内置自适应升压和防破音功能的11W D类及AB类音频功率放大器

11W Boosted Class D and Class AB Audio Amplifier

■ FEATURES

- Anti-Clipping Function (ACF)
- Filter-less Modulation, Eliminating Output Filter
- Output Power

11W (V_{BAT}=4V, R_{L}=3Ω, THD+N=10%, f_{IN} = 1kHz)

- Power Supply V_{BAT}: 2.7V~5.5V
- Low I_{DD}: 4mA @ VBAT=4.0V
- High Efficiency Boost Converter
  - -Adaptive boost converter
  - -Extends the playing time in battery supply applications
  - -Adjustable switch peak current limit to avoid over-pulling on battery current
- Class AB / Class D
- Over Current Protection, Thermal Protection, Low voltage malfunction prevention function included
- Pb-Free Packages, ESOP8

- 防削顶失真功能(防破音, Anti-Clipping Function, ACF)
- 免滤波器数字调制，直接驱动扬声器
- 输出功率

11W (V_{BAT}=4V, R_{L}=3Ω, THD+N=10%, f_{IN} = 1kHz)

- V_{BAT}供电范围：2.7V至5.5V
- 低静态电流：4mA @ VBAT = 4V
- 高效升压功能

-自适应升压，延长电池播放时间

-可调节最大限流值，有效防止电池拉死

- AB/D类可切换
- 保护功能:过流/过热/欠压异常保护功能
- 无铅封装，ESOP8

■ APPLICATIONS

- Bluetooth/Wi-Fi Speakers
- Portable Speakers
- Smart speakers
- Smart Home

- 蓝牙/ Wi-Fi音箱
- 便携式音箱
- 智能音箱
- 智能家居

■ DESCRIPTION

HTA8681, integrated with adaptive boost converter, is a mono Class D audio amplifier that drives up to continuous 11W (10% THD+N, 1kHz) into 3ohm speaker from a Li-battery voltage. It also integrates Class AB amplifier.

The built-in boost converter generates a Class D amplifier supply rail with a max voltage of 8.5V. The boost converter is automatically active only when a higher audio output power is required provide an adaptive voltage supply to the amplifier, which will significantly improve the efficiency and extends the playing time in battery supply applications.

HTA8681 features Anti-Clipping Function (ACF) which detects output signal clip due to the over input signal and suppresses the output signal clip automatically. Also, the ACF function can adapt the output clip caused by power supply voltage down with battery. It can significantly improve the sound quality, creating a very comfortable musical enjoyment, and to protect the speakers from overload damage. It also supplies ACF OFF mode.

Class AB amplifier mode is also available for HTA8681. Once the EMI Interference from class D and Boost Converter becomes an annoying problem, HTA8681 can be changed into Class AB mode.

HTA8681 has a filter-less modulation circuit which directly drives speakers while realizes low distortion and low noise characteristics. Thanks to filter-less, circuit design with fewer external parts can be made in portable applications.

As for protection function, over current protection function for speaker output terminals, over temperature protection function are also prepared.

HTA8681是一款内置自适应升压的单声道D类音频功率放大器，由锂电池供电时，THD+N=10%、1kHz信号条件下，能连续输出11W功率（3Ω负载）；另外，其还支持AB类模式。

HTA8681内置的升压，提供8.5V最大输出电压。其小音乐信号时不升压，仅当功率较大时，提供升压后的电压给D类功放，其可大幅提高系统效率，延长电池续航时间。

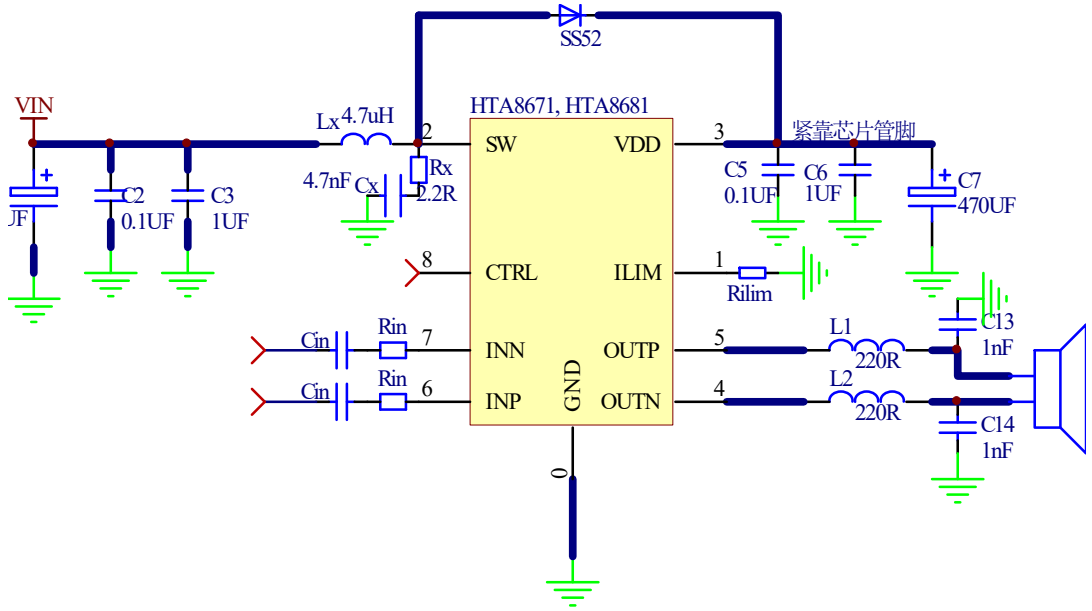
HTA8681的最大特点是防削顶失真（ACF）输出控制功能，可检测并抑制由于输入音乐、语音信号幅度过大所引起的输出信号削顶失真（破音），也能自适应地防止在BOOST升压电压下降所造成的输出削顶，显著提高音质，创造非常舒适的听音享受，并保护扬声器免受过载损坏。HTA8681还提供ACF-Off 模式。

HTA8681具有AB类和D类的自由切换功能，在受到D类功放EMI干扰困扰时，可随时切换至AB类音频功放模式。

HTA8681内部集成免滤波器数字调制技术，能够直接驱动扬声器，并最大程度减小脉冲输出信号的失真和噪音。输出无需滤波网络，极少的外部元器件节省了系统空间和成本，是便携式应用的理想选择。

此外，HTA8681集成了输出端过流保护、片内过温保护等功能。

■ TYPICAL APPLICATION



1. ILIM 脚设置升压电感的峰值电流限值，RILIM 电阻设置应不小于 120K.

R_{ILIM}电阻值	升压电感的峰值电流限值
330k	3A
200k	5A
150k	6.6A
130k	7.7A
120k	8A

2. 系统增益设置

D类增益	D类时芯片内部输入电阻RI与反馈电阻RF	AB类增益	AB类时芯片内部输入电阻RI与反馈电阻RF
23.5倍（27.4dB）	RF = 470k, RI = 20k	11.75倍（21.4dB）	RF = 235k, RI = 20k

外部增加输入电阻 R_{IN} 时，增益 $(dB) = 20 \times log\frac{RF}{RIN+R_I}$

3. CTRL 脚设置芯片的工作模式

CTRL pin	工作模式
>2.4V	Class D, ACF off
1.5~2.1V	Class D, ACF on

0.9~1.3V	Class AB, ACF off
<0.2V	Shutdown

4. 为减小 SW 毛刺和辐射，SW 端建议预留 Rx+Cx (2.2R+4.7nF)到地的网络。

5. 电感选择：推荐使用 4.7uH 电感，饱和电流应大于设置的 ILIM 值。

6. 二极管选择：反向电压 V_R 推荐 > 15V，额定电流 I_F 推荐>最高升压值/负载电阻值，推荐至少使用 1 个 SS52，或两个 SS52 并联。

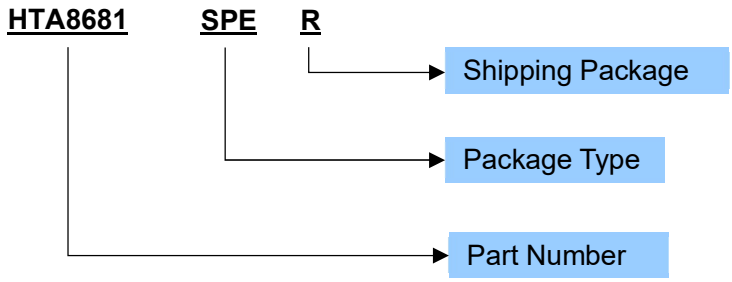
7. PVDD 电容：一般的，为保证低频的功率，在靠近二极管的输出电压处放置 0.1uF//1uF//470uF，并尽可能靠近 VDD 且使用粗走线连接。

8. 辐射和传导是关注项时，输出建议预留 LC 滤波器，即 L1 和 L2 改成电感 10uH，C13 和 C14 改成电容 0.68uF。

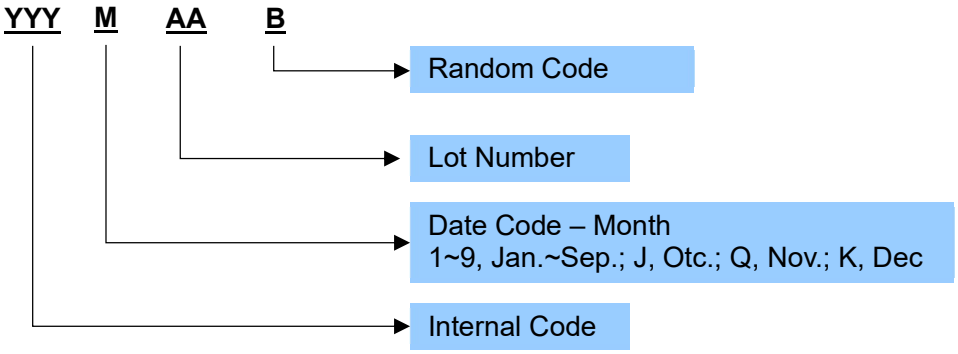
■ ORDERING INFORMATION

Part Number	Package Type	Package Abbr.	Eco Plan	MSL Level	Marking	Shipping Package / MOQ
HTA8681SPER	ESOP8	SPE	RoHS	MSL3	HTA8681 YYYMAAB[1]	Tape and Reel (R) / 2500pcs

Ordering Number

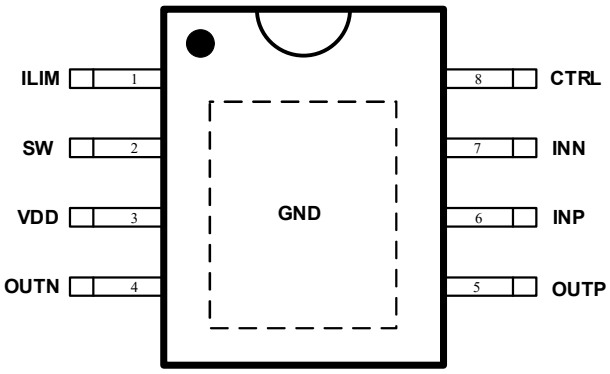


Production Tracking Code



[1] YYYMAAB is production tracking code

■ TERMINAL CONFIGURATION



Top View

■ TERMINAL FUNCTION

Terminal No.	Name	I/O[1]	Description
1	ILIM	I	Adjustable switch peak current limit. An external resistor should be connected between this pin and GND. 最大限流值设置端，外部接电阻到地。
2	SW	I	Boost and rectifying switch input. 升压整流开关输入端
3	VDD	P	Power Supply for internal power circuitry. 电源
4	OUTN	O	Negative pin for differential speaker amplifier. 输出负端
5	OUTP	O	Positive pin for differential speaker amplifier. 输出正端
6	INP	I	Positive input (differential+) for audio amplifier. 输入负端
7	INN	I	Negative input (differential-) for audio amplifier. 输入正端
8	CTRL	I	Mode Control Terminal. 模式控制脚
EP	GND	G	Ground. 地

[1] I: Input; O: Output; G: Ground; P: Power;

■ SPECIFICATIONS[1]

● Absolute Maximum Ratings[2]

Item	Symbol	Min.	Max.	Unit
Supply voltage range	V_{BAT}	-0.3	5.5	V
Input terminal voltage range	V_{IN}	−0.3	VDD+0.3	V
Operating Ambient Temperature	T_A	-40	85	℃
Junction Temperature	T_J	-40	150	℃
Storage Temperature	T_{STG}	-50	150	℃

● Recommended Operating Condition

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage range	V_{BAT}		2.7		5.5	V
Operating Ambient Temperature	T_a		-40	25	85	℃
Speaker Impedance	R_L		2	4		Ω

● Electrical Specification[3]

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
BOOST Converter						
Boost converter output voltage	VDD			8.5		V
Boost converter frequency	f_{SW}			300		kHz
Boost on threshold voltage	V_{B_TH}	Amplifier Output V_P		2.37		Vp

[1] Depending on parts and PCB layout, characteristics may be changed.
[2] Absolute Maximum Ratings is values which must not be exceeded to guarantee device reliability. With a system in which supply voltage might exceed supply voltage of PVDD/GND, external diodes are recommended to be used to assure that the voltage does not exceed the absolute maximum rating
[3] Depending on parts and pattern layout, characteristics may be changed.

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Class D Channel V_{SS}=0V, V_{BAT} =4V, R_{IILIM} = 150kohm, Ta=25ºC, C_{IN}=1uF, ACF-Off mode, unless otherwise specified							
Carrier clock frequency	f_{PWM}				400		kHz
Over current protection	Imax				6		A
System Gain	Av	External R_{IN}=0Ω			27.4		dB
Start-up time (power-on or shutdown release)	t_{STUP}				160		ms
ACF attenuation gain	Aa			-18		0	dB
Consumption current in shutdown mode	I_{SD}	CTRL=V_{SS}			0	1	μA
Total Harmonic Distortion plus Noise	THD+N	P_O=1.0W, R_L=4Ω, f=1kHz			0.1		%
Output Noise	V_N	f=20Hz~20kHz, A weighted, Av=27.4dB			110		μV_{rms}
Output offset voltage	V_{OS}				±2		mV
Quiescent current	I_{BAT}				4		mA
Output Power	P_O	R_L=4Ω	V_{BAT}=4V, f=1kHz, THD+N=10%		7.3		W
		R_L=3Ω			10.7		
		R_L=2Ω+33uH			13.8		
		R_L=8Ω			4.5		
		R_L=4Ω	V_{BAT}=4V, f=1kHz, THD+N=1%		6.2		
		R_L=3Ω,			8.8		
		R_L=2Ω+33uH			11.3		
		R_L=8Ω			3.7		
Efficiency (Class D + Boost)	η	V_{BAT}=4.2V, R_L=4Ω+22uH, THD+N = 10%			77		%
		V_{BAT}=4.2V, R_L=3Ω+22uH, THD+N = 10%			70		%
		V_{BAT}=4.2V, R_L=2Ω+33uH, THD+N = 10%			63		%
		V_{BAT}=4.2V, R_L=8Ω+22uH, THD+N = 10%			82		%

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Class AB Channel [1] V_{SS}=0V, V_{BAT} =3.7V, C_{IN} = 1uF, Ta=25ºC, unless otherwise specified							
Output Power	P_O	R_L=4Ω, V_{BAT}=3.5V	f=1kHz, THD+N=10%		1.25		W
		R_L=4Ω, V_{BAT}=4V			1.7		W
		R_L=4Ω, V_{BAT}=5.0V			2.76		W
		R_L=4Ω, V_{BAT}=3.5V	f=1kHz, THD+N=1%		1.0		W
		R_L=4Ω, V_{BAT}=4V			1.36		W
		R_L=4Ω, V_{BAT}=5.0V			2.2		W
Total Harmonic Distortion plus Noise	THD+N	P_O=0.01W	R_L=4Ω, f=1kHz		0.2		%
		P_O=0.1W			0.15		%
Output Noise	V_N	f=20Hz~20kHz, A weighted, Av=21.4dB			60		μV_{rms}
Output offset voltage	V_{OS}				±2		mV
Efficiency	η	R_L=4Ω, THD+N = 10%			70		%
		R_L=3Ω, THD+N = 10%			66		%

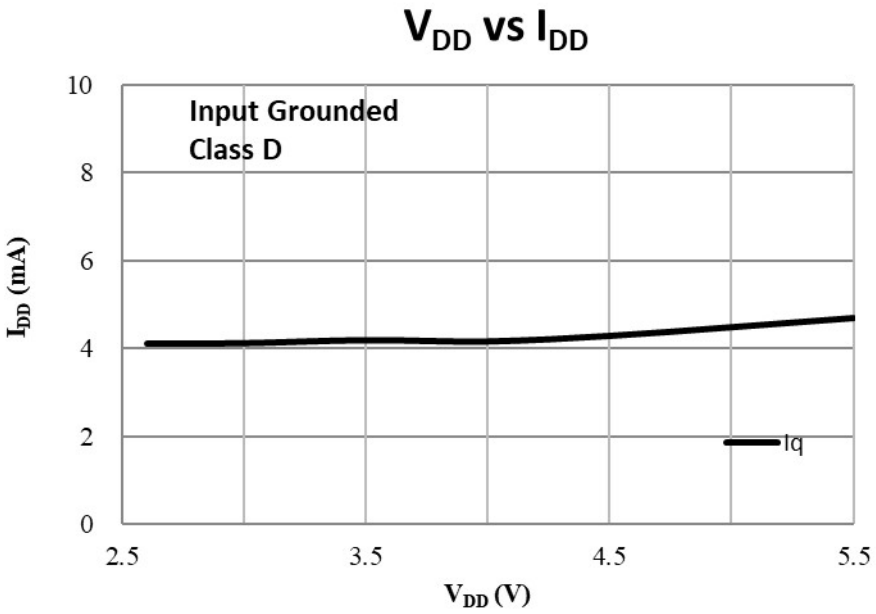
[1] In Class AB amplifier mode, boost converter is shutdown automatically. Due to the schottky rectifier, the voltage of PVDD terminal can be lower than VBAT, depending on the forward voltage of the rectifier V_F.

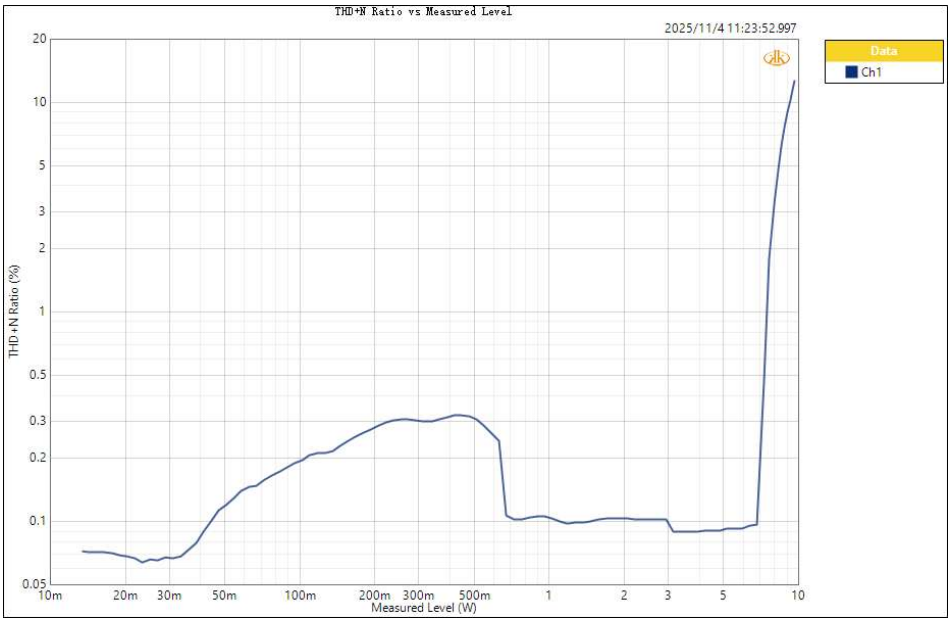
System Gain	Av_0	External R_{IN}=0Ω		21.4		dB
Quiescent current	I_{BAT}			9		mA
Start-up time (power-on, shutdown release, or switch between Class D and Class AB)	t_{STUP}			160		ms

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
CTRL Terminal Voltage						
ACF Off (Class D, Adaptive boost enabled) mode setting threshold voltage	V_{MOD1}		2.4		5	V
ACF ON (Class D, adaptive boost enabled) mode setting threshold voltage	V_{MOD2}		1.5		2.1	V
ACF Off (Class AB, boost disabled) mode setting threshold voltage	V_{MOD4}		0.9		1.3	V
SD mode setting threshold voltage	V_{MOD5}		0		0.2	V
SD wake up voltage	V_{CTRL_ON}		0.9			V

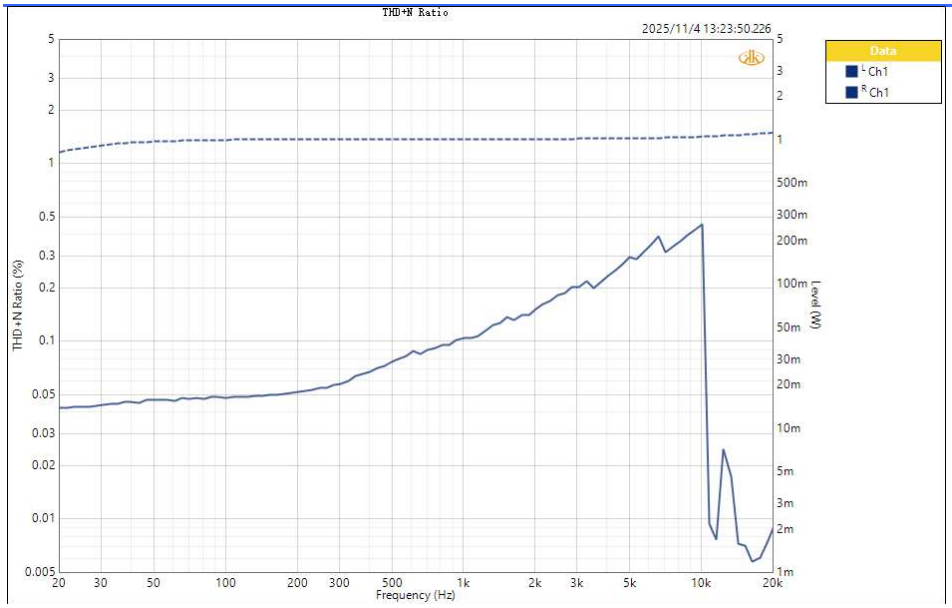
■ TYPICAL OPERATING CHARACTERISTICS

Class D, VBAT = 3.7V, f_{IN} = 1kHz, Load = 4ohm, unless otherwise specified.

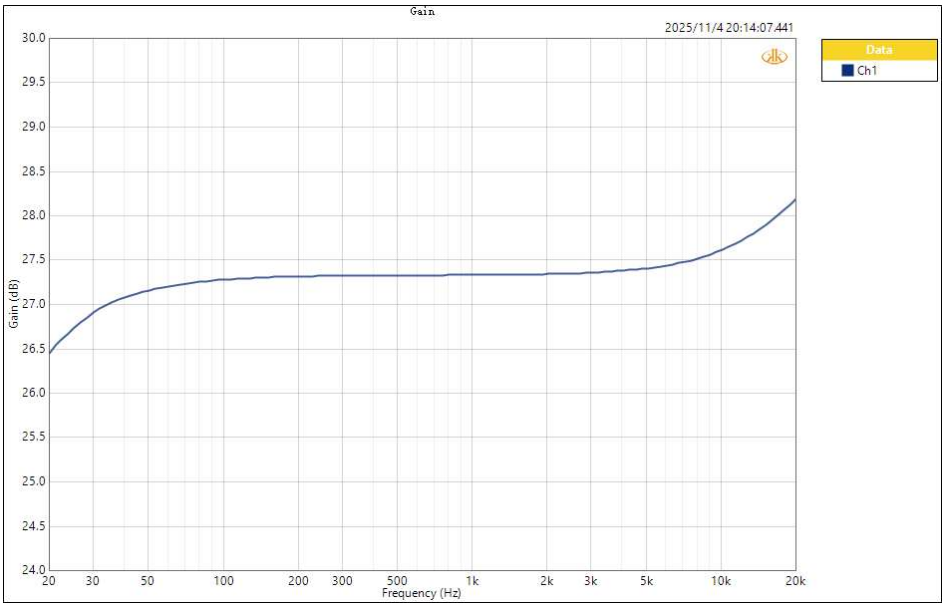




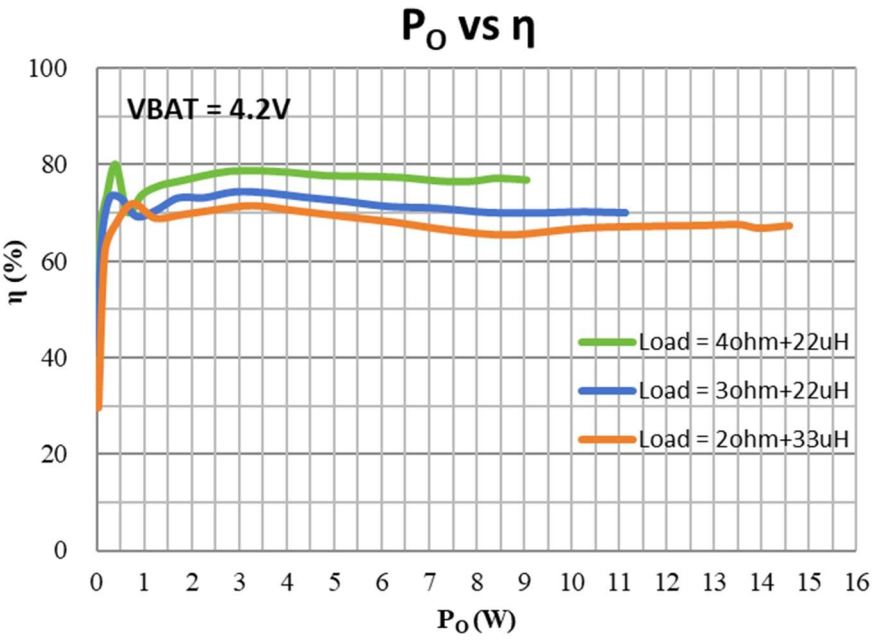
Output power vs THD+N, f = 1kHz



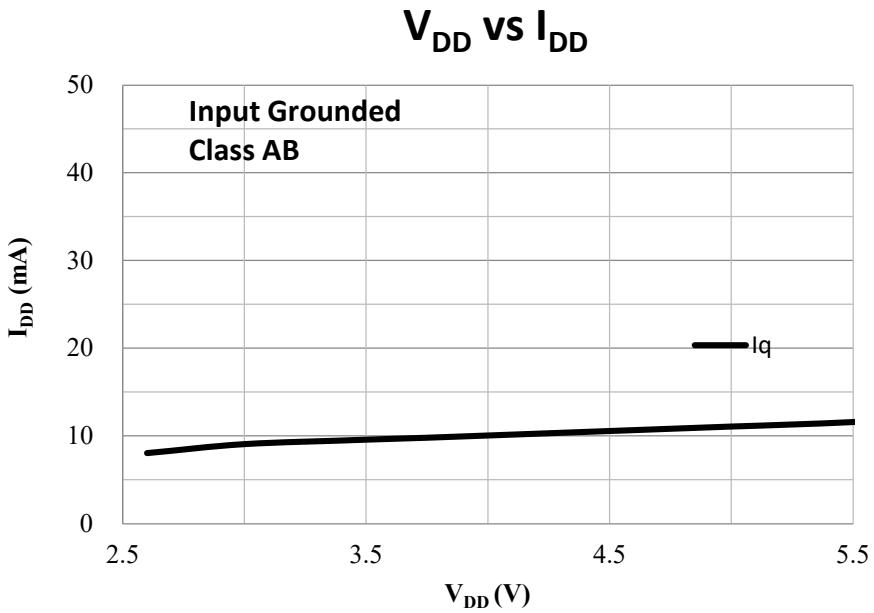
f_{IN} vs THD+N, Po ≈ 1W

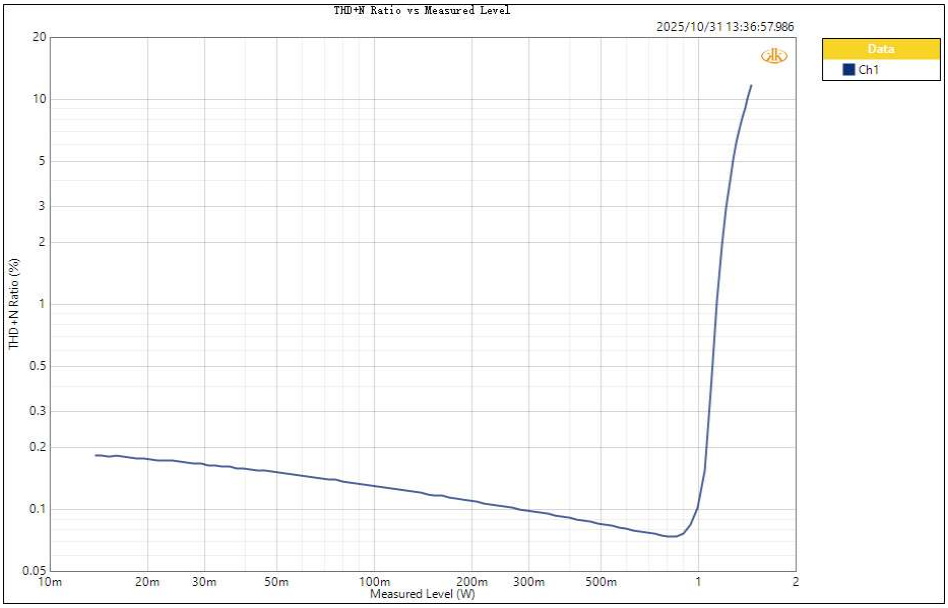


Frequency respond

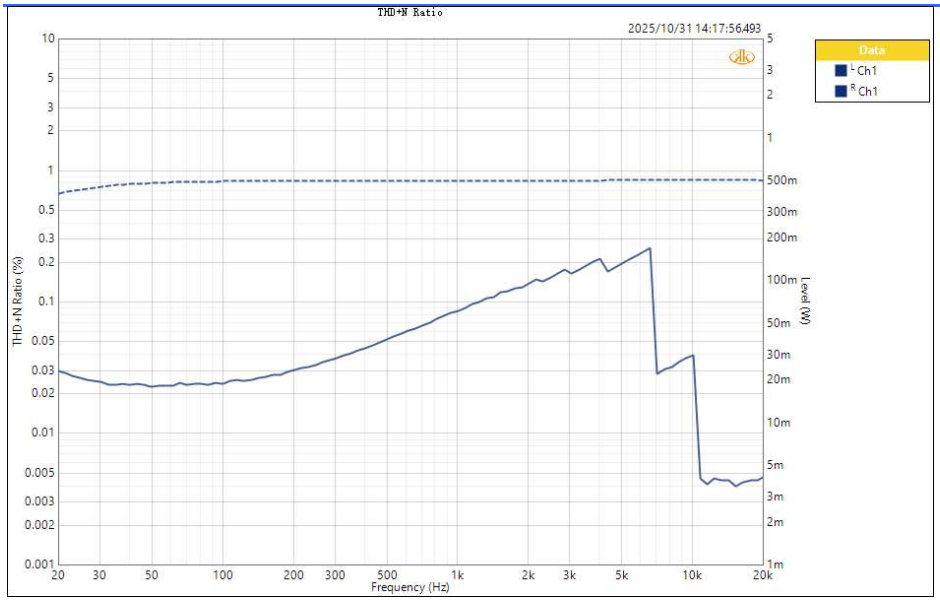

P_O vs η
VBAT = 4.2V
η (%)
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
P_O (W)
Load = 4ohm+22uH
Load = 3ohm+22uH
Load = 2ohm+33uH

Class AB, VBAT = 3.7V, f_{IN} = 1kHz, Load = 4ohm, unless otherwise specified.

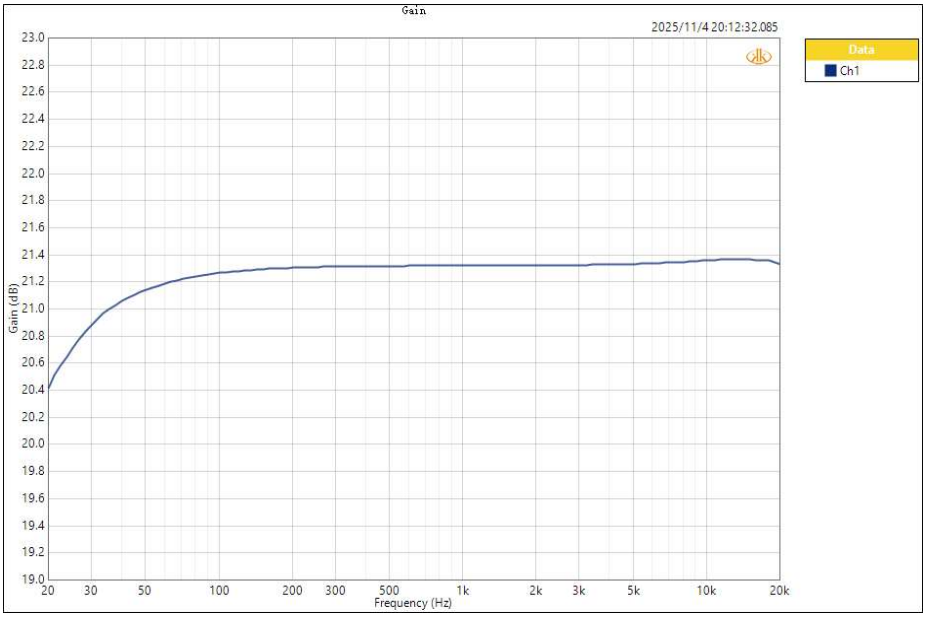




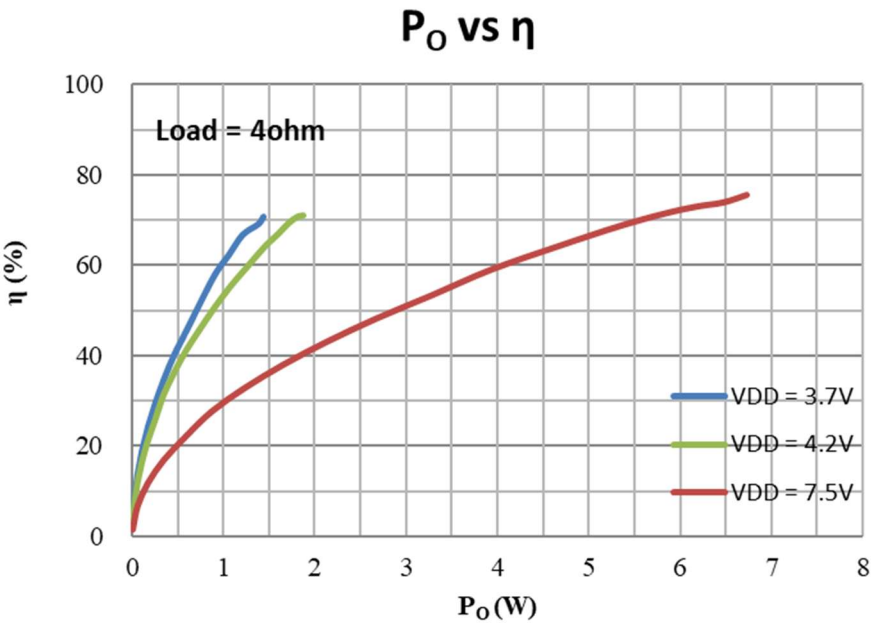
Output power vs THD+N, f = 1kHz



f_{IN} vs THD+N, Po ≈ 0.5W



Frequency respond

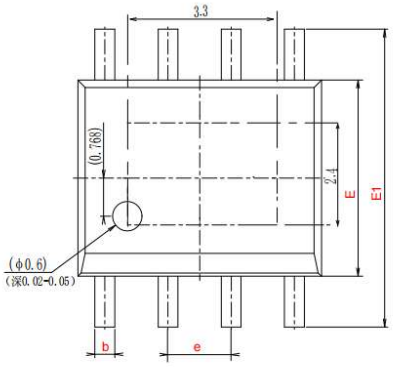

P_O vs η
Load = 4ohm
η (%)
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
P_O (W)
VDD = 3.7V
VDD = 4.2V
VDD = 7.5V

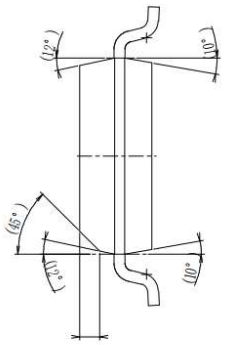
■ Revision History

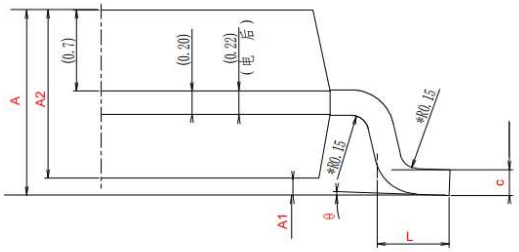
Date	Version	Revision Content
2025-11-7	V0.5	Preliminary version.

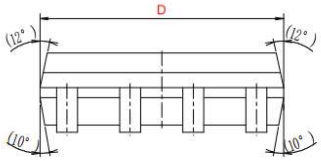
■ PACKAGE OUTLINE

SPE (ESOP8)



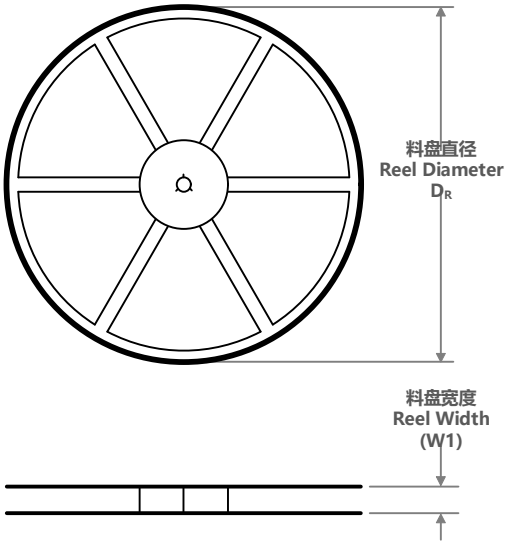


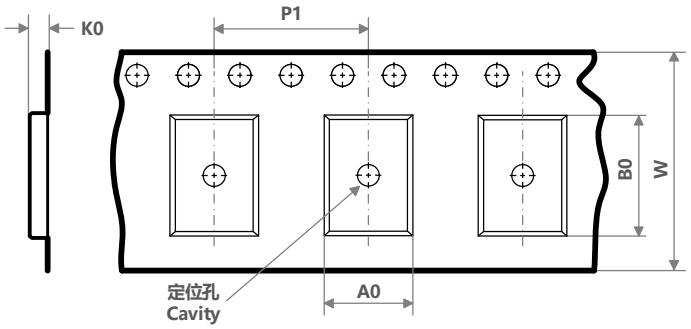




字符	Dimension millimeters		
	Min	Standard	Max
A	1.350	1.500	1.700
A1	0	0.050	0.150
A2	1.350	1.450	1.550
b	0.360	0.400	0.440
c	0.215	0.220	0.235
D	4.800	4.900	5.000
E	3.840	3.940	4.040
E1	5.900	6.000	6.100
e	1.27BSC		
L	0.400	0.550	0.700
Θ	0°		8°

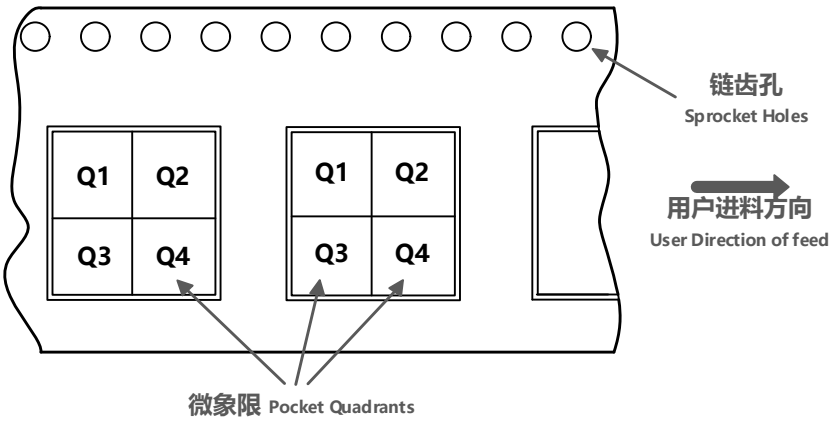
■ TAPE AND REEL INFORMATION





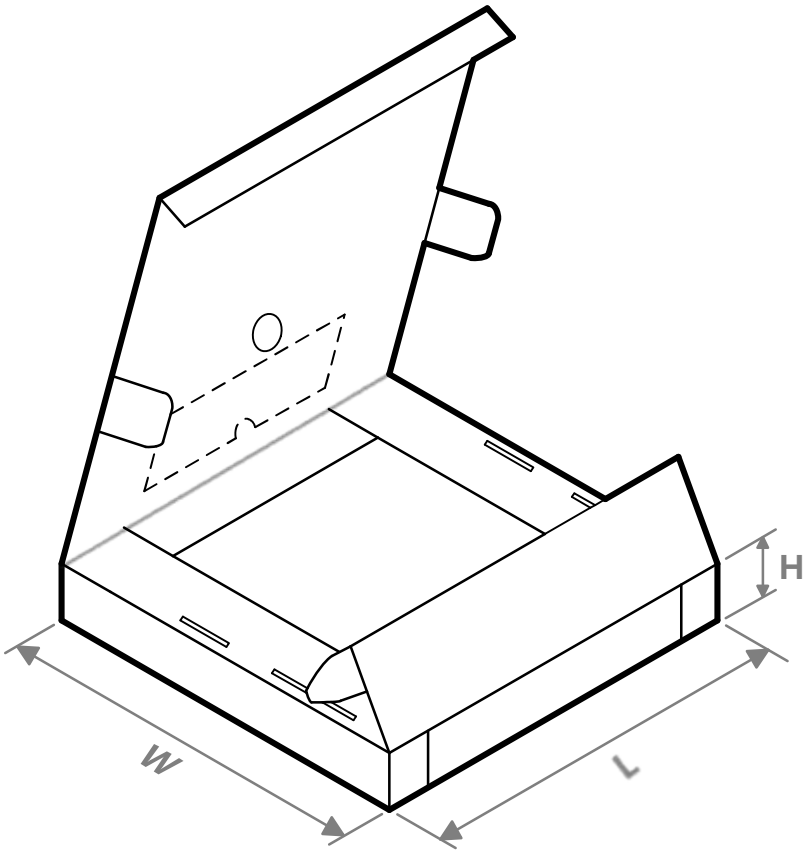
A0	Dimension designed to accommodate the component width; 料槽宽度
B0	Dimension designed to accommodate the component length; 料槽长度
K0	Dimension designed to accommodate the component thickness; 料槽厚度
W	Overall width of the carrier tape; 载带整体宽度
P1	Pitch between successive cavity centers; 相邻槽中心间距

编带 PIN1 方位象限分配
Quadrant Assignments for Pin1 Orientation in Tape



器件料号 Part No.	封装类型 Package Type	封装标识 Package Abbr.	引脚数 Pins	SPQ	料盘直径 D_R(mm)	料盘宽度 W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 象限 Quadrant
HTA8681SPER	ESOP	SPE	8	2500	330	12	6.65	5.55	1.95	8	12	Q1

■ TAPE AND REEL BOX INFORMATION



器件料号 Part No.	封装类型 Package Type	封装标识 Package Abbr.	引脚数 Pins	SPQ	长度 Length (mm)	宽度 Width (mm)	高度 Height (mm)
HTA8681SPER	ESOP	SPE	8	5000	360	345	65

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