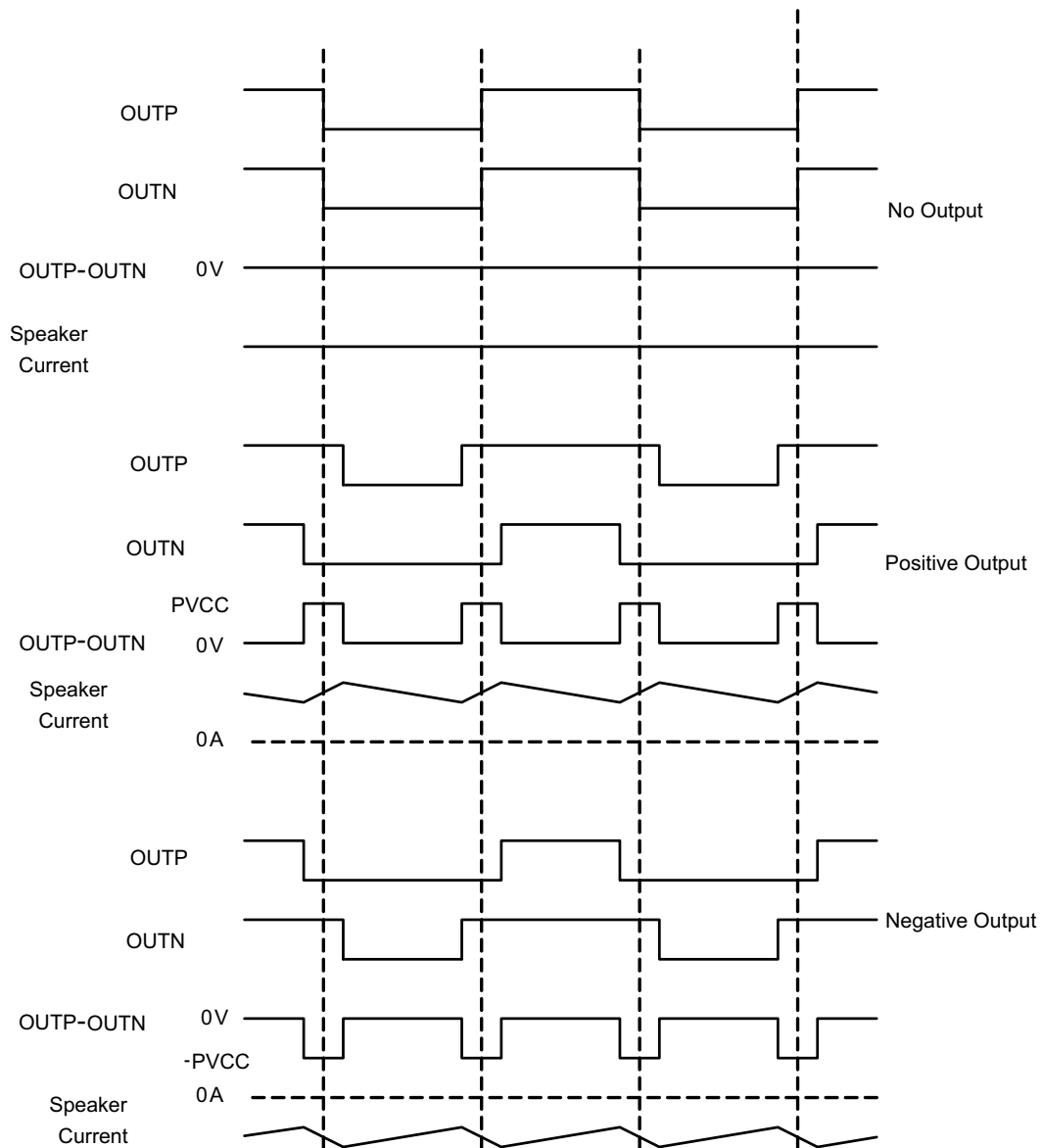


图 30. BD Mode Modulation

7.3.13 Efficiency: LC Filter Required with the Traditional Class-D Modulation Scheme

The main reason that the traditional class-D amplifier-based on AD modulation requires an output filter is that the switching waveform results in maximum current flow. This causes more loss in the load, which causes lower efficiency. The ripple current is large for the traditional modulation scheme, because the ripple current is proportional to voltage multiplied by the time at that voltage. The differential voltage swing is $2 \times V_{CC}$, and the time at each voltage is half the period for the traditional modulation scheme. An ideal LC filter is required to store the ripple current from each half cycle for the next half cycle, while any resistance causes power dissipation. The speaker is both resistive and reactive, whereas an LC filter is almost purely reactive.

The TPA3128D2 modulation scheme has little loss in the load without a filter because the pulses are short and the change in voltage is V_{CC} instead of $2 \times V_{CC}$. As the output power increases, the pulses widen, making the ripple current larger. Ripple current could be filtered with an LC filter for increased efficiency, but for most applications the filter is not required.

An LC filter with a cutoff frequency less than the class-D switching frequency allows the switching current to flow through the filter instead of the load. The filter has less resistance but higher impedance at the switching frequency than the speaker, which results in less power dissipation, therefore increasing efficiency.

7.3.14 Ferrite Bead Filter Considerations

Using the Advanced Emissions Suppression Technology in the TPA3128D2 amplifier, a high efficiency class-D audio amplifier can be designed while minimizing interference to surrounding circuits. Designing the amplifier can also be accomplished with only a low-cost ferrite bead filter. In this case the user must carefully select the ferrite bead used in the filter. One important aspect of the ferrite bead selection is the type of material used in the ferrite bead. Not all ferrite material is alike, therefore the user must select a material that is effective in the 10-MHz to 100-MHz range which is key to the operation of the class-D amplifier. Many of the specifications regulating consumer electronics have emissions limits as low as 30 MHz. The ferrite bead filter should be used to block radiation in the 30-MHz and above range from appearing on the speaker wires and the power supply lines which are good antennas for these signals. 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 ferrite bead must be large enough to maintain its impedance at the peak currents expected for the amplifier. Some ferrite bead manufacturers specify the bead impedance at a variety of current levels. In this case the user can make sure the ferrite bead maintains an adequate amount of impedance at the peak current the amplifier will see. If these specifications are not available, the device can also estimate the bead current handling capability by measuring the resonant frequency of the filter output at low power and at maximum power. A change of resonant frequency of less than fifty percent under this condition is desirable. Examples of ferrite beads which have been tested and work well with the TPA3130D2 can be seen in the TPA3130D2EVM user guide [SLOU341](#).

A high quality ceramic capacitor is also required for the ferrite bead filter. A low ESR capacitor with good temperature and voltage characteristics will work best.

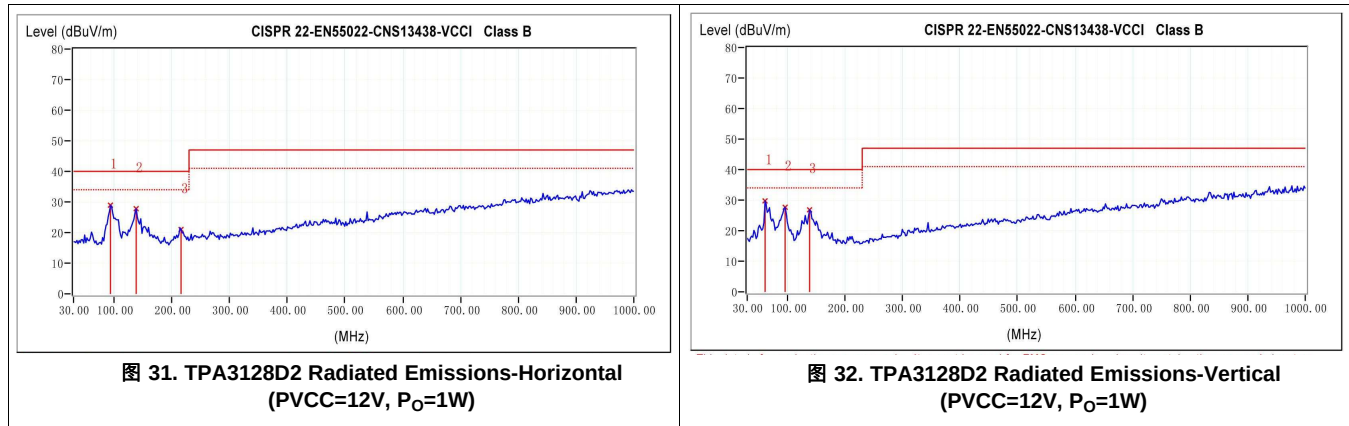
Additional EMC improvements may be obtained by adding snubber networks from each of the class-D outputs to ground. Suggested values for a simple RC series snubber network would be 18Ω in series with a 330 pF capacitor although design of the snubber network is specific to every application and must be designed taking into account the parasitic reactance of the printed circuit board as well as the audio amp. Take care to evaluate the stress on the component in the snubber network especially if the amp is running at high P_{VCC} . Also, make sure the layout of the snubber network is tight and returns directly to the GND pins on the IC.

[图 31](#) 和 [图 32](#) 是 TPA3128D2 EN55022 辐射发射测试结果，使用了 TPA3128D2EVM 与 8- Ω 扬声器。

TPA3128D2

ZHCSFV8A – MAY 2016 – REVISED DECEMBER 2016

www.ti.com.cn



7.3.15 When to Use an Output Filter for EMI Suppression

A complete LC reconstruction filter should be added in some circuit instances. 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.

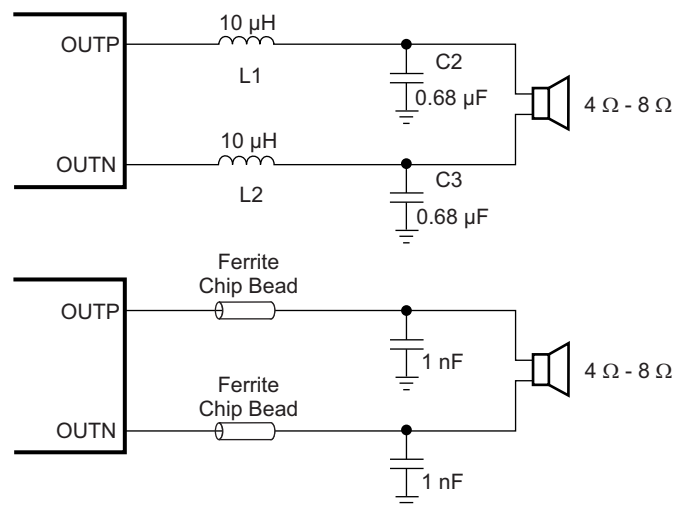


图 33. TPA3128D2 Output Filters

7.3.16 AM Avoidance EMI Reduction

表 6. AM Frequencies

US AM FREQUENCY (kHz)	EUROPEAN AM FREQUENCY (kHz)	SWITCHING FREQUENCY (kHz)	AM2	AM1	AM0
	522-540				
540-917	540-914	500	0	0	1
917-1125	914-1122	600 (or 400)	0 0	1 0	0 0
1125-1375	1122-1373	500	0	0	1
1375-1547	1373-1548	600 (or 400)	0 0	1 0	0 0

表 6. AM Frequencies (接下页)

US	EUROPEAN	SWITCHING FREQUENCY (kHz)	AM2	AM1	AM0
AM FREQUENCY (kHz)	AM FREQUENCY (kHz)				
1547-1700	1548-1701	600 (or 500)	0	1	0
			0	0	1

7.4 Device Functional Modes

7.4.1 PBTL Mode

The TPA3128D2 can be connected in PBTL mode enabling up to 60W output power. This is done by:

- Connect INPL and INNPL directly to Ground (without capacitors) this sets the device in Mono mode during power up.
- Connect OUTPR and OUTNR together for the positive speaker terminal and OUTNL and OUTPL together for the negative pin.
- Analog input signal is applied to INPR and INNR.

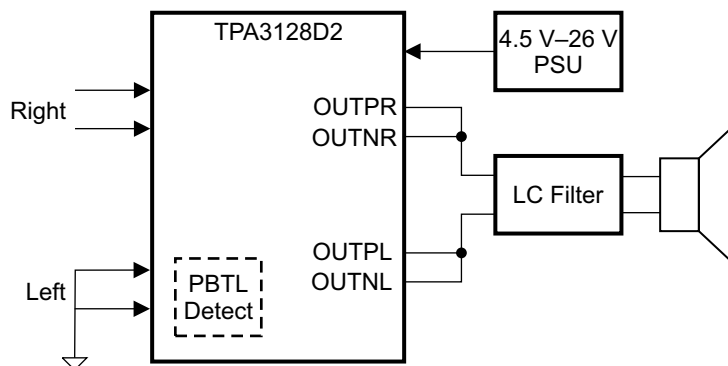


图 34. PBTL Mode

7.4.2 Mono Mode (Single Channel Mode)

The TPA3128D2 can be connected in MONO mode to cut the idle power-loss nearly by half. This is done by:

- Connect INPR and INNR directly to Ground (without capacitors) this sets the device in Mono mode during power up.
- Connect OUTPL and OUTNL to speaker just like normal BTL mode.
- Analog input signal is applied to INPL and INNPL.

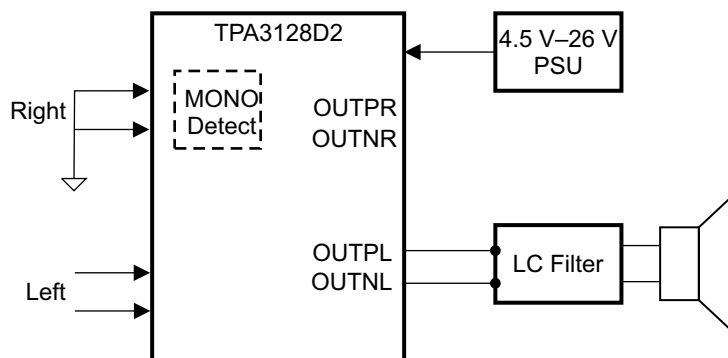


图 35. MONO Mode

8 Applications and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

This section describes a 2.1 Master and Slave application. The Master is configured as stereo outputs and the Slave is configured as mono PBTL output.

8.2 Typical Application

A 2.1 solution, U1 TPA3128D2 in Master mode 400 kHz, BTL, gain of 20 dB, power limit not implemented. U2 in Slave, PBTL mode gain of 20dB. Inputs are connected for differential inputs.

Typical Application (接下页)

8.2.1 Design Requiriements

DESIGN PARAMETERS	EXAMPLE VALUE
Input voltage range PVCC	4.5 V to 26 V
PWM output frequencies	300kHz, 400 kHz, 500 kHz, 600 kHz, 1 MHz or 1.2 MHz
Maximum output power	50 W

8.2.2 Detailed Design Procedure

The TPA3128D2 is a very flexible and easy to use Class D amplifier; therefore the design process is straightforward. Before beginning the design, gather the following information regarding the audio system.

- PVCC rail planned for the design
- Speaker or load impedance
- Maximum output power requirement
- Desired PWM frequency

8.2.2.1 Select the PWM Frequency

Set the PWM frequency by using AM0, AM1 and AM2 pins.

8.2.2.2 Select the Amplifier Gain and Master/Slave Mode

In order to select the amplifier gain setting, the designer must determine the maximum power target and the speaker impedance. Once these parameters have been determined, calculate the required output voltage swing which delivers the maximum output power.

Choose the lowest analog gain setting that corresponds to produce an output voltage swing greater than the required output swing for maximum power. The analog gain and master/slave mode can be set by selecting the voltage divider resistors (R1 and R2) on the Gain/SLV pin.

8.2.2.3 Select Input Capacitance

Select the bulk capacitors at the PVCC inputs for proper voltage margin and adequate capacitance to support the power requirements. In practice, with a well-designed power supply, two 100-μF, 50-V capacitors should be sufficient. One capacitor should be placed near the PVCC inputs at each side of the device. PVCC capacitors should be a low ESR type because they are being used in a high-speed switching application.

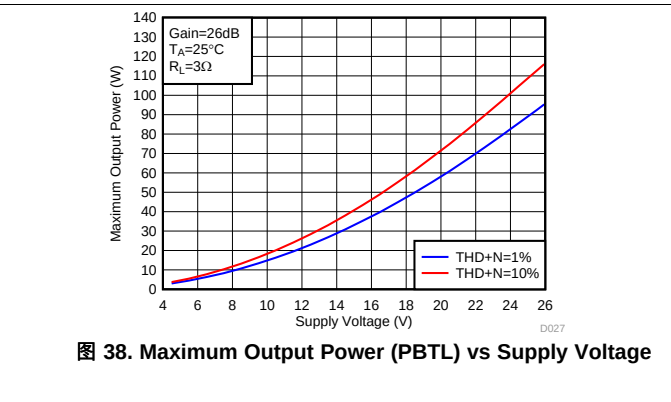
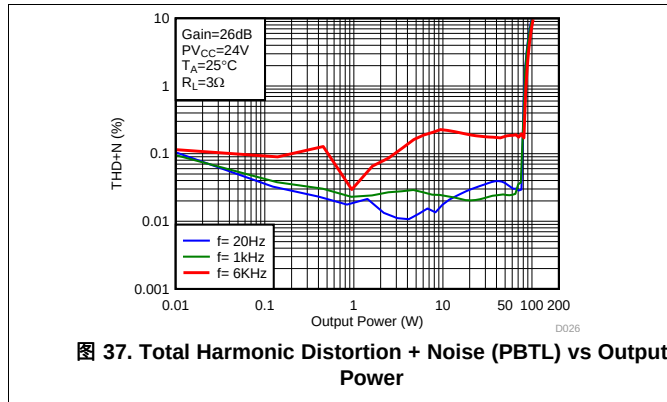
8.2.2.4 Select Decoupling Capacitors

Good quality decoupling capacitors must be added at each of the PVCC inputs to provide good reliability, good audio performance, and to meet regulatory requirements. X5R or better ratings should be used in this application. Consider temperature, ripple current, and voltage overshoots when selecting decoupling capacitors. Also, these decoupling capacitors should be located near the PVCC and GND connections to the device in order to minimize series inductances.

8.2.2.5 Select Bootstrap Capacitors

Each of the outputs require bootstrap capacitors to provide gate drive for the high-side output FETs. For this design, use 0.22-μF, 25-V capacitors of X5R quality or better.

8.2.3 Application Curves



9 Power Supply Recommendations

The power supply requirements for the TPA3128D2 consist of one higher-voltage supply to power the output stage of the speaker amplifier. Several on-chip regulators are included on the TPA3128D2 to generate the voltages necessary for the internal circuitry of the audio path. The voltage regulators which have been integrated are sized only to provide the current necessary to power the internal circuitry. The external pins are provided only as a connection point for off-chip bypass capacitors to filter the supply. Connecting external circuitry to these regulator outputs may result in reduced performance and damage to the device. The high voltage supply, between 4.5 V and 26 V, supplies the analog circuitry (AVCC) and the power stage (PVCC). The AVCC supply feeds internal LDO including GVDD. This LDO output are connected to external pins for filtering purposes, but should not be connected to external circuits. GVDD LDO output have been sized to provide current necessary for internal functions but not for external loading.

9.1 Power Supply Mode

The TPA3128D2 device supports both single and dual power supply modes. Dual power supply mode is benefit for low PVCC power consumption. For dual power supply mode application, when AVCC is supplied with 4.5V power, PVCC is recommended to be lower than 20V. When PVCC is supplied with power greater than 20V, AVCC is recommended to be higher than 6V.

10 Layout

10.1 Layout Guidelines

The TPA3128D2 can be used with a small, inexpensive ferrite bead output filter for most applications. However, because the class-D switching edges are fast, the layout of the printed circuit board must be planned carefully. The following suggestions will help to meet EMC requirements.

- **Decoupling capacitors** — The high-frequency decoupling capacitors should be placed as close to the PVCC and AVCC terminals as possible. Large (100 μ F or greater) bulk power supply decoupling capacitors should be placed near the TPA3128D2 on the PVCC supplies. Local, high-frequency bypass capacitors should be placed as close to the PVCC pins as possible. These caps can be connected to the IC GND pad directly for an excellent ground connection. Consider adding a small, good quality low ESR ceramic capacitor between 220 pF and 1 nF and a larger mid-frequency cap of value between 100 nF and 1 μ F also of good quality to the PVCC connections at each end of the chip.
- **Keep the current loop from each of the outputs through the ferrite bead and the small filter cap and back to GND as small and tight as possible.** The size of this current loop determines its effectiveness as an antenna.
- **Grounding** — The PVCC decoupling capacitors should connect to GND. All ground should be connected at the IC GND, which should be used as a central ground connection or star ground for the TPA3128D2.
- **Output filter** — The ferrite EMI filter (see 图 33) should be placed as close to the output terminals as possible for the best EMI performance. The LC filter should be placed close to the outputs. The capacitors used in both the ferrite and LC filters should be grounded.

Layout Guidelines (接下页)

For an example layout, see the TPA3128D2 Evaluation Module (TPA3128D2EVM) User Guide (SLOU336). Both the EVM user manual and the thermal pad application reports, SLMA002 and SLMA004, are available on the TI Web site at <http://www.ti.com>.

10.2 Layout Example

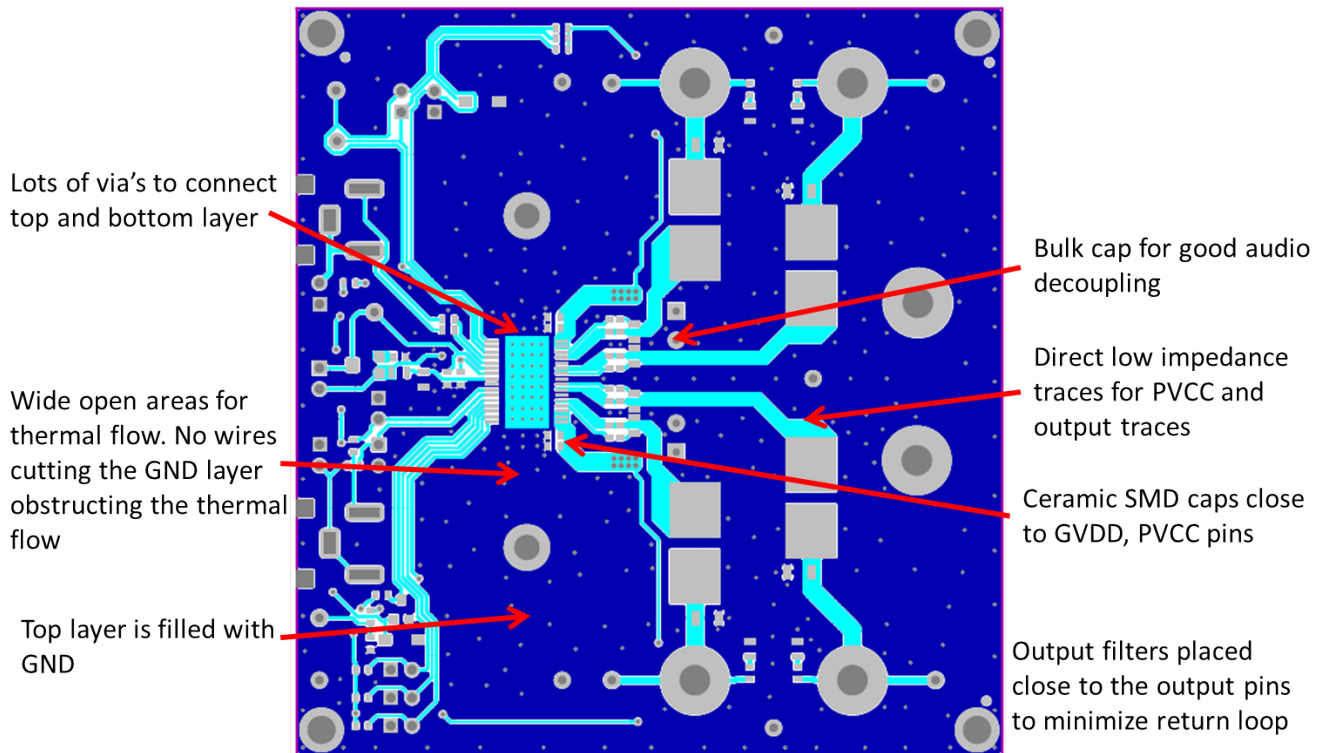


图 39. Layout Example Top

Layout Example (接下页)

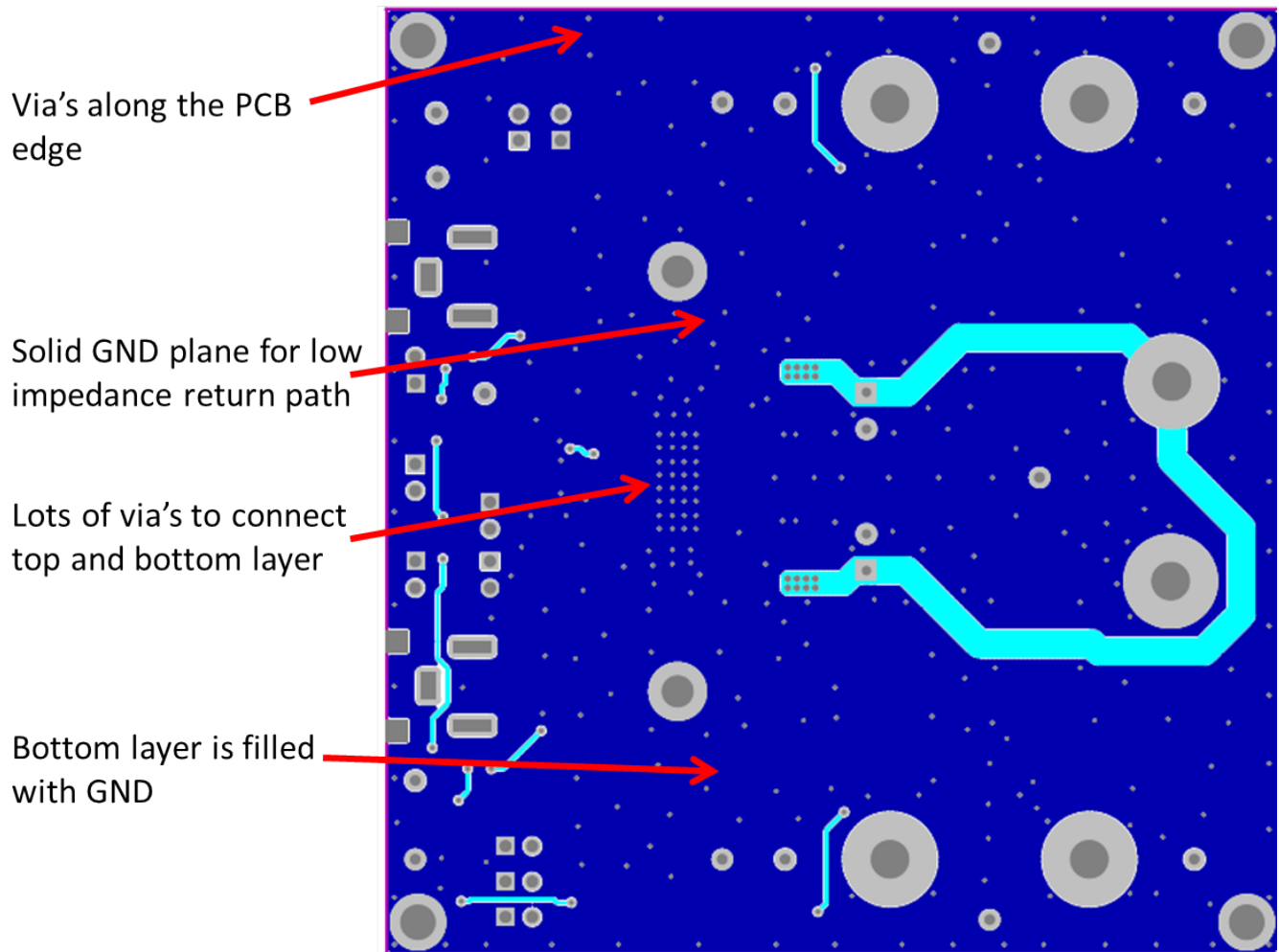


图 40. Layout Example Bottom

11 器件和文档支持

11.1 文档支持

11.2 社区资源

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.3 商标

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

11.4 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。这些信息是针对指定器件可提供的最新数据。这些数据会在无通知且不对本文档进行修订的情况下发生改变。欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPA3128D2DAP	ACTIVE	HTSSOP	DAP	32	46	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	TPA3128D2	Samples
TPA3128D2DAPR	ACTIVE	HTSSOP	DAP	32	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	-40 to 85	TPA3128D2	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

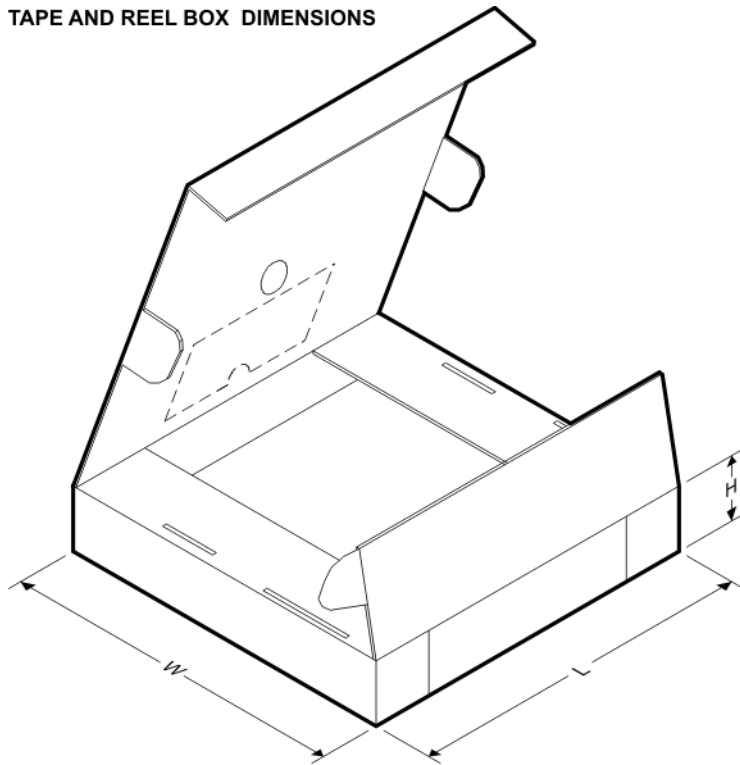
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPA3128D2DAPR	HTSSOP	DAP	32	2000	330.0	24.4	8.6	11.5	1.6	12.0	24.0	Q1

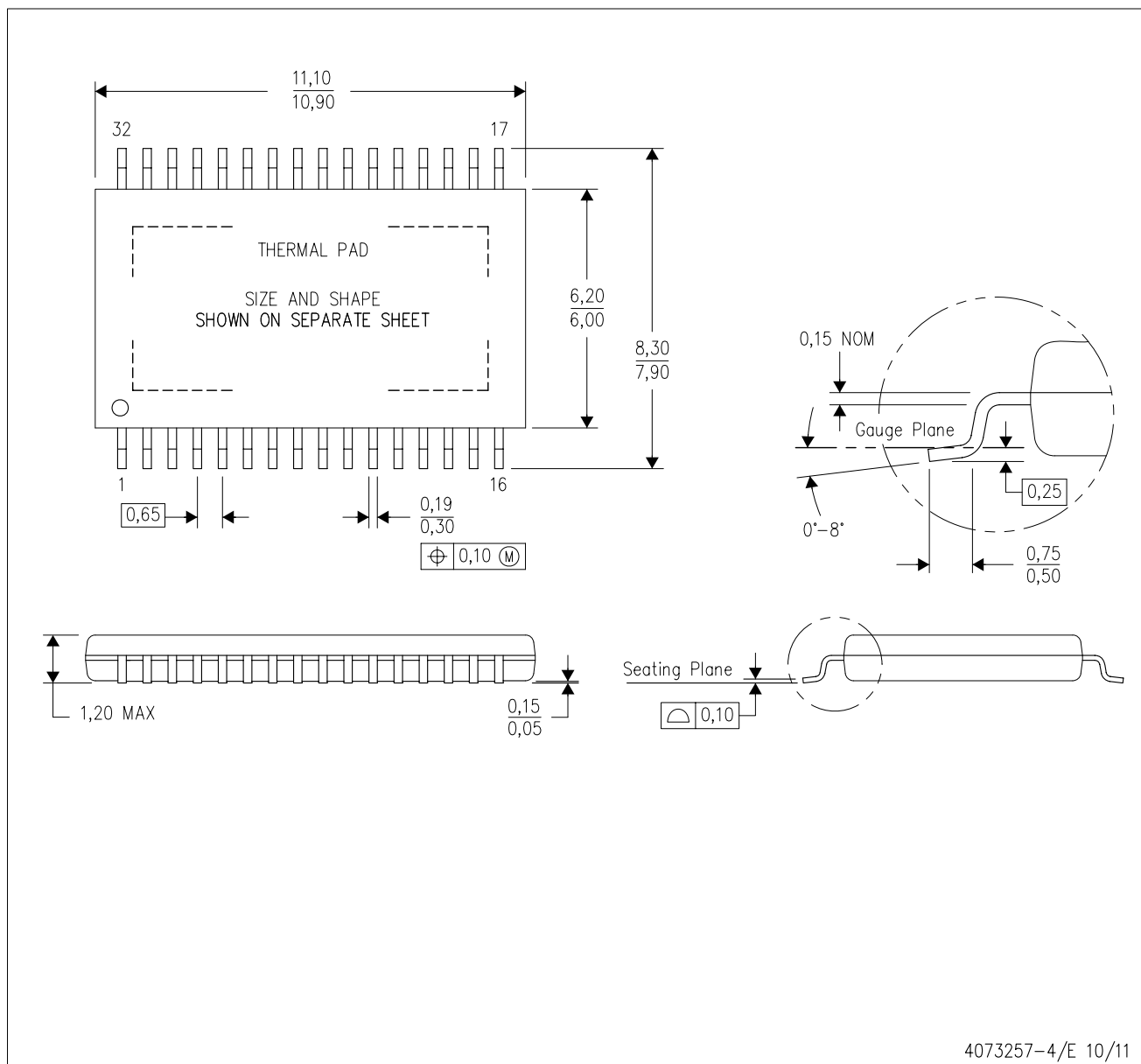
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPA3128D2DAPR	HTSSOP	DAP	32	2000	367.0	367.0	45.0

DAP (R-PDSO-G32) PowerPAD™ PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at www.ti.com <<http://www.ti.com>>.
-  Falls within JEDEC MO-153 Variation DCT.

DAP (R-PDSO-G32)

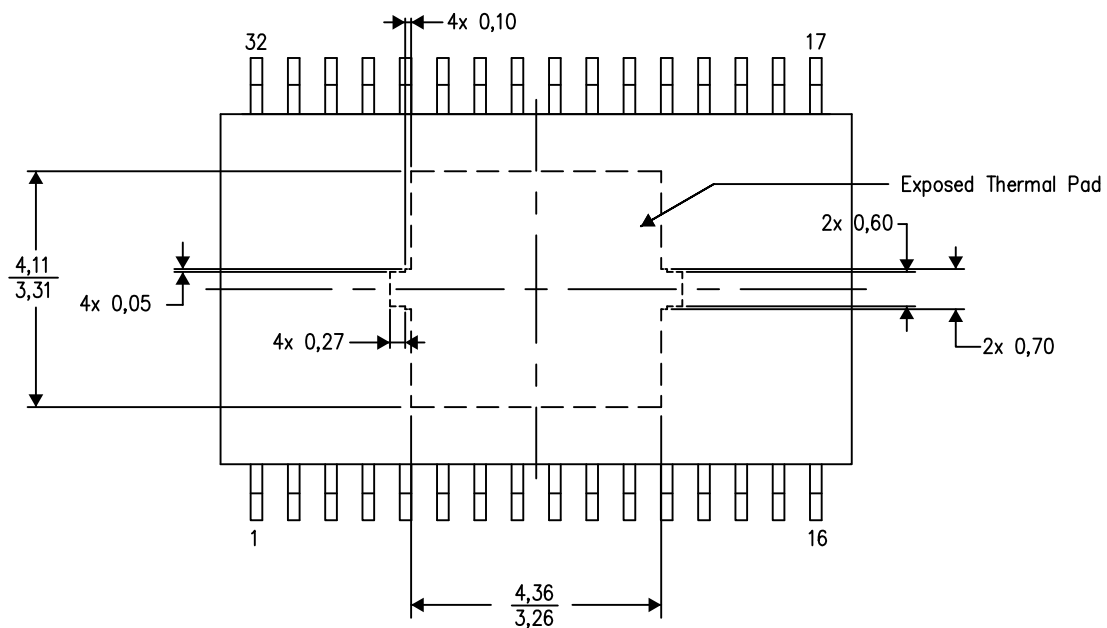
PowerPAD™ PLASTIC SMALL OUTLINE

THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the PCB. After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Top View
Exposed Thermal Pad Dimensions

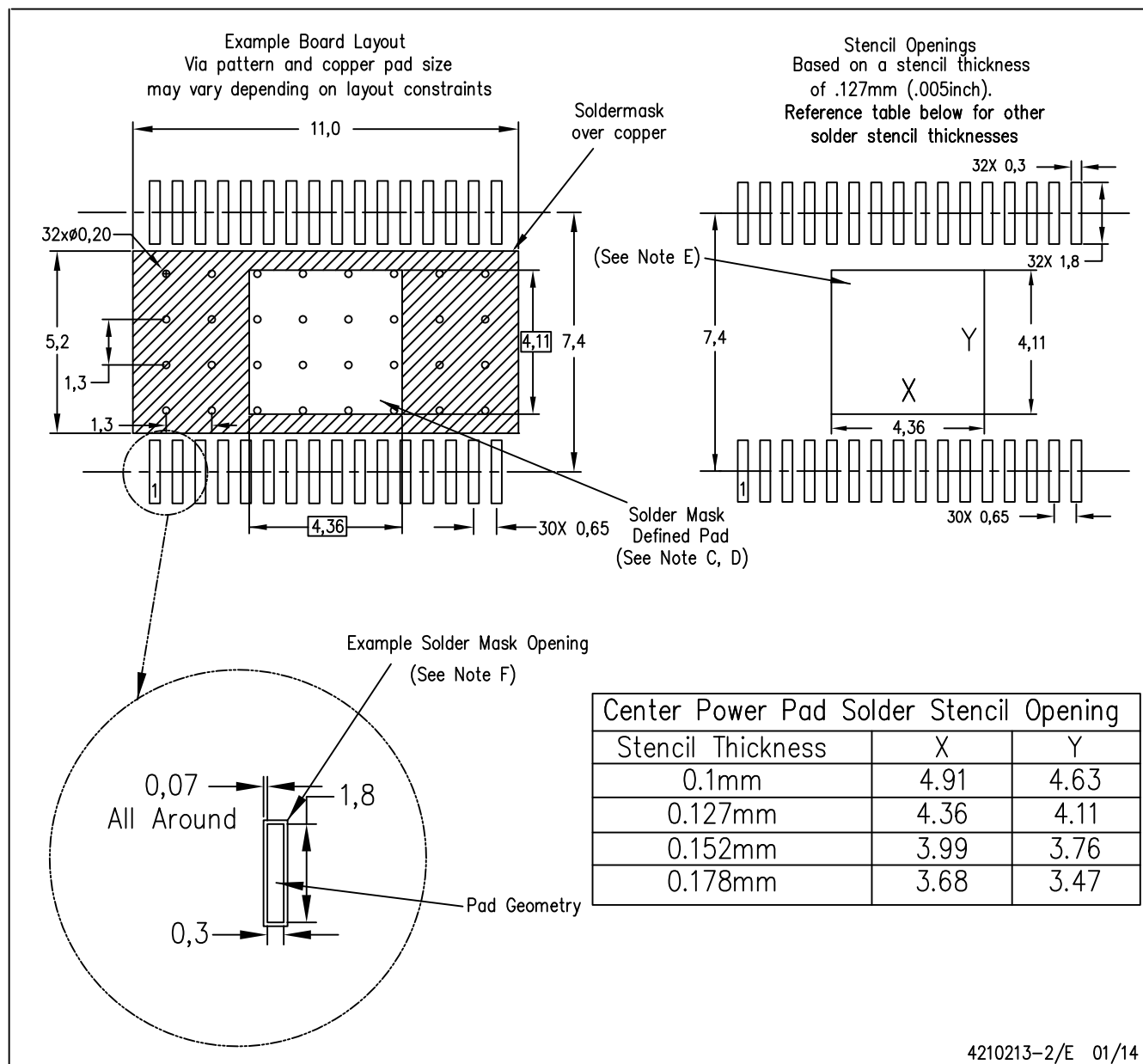
4206319-3/M 09/13

NOTE: All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments.

LAND PATTERN DATA

DAP (R-PDSO-G32) PowerPAD™ PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>. Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - Contact the board fabrication site for recommended soldermask tolerances.

PowerPAD is a trademark of Texas Instruments

重要声明

德州仪器 (TI) 公司有权按照最新发布的 JESD46 对其半导体产品和服务进行纠正、增强、改进和其他修改，并不再按最新发布的 JESD48 提供任何产品和服务。买方在下订单前应获取最新的相关信息，并验证这些信息是否完整且是最新的。

TI 公布的半导体产品销售条款 (<http://www.ti.com/sc/docs/stdterms.htm>) 适用于 TI 已认证和批准上市的已封装集成电路产品的销售。另有其他条款可能适用于其他类型 TI 产品及服务的使用或销售。

复制 TI 数据表上 TI 信息的重要部分时，不得变更该等信息，且必须随附所有相关保证、条件、限制和通知，否则不得复制。TI 对该等复制文件不承担任何责任。第三方信息可能受到其它限制条件的制约。在转售 TI 产品或服务时，如果存在对产品或服务参数的虚假陈述，则会失去相关 TI 产品或服务的明示或暗示保证，且构成不公平的、欺诈性商业行为。TI 对此类虚假陈述不承担任何责任。

买方和在系统中整合 TI 产品的其他开发人员（总称“设计人员”）理解并同意，设计人员在设计应用时应自行实施独立的分析、评价和判断，且应全权负责并确保应用的安全性，及设计人员的应用（包括应用中使用的 TI 产品）应符合所有适用的法律法规及其他相关要求。设计人员就自己设计的应用声明，其具备制订和实施下列保障措施所需的一切必要专业知识，能够 (1) 预见故障的危险后果，(2) 监视故障及其后果，以及 (3) 降低可能导致危险的故障几率并采取适当措施。设计人员同意，在使用或分发包含 TI 产品的任何应用前，将彻底测试该等应用和该等应用中所用 TI 产品的功能。

TI 提供技术、应用或其他设计建议、质量特点、可靠性数据或其他服务或信息，包括但不限于与评估模块有关的参考设计和材料（总称“TI 资源”），旨在帮助设计人员开发整合了 TI 产品的应用，如果设计人员（个人，或如果是代表公司，则为设计人员的公司）以任何方式下载、访问或使用任何特定的 TI 资源，即表示其同意仅为该等目标，按照本通知的条款使用任何特定 TI 资源。

TI 所提供的 TI 资源，并未扩大或以其他方式修改 TI 对 TI 产品的公开适用的质保及质保免责声明；也未导致 TI 承担任何额外的义务或责任。TI 有权对其 TI 资源进行纠正、增强、改进和其他修改。除特定 TI 资源的公开文档中明确列出的测试外，TI 未进行任何其他测试。

设计人员只有在开发包含该等 TI 资源所列 TI 产品的应用时，才被授权使用、复制和修改任何相关 TI 资源。但并未依据禁止反言原则或其他法律授予您任何 TI 知识产权的任何其他明示或默示的许可，也未授予您 TI 或第三方的任何技术或知识产权的许可，该等许可包括但不限于任何专利权、版权、屏蔽作品权或与其他 TI 产品或服务的任何整合、机器制作、流程相关的其他知识产权。涉及或参考了第三方产品或服务的信息不构成使用此类产品或服务的许可或与其相关的保证或认可。使用 TI 资源可能需要您向第三方获得对该等第三方专利或其他知识产权的许可。

TI 资源系“按原样”提供。TI 兹免除对资源及其使用作出所有其他明确或默示的保证或陈述，包括但不限于对准确性或完整性、产权保证、无屡发故障保证，以及适销性、适合特定用途和不侵犯任何第三方知识产权的任何默认保证。TI 不负任何责任，包括但不限于因组合产品所致或与之有关的申索，也不为或对设计人员进行辩护或赔偿，即使该等产品组合已列于 TI 资源或其他地方。对因 TI 资源或其使用引起或与之有关的任何实际的、直接的、特殊的、附带的、间接的、惩罚性的、偶发的、从属或惩戒性损害赔偿，不管 TI 是否获悉可能会产生上述损害赔偿，TI 概不负责。

除 TI 已明确指出特定产品已达到特定行业标准（例如 ISO/TS 16949 和 ISO 26262）的要求外，TI 不对未达到任何该等行业标准要求而承担任何责任。

如果 TI 明确宣称产品有助于功能安全或符合行业功能安全标准，则该等产品旨在帮助客户设计和创作自己的符合相关功能安全标准和要求的的应用。在应用内使用产品的行为本身不会配有安全特性。设计人员必须确保遵守适用于其应用的相关安全要求和标准。设计人员不可将任何 TI 产品用于关乎性命的医疗设备，除非已由各方获得授权的管理人员签署专门的合同对此类应用专门作出规定。关乎性命的医疗设备是指出现故障会导致严重身体伤害或死亡的医疗设备（例如生命保障设备、心脏起搏器、心脏除颤器、人工心脏泵、神经刺激器以及植入设备）。此类设备包括但不限于，美国食品药品监督管理局认定为 III 类设备的设备，以及在美国以外的其他国家或地区认定为同等类别设备的所有医疗设备。

TI 可能明确指定某些产品具备某些特定资格（例如 Q100、军用级或增强型产品）。设计人员同意，其具备一切必要专业知识，可以为自己的应用选择适合的产品，并且正确选择产品的风险由设计人员承担。设计人员单方面负责遵守与该等选择有关的所有法律或监管要求。

设计人员同意向 TI 及其代表全额赔偿因其不遵守本通知条款和条件而引起的任何损害、费用、损失和/或责任。

邮寄地址：上海市浦东新区世纪大道 1568 号中建大厦 32 楼，邮政编码：200122
Copyright © 2017 德州仪器半导体技术（上海）有限公司