

内置自适应H类升压和防破音功能的6W全频段D类及AB类音频功率放大器

6W in 20~20kHz full band Boosted Class D and Class AB Audio Amplifier

■ FEATURES

- Anti-Clipping Function (ACF)
 - Filter-less Modulation, Eliminating Output Filter
 - Output Power
- 6W ($V_{BAT}=3.3\sim 4.2V$, $R_L=4\Omega$, THD+N<1%, 20-20kHz full band)
- 3W ($V_{BAT}=3.3\sim 4.2V$, $R_L=8\Omega$, THD+N<1%, 20-20kHz full band)
- Power Supply V_{BAT} : 3.0V~5.5V
 - High Efficiency Class H Boost Converter
 - Multiple boost voltages automatically adjust Class D audio amplifier
 - 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, SSOP10L-PP, QFN3×3-16L
- 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
- 6W ($V_{BAT}=3.3\sim 4.2V$, $R_L=4\Omega$, THD+N<1%, 20-20kHz full band)
- 3W ($V_{BAT}=3.3\sim 4.2V$, $R_L=8\Omega$, THD+N<1%, 20-20kHz full band)
- V_{BAT} 供电范围: 3.0V至5.5V
 - 高效H类升压功能
 - 自适应功放功率的升压轨, 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, SSOP10L-PP, QFN3×3-16L

■ APPLICATIONS

- | | | | |
|----------------------------|---------------------|---------------|---------|
| • Bluetooth/Wi-Fi Speakers | • Portable Speakers | • 蓝牙/ Wi-Fi音箱 | • 便携式音箱 |
| • Smart speakers | • Smart Home | • 智能音箱 | • 智能家居 |

■ DESCRIPTION

HT8731, integrated with adaptive class H boost converter, is a mono Class D audio amplifier that drives up to continuous 6W (<1% THD+N, 20-20kHz full band) into 4ohm speaker from a Li-battery voltage. It also integrates Class AB amplifier.

The built-in Class H boost converter generates a Class D amplifier supply rail with a max voltage of 8.0V. The boost converter is automatically active only when a higher audio output power is required and will track the signal to provide an adaptive voltage supply to the amplifier, which will significantly improve the efficiency and extends the playing time in battery supply applications.

HT8731 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 supplies 2 different ACF mode with different audio experience, and also ACF OFF mode.

Class AB amplifier mode is also available for HT8731. Once the EMI Interference from class D and Boost Converter becomes an annoying problem, HT8731 can be changed into Class AB mode.

HT8731 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.

HT8731是一款内置自适应H类升压的单声道D类音频功率放大器，由锂电池供电时，THD+N<1%、20-20kHz全频段信号条件下，能连续输出6W功率（4Ω负载）；另外，其还支持AB类模式。

HT8731内置的H类升压，提供8.0V最大输出电压。其小音乐信号时不升压，仅当功率较大时，提供一个适应输出功率的电压给D类功放，其可大幅提高系统效率，延长电池续航时间。

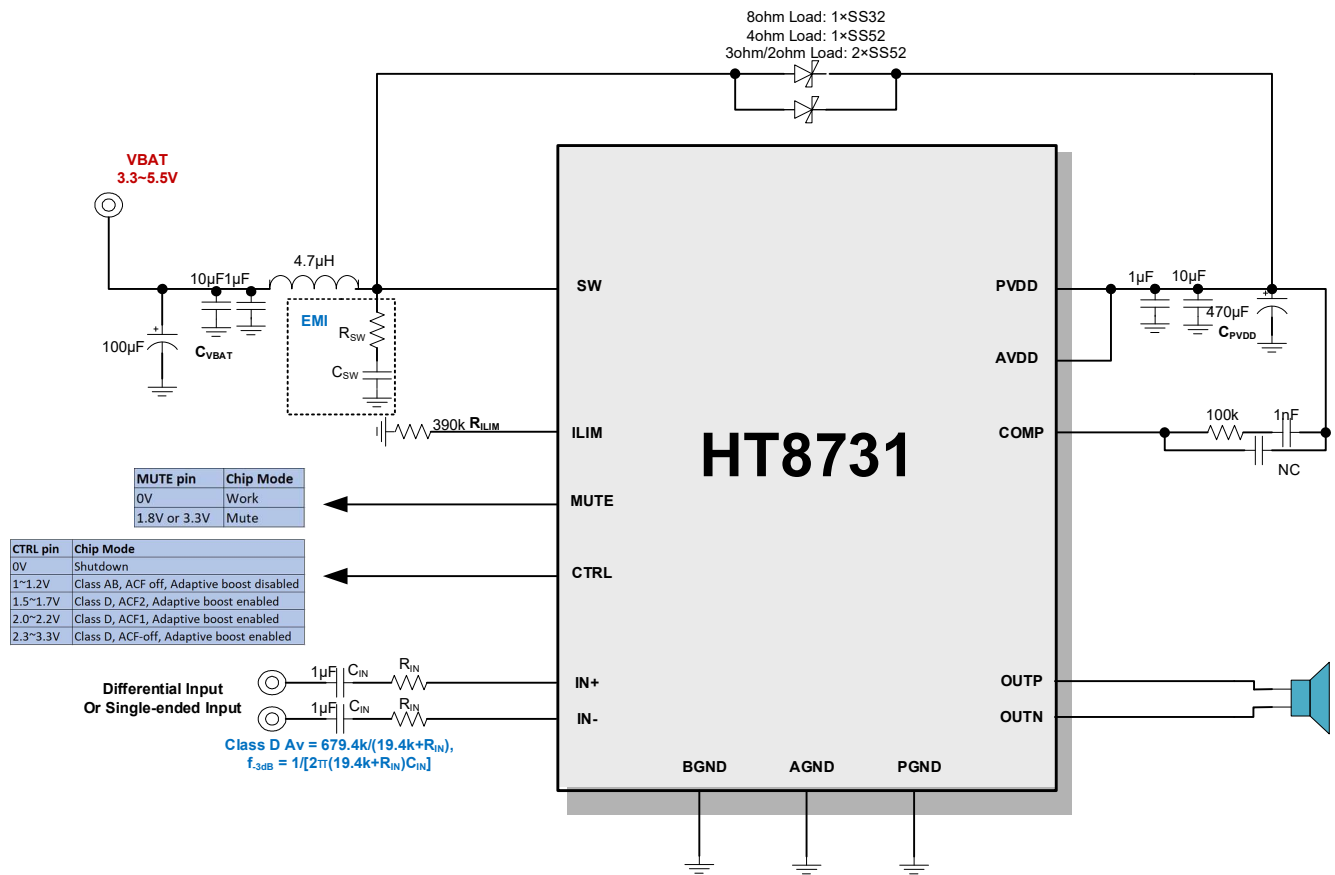
HT8731的最大特点是防削顶失真（ACF）输出控制功能，可检测并抑制由于输入音乐、语音信号幅度过大所引起的输出信号削顶失真（破音），也能自适应地防止在BOOST升压电压下降所造成的输出削顶，显著提高音质，创造非常舒适的听音享受，并保护扬声器免受过载损坏。HT8731提供两种不同音乐体验的ACF模式，以及ACF-Off 模式。

HT8731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。

HT8731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。

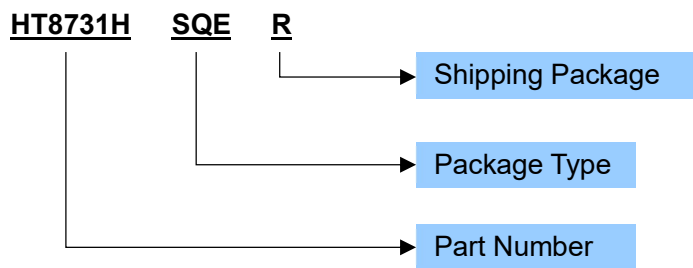
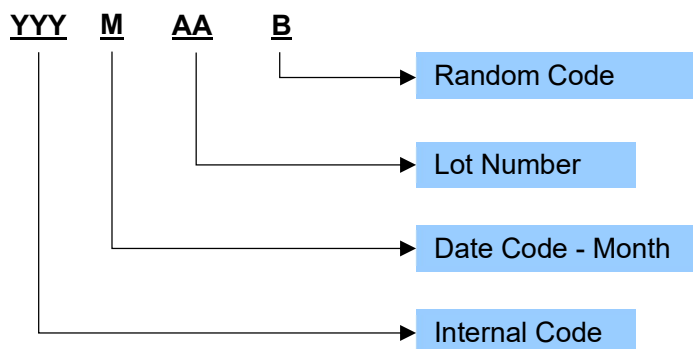
此外，HT8731集成了输出端过流保护、片内过温保护等功能。

■ TYPICAL APPLICATION

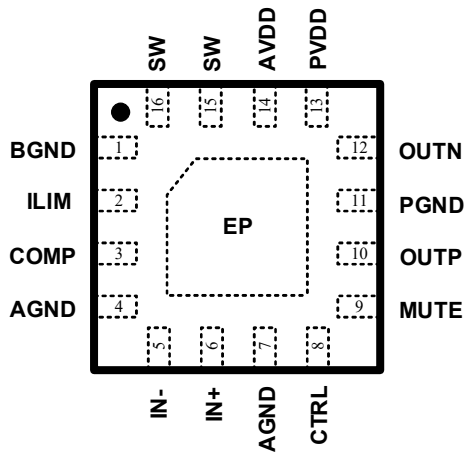


ORDERING INFORMATION

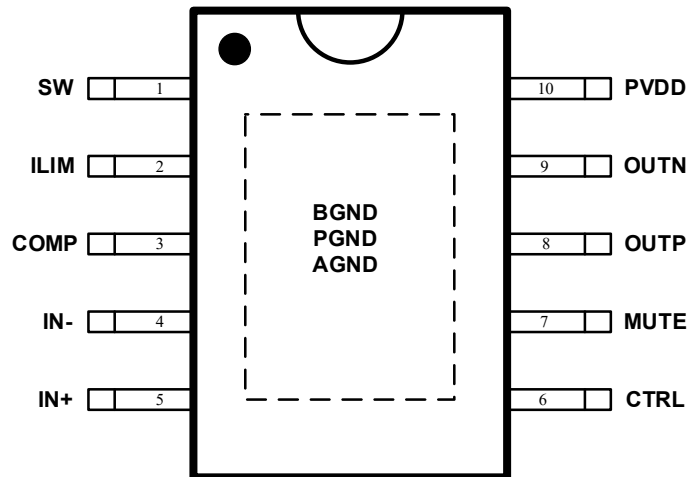
Ordering Number	Package Type	Marking	Operating Temperature Range	Shipping Package / MOQ
HT8731HSQER	QFN3×3-16L(SQE)	HT8731HsQ YYMAAB ¹	-40℃～85℃	Tape and Reel (R) / 5000pcs
HT8731SPER	SSOP10L-PP(SPE)	HT8731 ^{SPE} YYMAAB	-40℃～85℃	Tape and Reel (R) / 2500pcs
HT8731SPET	SSOP10L-PP(SPE)	HT8731 ^{SPE} YYMAAB	-40℃～85℃	Tube (T) / 100pcs

Ordering Number

Production Tracking Code

¹ YYMAAB is production tracking code

■ TERMINAL CONFIGURATION



QFN3x3-16L(SQE) Top View



SSOP10L-PP(SPE) Top View

■ TERMINAL FUNCTION

Terminal No.		Name	I/O ¹	Description
SQE	SPE			
1	EP	BGND	G	Ground for boost converter circuitry. 升压电路地
4, 7		AGND	G	Ground for analog circuitry. 模拟电路地
11		PGND	G	Ground for power circuitry. 功率电路地
2	2	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。
3	3	COMP	O	Output of the internal error amplifier, the loop compensation network should be connected between this pin and the AGND pin. 环路补偿脚，接补偿电路到地。
5	4	IN-	I	Negative input (differential-) for audio amplifier. 输入正端
6	5	IN+	I	Positive input (differential+) for audio amplifier. 输入负端
8	6	CTRL	I	Mode Control Terminal. 模式控制脚
9	7	MUTE	I	MUTE control set. The audio amplifier is muted when it is pulled high. 静音控制，拉高时芯片静音
10	8	OUTP	O	Positive pin for differential speaker amplifier. 输出正端
12	9	OUTN	O	Negative pin for differential speaker amplifier. 输出负端
13	10	PVDD	P	Power Supply for internal power circuitry. 功率电源
14	/	AVDD	P	Power supply for internal analog circuitry. 模拟电源端
15, 16	1	SW	I	Boost and rectifying switch input. 升压整流开关输入端
EP	/	/	/	A matching ground pad should be provided on the PCB and the device connected to it via solder. 接地，增加散热。

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

■ SPECIFICATIONS¹

● Absolute Maximum Ratings²

Item	Symbol	Min.	Max.	Unit
Supply voltage range	V _{BAT}	-0.3	5.5	V
Input terminal voltage range	V _{IN}	-0.3	PVDD + 0.3	V
Operating Ambient Temperature	T _A	-40	85	°C
Junction Temperature	T _J	-40	150	°C
Storage Temperature	T _{STG}	-50	150	°C

● Recommended Operating Condition

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage range	V _{BAT}		3.0		5.5	V
Operating Ambient Temperature	T _a		-40	25	85	°C
High-level input voltage	V _{IH}		1.5			V
Low-level input voltage	V _{IL}				0.3	V
Speaker Impedance	R _L		2	4		Ω

● Electrical Specification³

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
BOOST Converter						
Maximum Boost converter output voltage	PVDD			8.0		V
Boost converter frequency	f _{SW}			360		kHz
Boost on threshold voltage	V _{B_TH1}	Amplifier Output V _P		2.2		V _p
	V _{B_TH2}	Amplifier Output V _P		4.7		V _p
	V _{B_TH3}	Amplifier Output V _P		5.4		V _p
Boost shut off time	t _{BOOST_OFF}			208		ms

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 $V_{SS}=0V$, $V_{BAT}=3.7V$, $R_{IN}=15k\Omega$, $T_a=25^\circ C$, $C_{IN}=1\mu F$, ACF-Off mode, unless otherwise specified						
Carrier clock frequency	f_{PWM}			360		kHz
Over current protection	I_{max}				6	A
System Gain	A_v	External $R_{IN}=0\Omega$		30		dB
Start-up time (power-on or shutdown release)	t_{STUP}			110		ms
ACF attenuation gain	A_a		-16		0	dB
Consumption current in shutdown mode	I_{SD}	$CTRL=V_{SS}$		1		μA
Total Harmonic Distortion plus Noise	THD+N	$P_O=1.0W$, $R_L=4\Omega$, $f=1kHz$		0.02		%
Output Noise	V_N	$f=20Hz\sim 20kHz$, A weighted, $A_v=26dB$		130		μV_{rms}
Output offset voltage	V_{OS}			± 2		mV
Quiescent current	I_{BAT}			15		mA
		Mute		1.7		mA
Output Power	P_O	$R_L=4\Omega$	$V_{BAT}=3.7V$, $f=1kHz$, THD+N=10%		7.6	W
		$R_L=3\Omega$			9	
		$R_L=2\Omega+33\mu H$			11	
		$R_L=8\Omega$			4	
		$R_L=4\Omega$	$V_{BAT}=3.7V$, $f=1kHz$, THD+N=1%		6.2	W
		$R_L=3\Omega$			7.5	
		$R_L=2\Omega+33\mu H$			8.5	
		$R_L=8\Omega$			3.3	
		$R_L=4\Omega$	THD+N<1%, 20-20kHz full band		6	W
		$R_L=8\Omega$			3	W
Efficiency (Class D + Boost)	η	$V_{BAT}=4.2V$, $R_L=4\Omega$, THD+N = 10%		74		%
		$V_{BAT}=4.2V$, $R_L=3\Omega$, THD+N = 10%		70		%
		$V_{BAT}=4.2V$, $R_L=2\Omega+33\mu H$, THD+N = 10%		66		%
		$V_{BAT}=4.2V$, $R_L=8\Omega$, THD+N = 10%		78		%

Class AB Channel ¹ $V_{SS}=0V$, $V_{BAT}=3.6V$, $C_{IN}=1\mu F$, $R_{IN}=15\Omega$, $T_a=25^\circ C$, unless otherwise specified						
Output Power	P_O	$R_L=4\Omega$, $V_{BAT}=3.6V$	$f=1kHz$, THD+N=10%		1.3	W
		$R_L=4\Omega$, $V_{BAT}=4.2V$			1.8	W
		$R_L=4\Omega$, $V_{BAT}=5.0V$			2.65	W
		$R_L=4\Omega$, $V_{BAT}=3.6V$	$f=1kHz$, THD+N=1%		1.0	W
		$R_L=4\Omega$, $V_{BAT}=4.2V$			1.5	W
		$R_L=4\Omega$, $V_{BAT}=5.0V$			2.1	W
Total Harmonic Distortion plus Noise	THD+N	$P_O=0.01W$	$R_L=4\Omega$, $f=1kHz$		0.2	%
		$P_O=0.1W$			0.1	%
Output Noise	V_N	$f=20Hz\sim 20kHz$, A weighted, $A_v=22dB$		70		μV_{rms}
Output offset voltage	V_{OS}			± 1		mV

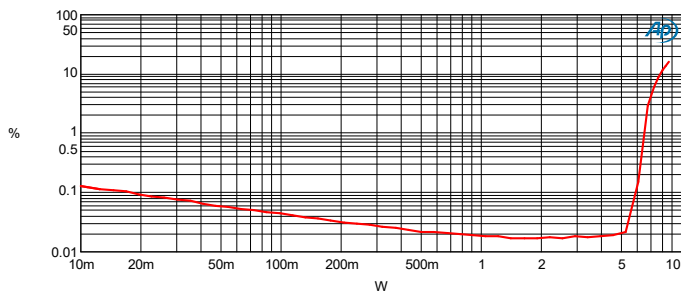
¹ In Class AB amplifier mode, boost converter is shutdown automatically. Due to the schottky rectifier, the voltage of PVDD terminal can be lower than VBAT, depending on the forward voltage of the rectifier V_F .

Efficiency	η	$R_L=4\Omega+22\mu H$, THD+N = 10%		70		%
		$R_L=8\Omega+33\mu H$, THD+N = 10%		74.5		%
System Gain	A_{V0}	External $R_{IN}=0\Omega$		22		dB
Quiescent current	I_{BAT}			8		mA
		Mute		1.5		mA
Start-up time (power-on, shutdown release, or switch between Class D and Class AB)	t_{STUP}			110		ms

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
CTRL Terminal Voltage						
ACF Off (Class D, Adaptive boost enabled) mode setting threshold voltage	V_{MOD1}		2.3		5	V
ACF-1 (Class D, adaptive boost enabled) mode setting threshold voltage	V_{MOD2}		2.0		2.2	V
ACF-2 (Class D, adaptive boost enabled) mode setting threshold voltage	V_{MOD3}		1.5		1.7	V
ACF Off (Class AB, boost disabled) mode setting threshold voltage	V_{MOD4}		1.0		1.2	V
SD mode setting threshold voltage	V_{MOD5}		0		0.3	V
SD wake up voltage	V_{CTRL_ON}		1.0			V
Internal pull-down Resistor of CTRL	R_{CTRL}			210		K Ω
MUTE Terminal Voltage						
High-level input voltage	V_{IH}		1.5			V
Low-level input voltage	V_{IL}				0.3	V
Internal pull-down Resistor of MUTE	R_{MUTE}			300		K Ω

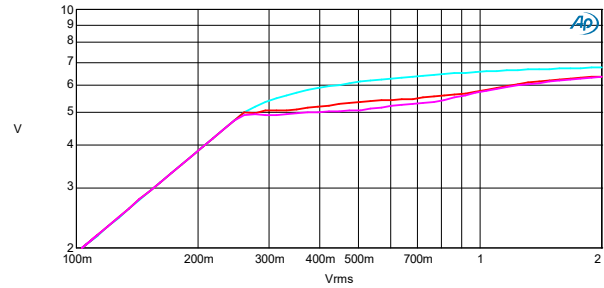
TYPICAL OPERATING CHARACTERISTICS

Class D, VBAT = 4.0V, f_{IN} = 1kHz, Load = 4ohm, unless otherwise specified.



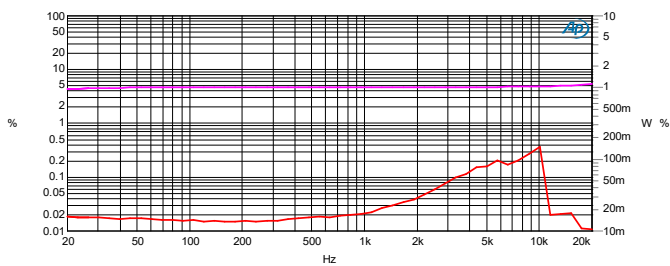
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:THD+N Ratio A	Left	RL = 4ohm, f = 1k

Po vs THD+N.ats2



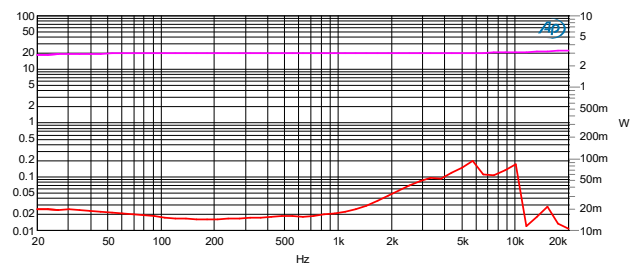
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	2	Analyzer:Level A	Left	ACF OFF
2	1	Red	Solid	2	Analyzer:Level A	Left	ACF1
3	1	Magenta	Solid	2	Analyzer:Level A	Left	ACF2

VIN vs VOUT.ats2



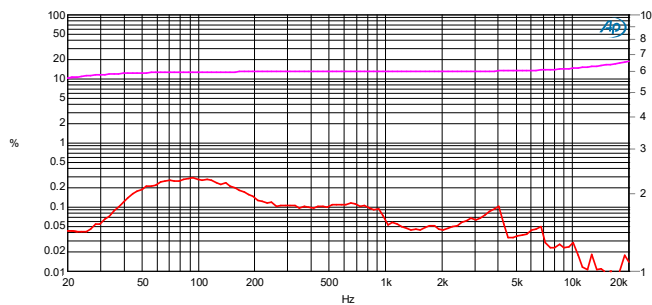
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:THD+N Ratio A	Left	Po = 1W, RL = 4ohm
1	2	Magenta	Solid	2	Analyzer:Level A	Right	Po = 1W, RL = 4ohm

f vs THD+N.ats2



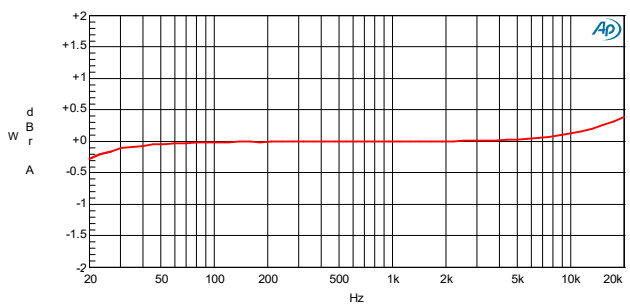
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:THD+N Ratio A	Left	Po = 3W, RL = 4ohm
1	2	Magenta	Solid	2	Analyzer:Level A	Right	Po = 3W, RL = 4ohm

f vs THD+N.ats2



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:THD+N Ratio A	Left	Vbat=4V, RL=4ohm, Po=6W
1	2	Magenta	Solid	2	Analyzer:Level A	Right	Vbat=4V, RL=4ohm, Po=6W

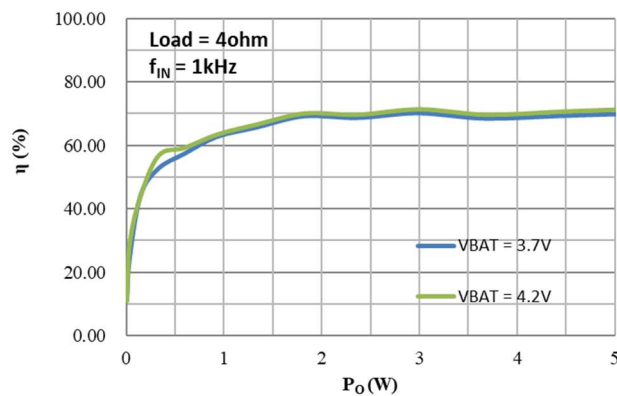
f vs THD+N.ats2



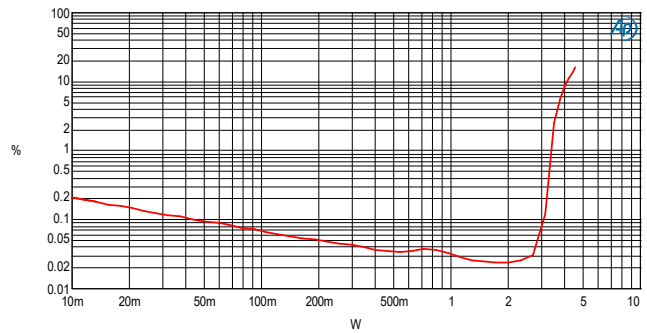
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:Level A	Left	

Frequency Respond.ats2

P_O vs η

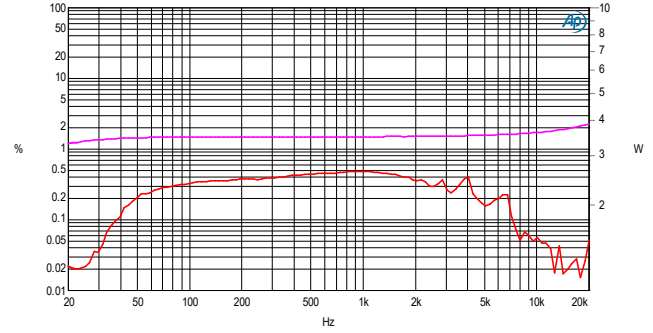


Class D, VBAT = 4.0V, f_{IN} = 1kHz, Load = 8ohm, unless otherwise specified.



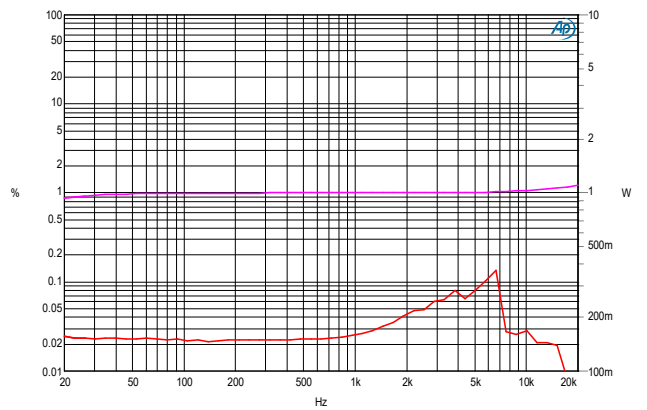
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer.THD+N Ratio A	Left	Vbat=4V, f=1kHz, RL=8ohm

Po vs THD+N.ats2



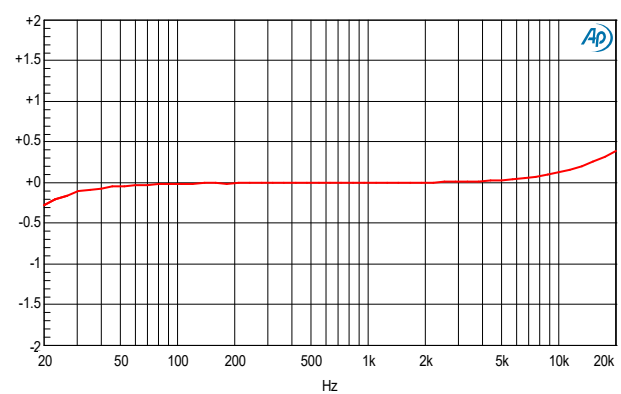
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer.THD+N Ratio A	Left	Vbat=4V, RL=8ohm, Po=3.5W
1	2	Magenta	Solid	2	Analyzer.Level A	Right	Vbat=4V, RL=8ohm, Po=3.5W

f vs THD+N.ats2



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer.THD+N Ratio A	Left	Vbat=4V, RL=8ohm, Po=1W
1	2	Magenta	Solid	2	Analyzer.Level A	Right	Vbat=4V, RL=8ohm, Po=1W

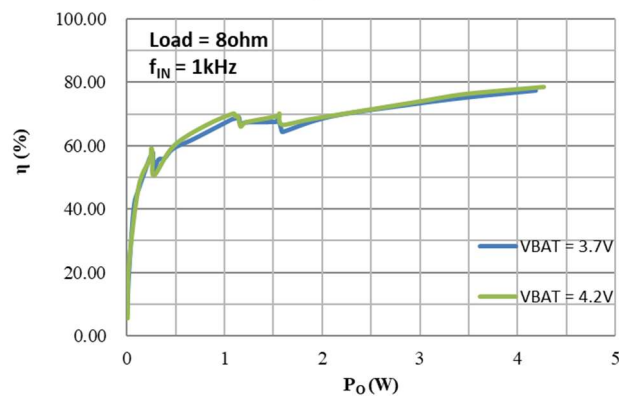
f vs THD+N.ats2



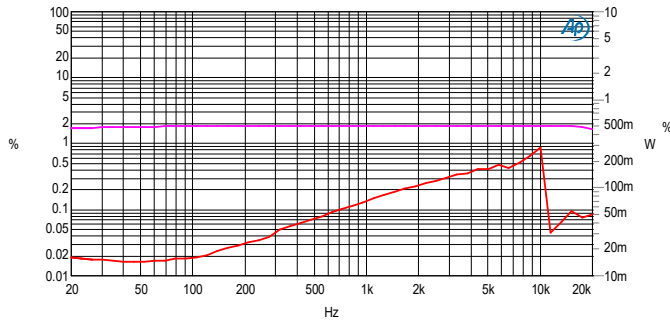
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer.Level A	Left	

Frequency Respond.ats2

P_O vs η

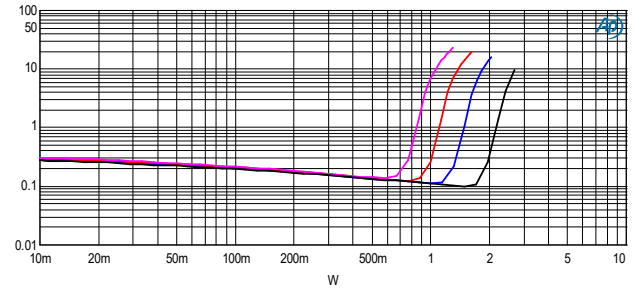


Class AB, VBAT = 4.0V, $f_{IN} = 1\text{kHz}$, Load = 4ohm, unless otherwise specified



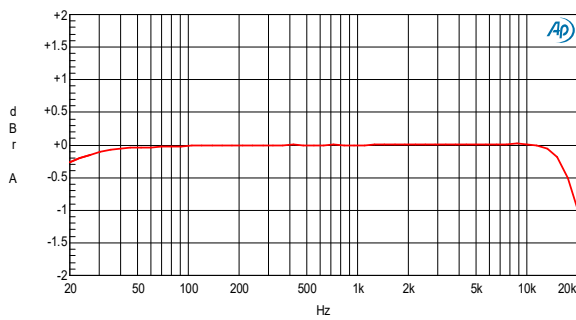
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:THD+N Ratio A	Left	Po=0.5W, RL=4ohm
1	2	Magenta	Solid	2	Analyzer:Level A	Right	Po=0.5W, RL=4ohm

f vs THD+N.ats2



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Black	Solid	2	Analyzer:THD+N Ratio A	Left	f=1kHz, Vbat=5.0V, RL=4ohm
2	1	Blue	Solid	2	Analyzer:THD+N Ratio A	Left	f=1kHz, Vbat=4.2V, RL=4ohm
3	1	Red	Solid	2	Analyzer:THD+N Ratio A	Left	f=1kHz, Vbat=3.7V, RL=4ohm
4	1	Magenta	Solid	2	Analyzer:THD+N Ratio A	Left	f=1kHz, Vbat=3.3V, RL=4ohm

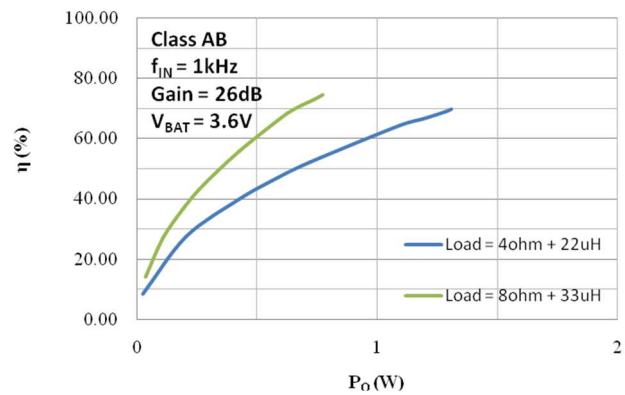
Po vs THD+N.ats2



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Analyzer:Level A	Left	Po = 1W, RL = 4ohm

Frequency Respond.ats2

P_O vs η



APPLICATION INFORMATION

1 Adaptive Boost Converter

The HT8731 consists of an adaptive Class H boost converter and an audio amplifier. The boost converter takes the supply voltage, VBAT, and increases it to a higher output voltage to drives the audio amplifier. This improves loudness over non-boosted solutions. An external inductor and diode should be added for the boost converter.

The boost converter is adaptive and activates automatically depending on the output audio signal amplitude. When the output audio signal exceeds a preset voltage threshold (Boost on Threshold Voltage V_{B_TH}), the boost converter is enabled, and the output voltage of boost converter is the preset voltage. When the audio output voltage is lower than the threshold voltage, the boost deactivates automatically.

To avoid an accidental large peak current, an internal cycle-by-cycle current limit is adopted. The low-side switch is turned off immediately as soon as the switch current touches the limit (ILIM). The peak switch current limit can be set by a resistor (RILIM) at the ILIM pin to ground.

Component selection for the boost converter in Some typical applications are detailed as follows.

HT8731 包含一个自适应 H 类升压和一个功放。其中自适应升压电路将输入的电池电压 VBAT 升压至更高的电压，以提供给功放。该方法可提升功放的输出功率。该自适应升压需要外部放置电感和二极管。

HT8731 集成的升压模块具有自适应多段升压功能，即只有当输出信号大于升压阈值 V_{B_TH} 时，HT8731 才会进入对应的升压模式，该功能能增加系统整体效率，在播放音乐时大大提高锂电池续航时间。

在 ILIM 脚外接电阻到地，可设置升压的输入最大峰值电流。

升压电路的相关典型参数如下表。

Table 1 Component Selection for Boost Converter with One Cell Battery Power Supply

Speaker Resistance	Input capacitor	Output Capacitor	Inductor (Inductance, I_{SAT})	Schottky Diode	R _{ILIM}
8Ω	1uF//10uF//10uF	1uF//10uF//100uF	4.7~6.8uH, 2.5A	SS32	510k
4Ω	1uF//10uF//10uF	1uF//10uF//470uF	4.7~6.8uH, 4.5A	1×SS52	390k
3Ω	1uF//10uF//220uF	1uF//10uF//470uF	4.7~6.8uH, 6.5A	2×SS52	270k
2Ω	1uF//10uF//220uF	1uF//10uF//470uF	4.7~6.8uH, 9A	2×SS52	270k

The HT8731 requires external compensation for the stability of boost converter. The COMP pin is the output of the internal error amplifier. An external resistor 100k in serial with a ceramic capacitor 1nF connected from the COMP pin to GND can be applied in most cases.

Adding an RC snubber across the SW pin and the power ground can help reduce the radiation EMI levels. The RC snubber should be placed as close as possible to the switching node and the power ground.

HT8731 升压需要外部补偿电路以维持升压稳定性。对于大多数应用，COMP 外部需要接电阻 100k 串联 1nF 电容到地。

SW 端加 RC 到地，可有效减少辐射干扰，RC 电路需尽可能靠近 SW 和 GND。

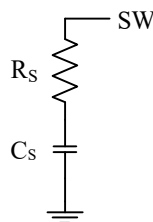


Figure 1 Placement of RC Snubber

2 Analog Signal Input Configuration

HT8731 is an amplifier with analog input (single-ended or differential).

For a differential operation, input signals into IN+ and IN- pins via DC-cut capacitors (C_{IN}) and external input resistors R_{IN} . The input signal gain is calculated by . And the high pass cut-off frequency of input signal can be calculated by

$$A_v \approx \frac{R_F}{\text{External } R_{IN} + \text{Internal } R_{IN}}, R_F = 679.4k, R_{IN} = 19.4k \text{ in Class D mode. } R_F = 433.2k, R_{IN} = 19.4k \text{ In Class AB mode. And the high pass cut-off frequency of input signal can be calculated by } f_c = \frac{1}{2\pi(\text{External } R_{IN} + \text{Internal } R_{IN}) \times C_{IN}}.$$

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

HT8731 接受模拟差分或单端音频信号输入，产生 PWM 脉冲输出信号（D 类模式）或音频信号（AB 类模式）驱动扬声器。

对差分输入，通过隔直电容 C_{IN} 和输入电阻 R_{IN} 分别输入到 IN+ 和 IN- 端。系统增益 $A_v \approx \frac{R_F}{\text{External } R_{IN} + \text{Internal } R_{IN}}$ ，D 类模式下， $R_F = 679.4k$ ， $R_{IN} = 19.4k$ ，AB 类模式下 $R_F = 433.2k$ ， $R_{IN} = 19.4k$ 。高通滤波器截止频率为 $f_c = \frac{1}{2\pi(\text{External } R_{IN} + \text{Internal } R_{IN}) \times C_{IN}}$ 。

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

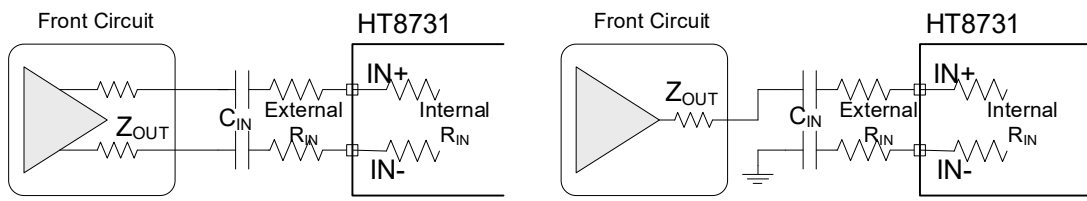


Figure 2 (1) Differential Input;

(2) Single-ended Input

3 Output Configuration

As mentioned, HT8731 can directly drive speakers without any other components. But there are exceptions. Once HT8731 works in class D mode, the cable lined to the speaker is very long, and EMI is concerned, ferrite beads or L-C filter is needed.

一般而言，输出端可直接连接负载喇叭。如果输出端的输出线较长，或者对 EMI 的要求较高，则可选择添置铁氧体磁珠或 LC 滤波器。

4 CTRL Terminal Device Functional Modes

HT8731 can work in different modes by setting the CTRL terminal, shown as follow.

HT8731 在 CTRL 端输入不同电压值，能实现 4 种工作模式，详见下表。

Table 2 Component Selection for Boost Converter with One Cell Battery Power Supply

Mode	CTRL Voltage		
	MIN	TYP	MAX
Class D mode in ACF-Off with adaptive Boost Converter enabled	2.5V	3.3V	5V
Class D mode in ACF1 with adaptive Boost Converter enabled	2.0V	2.1V	2.2V
Class D mode in ACF2 with adaptive Boost Converter enabled	1.5V	1.6V	1.7V
Class AB mode in ACF-Off with adaptive Boost Converter disabled	1.0V	1.2V	1.3V
SD(Shutdown) Mode	0V	0.3V	0.4V

4.1 Anti-Clipping Function (ACF)

In ACF modes (ACF1 or ACF2), HT8731 attenuates system gain to an appropriate value when an excessive input is applied, so as not to cause the clipping at the differential signal output. In this way, the output audio signal is controlled in order to obtain a maximum output level without distortion. And HT8731 also follows to the clips of the output waveform due to the decrease in the power-supply voltage.

The Attack time of ACF Function is a time interval until system gain falls to target attenuation gain -3dB when a big enough signal input. And, the Release Time is a time from target attenuation gain to not working of ACF. The maximum attenuation gain is 16dB.

在 ACF 模式（ACF1 或者 ACF2）下，当电路检测到输入信号幅度过大而产生输出削顶时，HT8731 通过自动调整系统增益，控制输出达到一种最大限度的无削顶失真功率水平，由此大大改善了音质效果。此外，当电源电压下降时，HT8731 也能自动衰减输出增益，实现与 PVDD 下降值相匹配的最大限度无削顶输出水平。

ACF 模式下的启动时间（Attack time）指在突然输入足够大信号而产生输出削顶的条件下，ACF 启动对放大器的增益调整速率，以 ms/dB 为单位；释放时间（Release time）指产生削顶的输入条件消失，增益退出衰减状态的速率，以 ms/dB 为单位。HT8731 的最大衰减增益为 16dB。

Table 3 Attack time and Release time

ACF mode	Attack time	Release time
ACF-1	50ms	64ms
ACF-2	2.5ms	1200ms

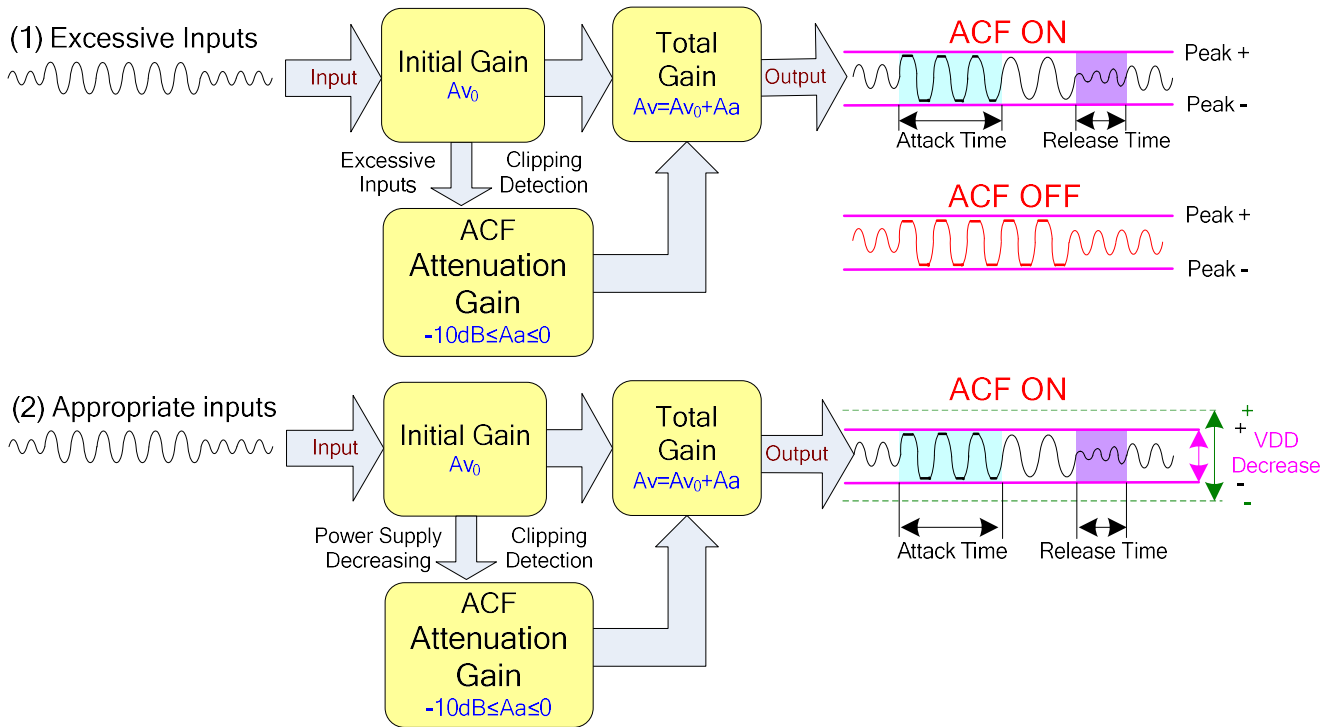


Table 4 the ACF Function Operation Outline

4.2 SD Mode

In shutdown mode, HT8731 shuts all circuit down and minimizes the power consumption. And, the output terminals become Weak Low (A high resistance grounded state)

在关断模式（低功耗待机）下，芯片关闭所有功能并将功耗降低到最小，输出端为弱低电平状态（内部通过电阻接地）。

5 MUTE Terminal Setting

HT8731 can work in mute mode by setting MUTE terminal as high. Otherwise, the mute terminal can be floating or connected to GND, HT8731 goes into normal operation.

MUTE 脚拉高时，HT8731 进入静音状态。MUTE 脚悬空或接地时，HT8731 进入正常工作状态。

6 Protection Function

HT8731 has the protection functions such as Over-Current Protection function and Thermal Protection function.

HT8731 具有以下几种保护功能：输出端过流保护、片内过温保护、电源欠压异常保护。

(1) Over-current Protection function

(1) 过流保护

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.

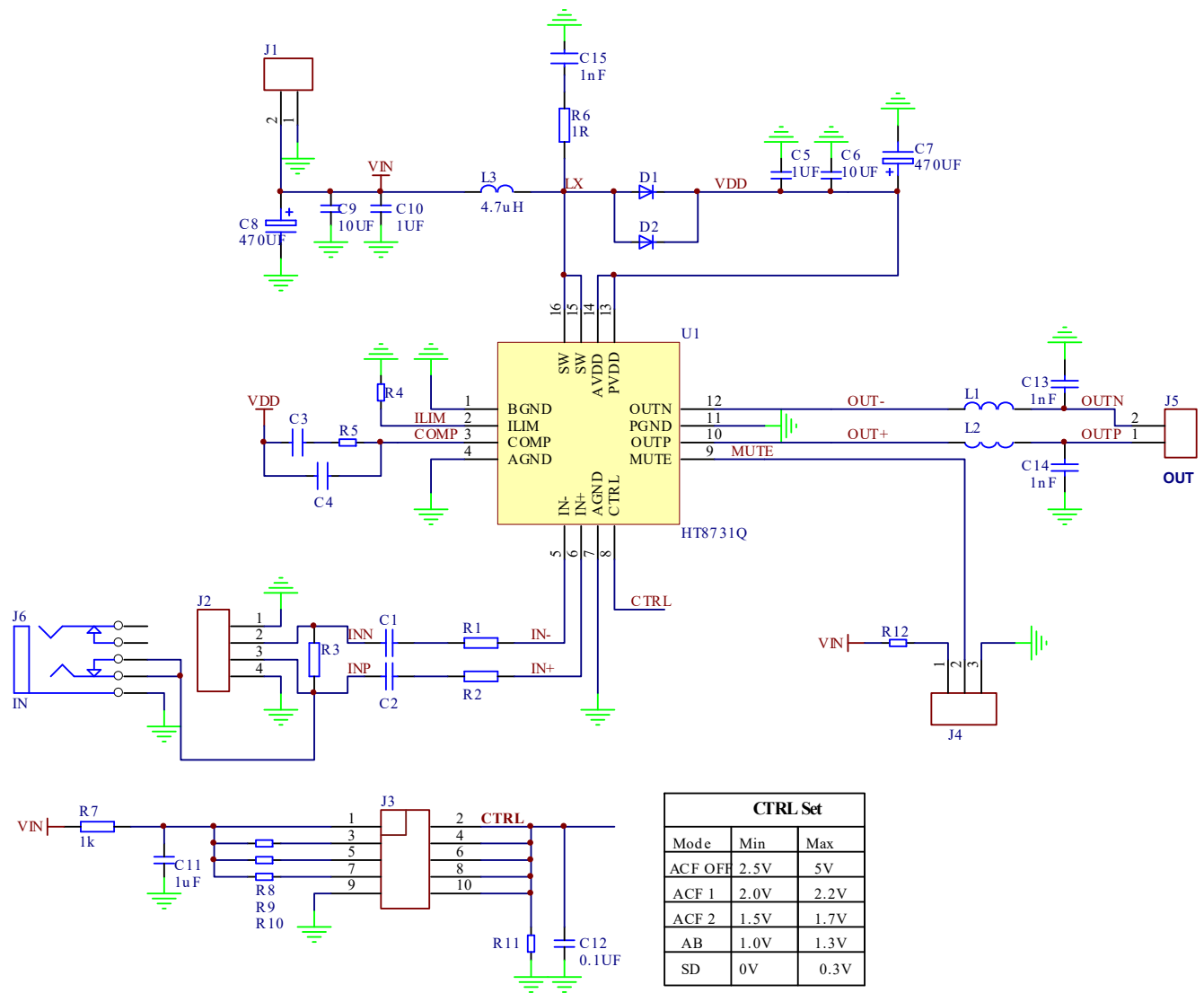
当检测到一输出端对电源、对地、或对另一输出端短路时，过流保护启动，输出端切换至高阻态，防止芯片烧毁损坏。短路情况消除后，通过关断、唤醒一次芯片，或重新上电均能使芯片退出保护模式。

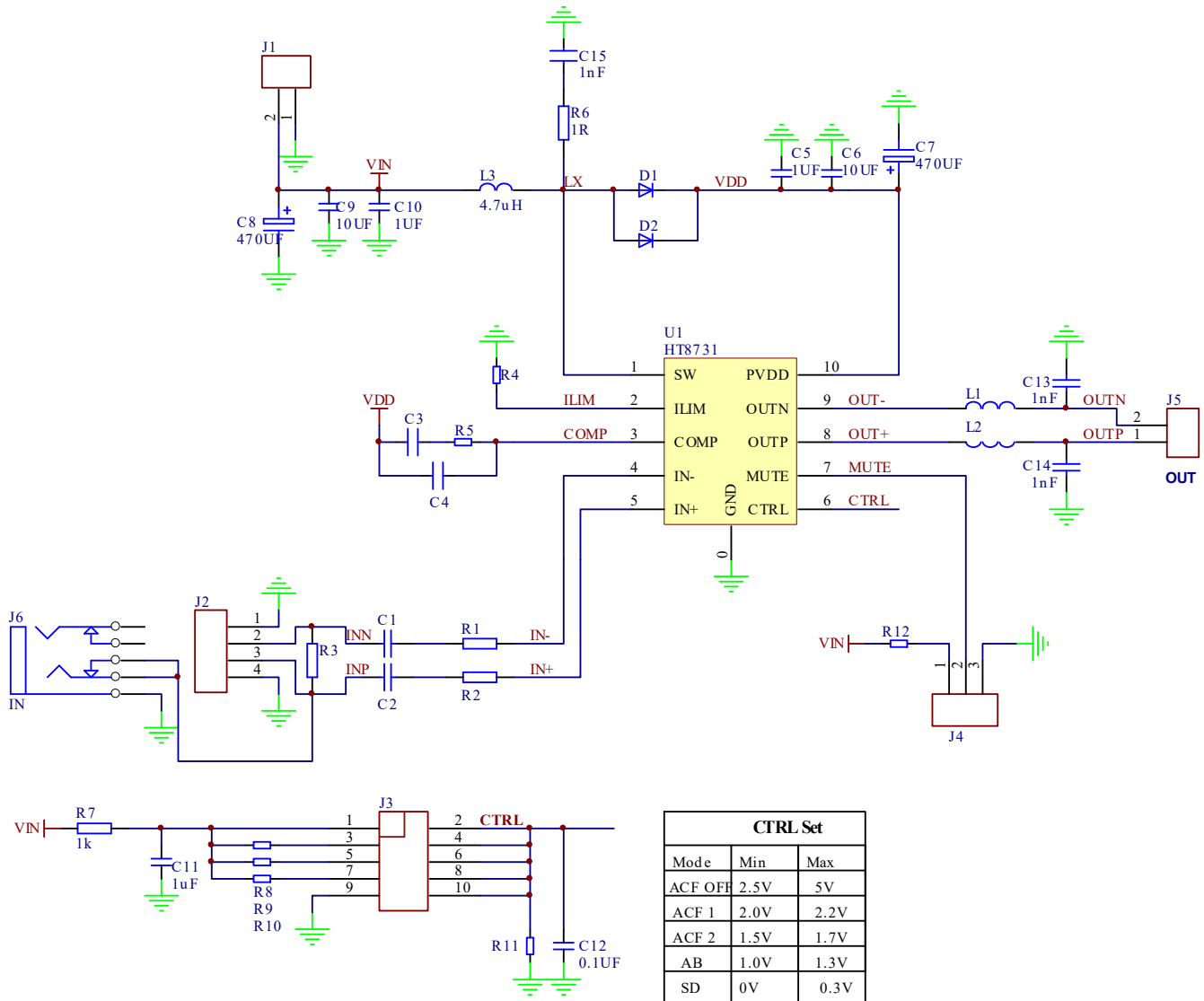
(2) Thermal Protection function

(2) 过温保护

When excessive high temperature of HT8731 (150°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).

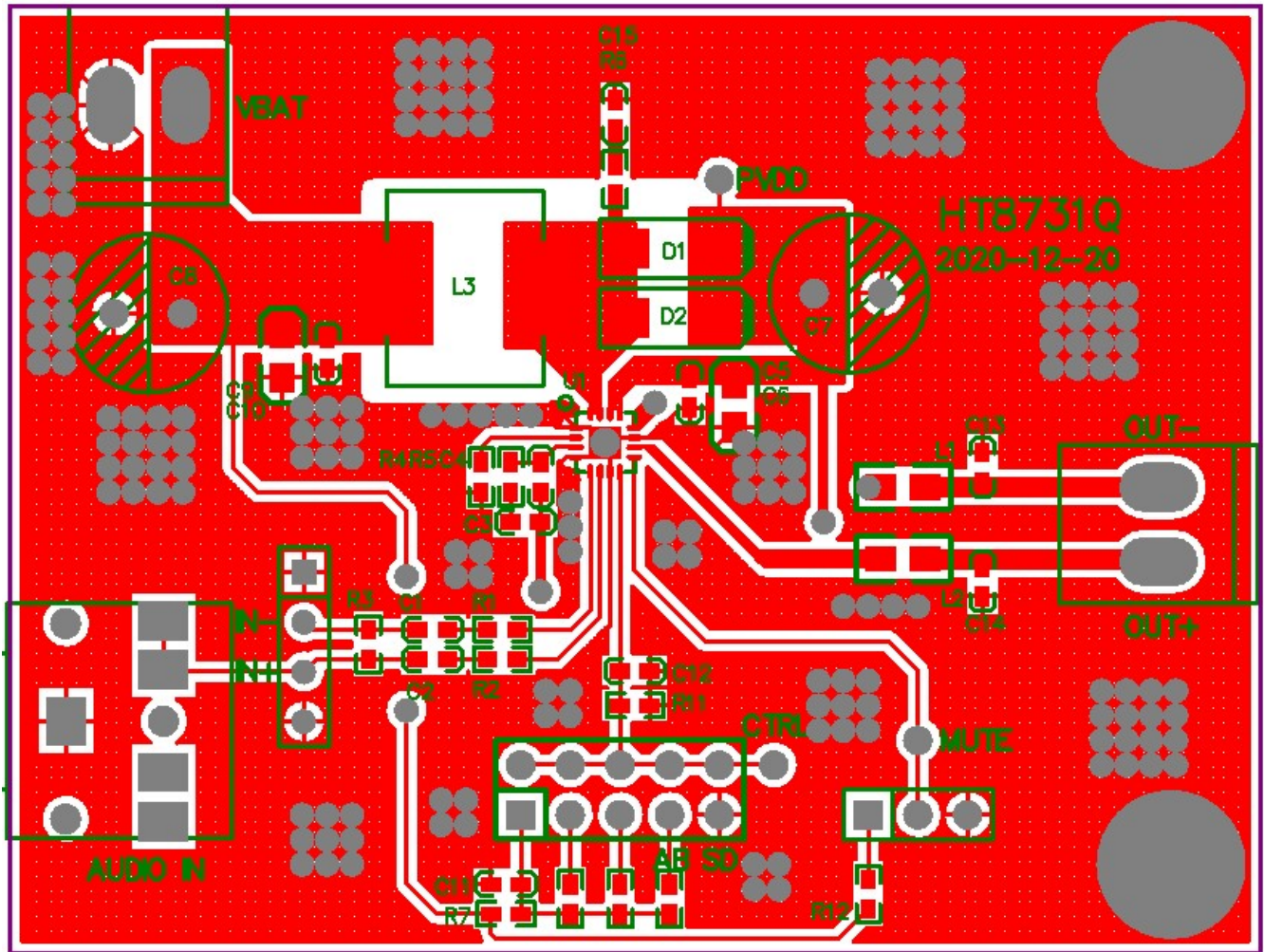
当检测到芯片内温度超过 150°C 时，过温保护启动，正负输出端切换至弱低电平状态（内部通过高阻接地），防止芯片被热击穿损坏。

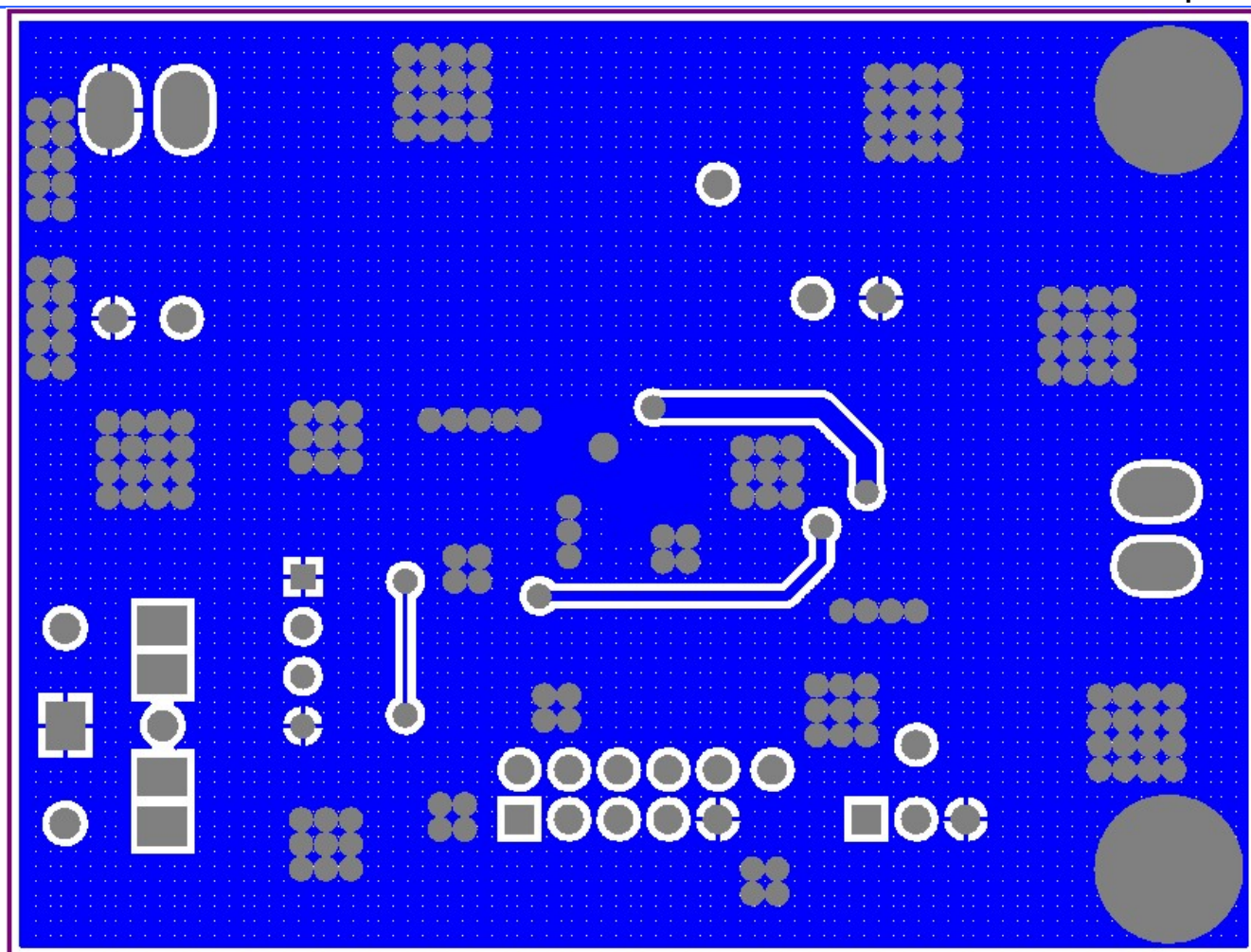
7 Typical Circuit Diagram
SQE (QFN3×3-16L)


SPE (SSOP10L-PP)


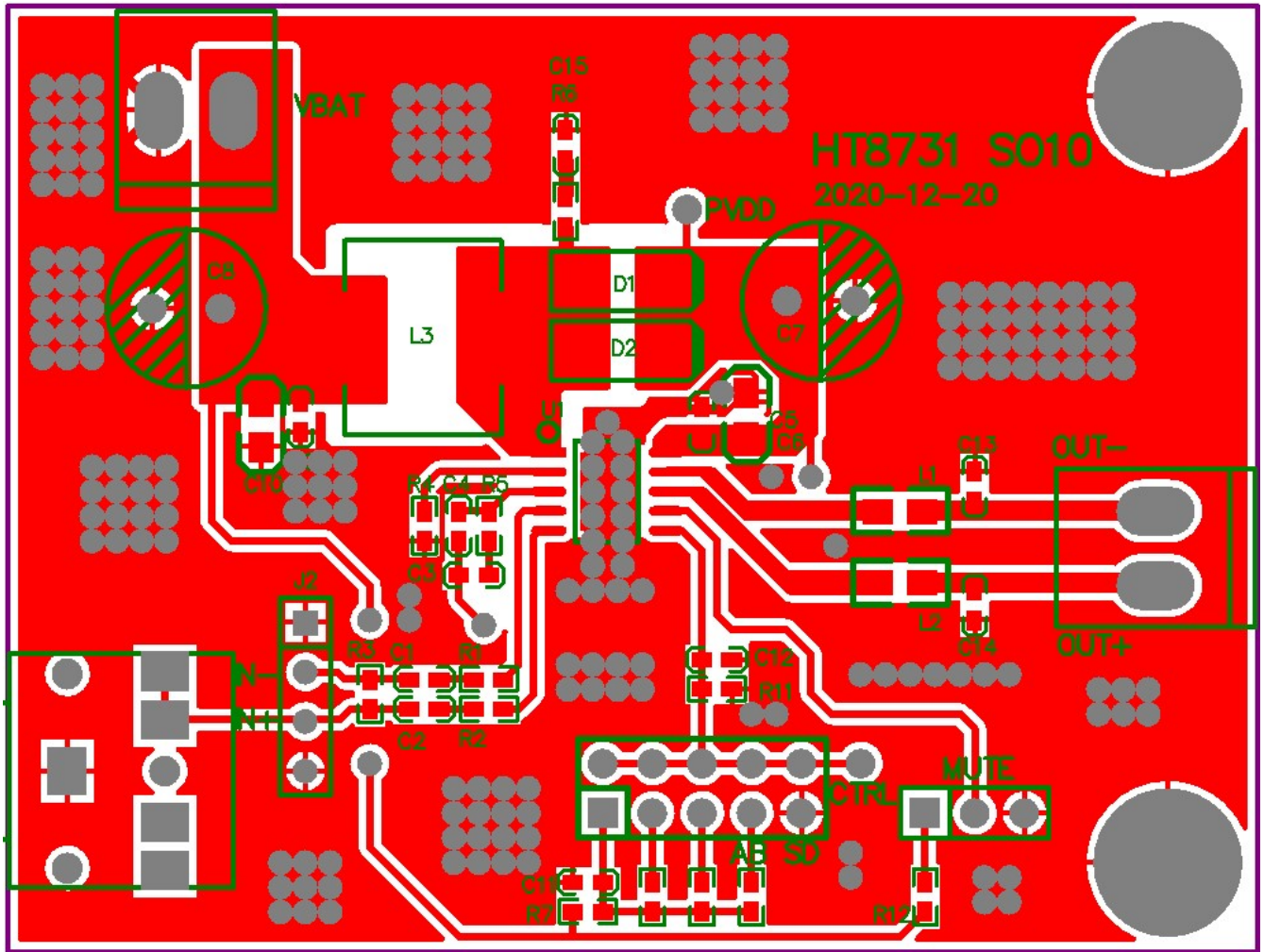
8 PCB Layout

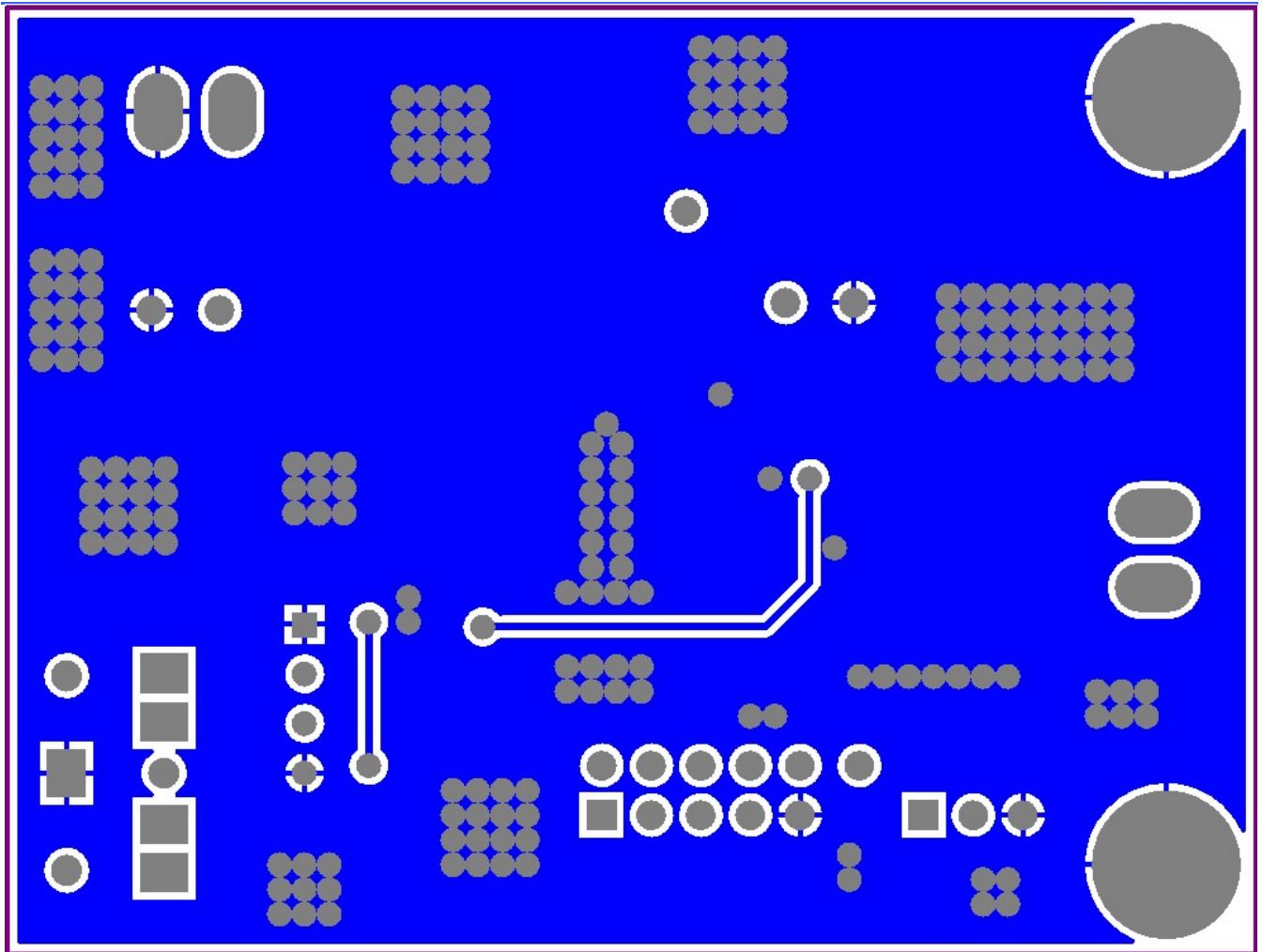
SQE (QFN3×3-16L)

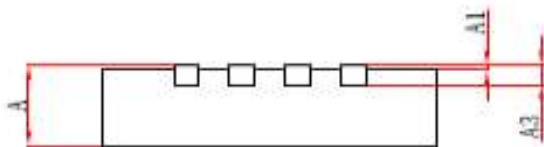
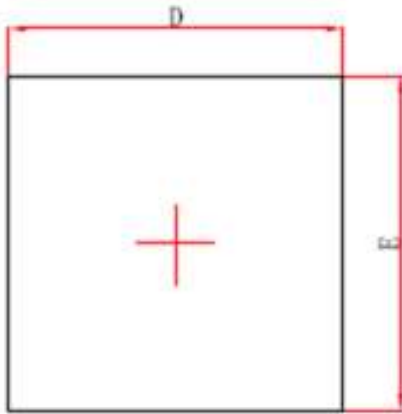
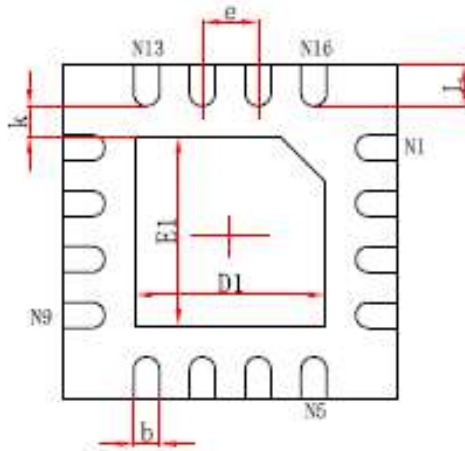




SPE (SSOP10L-PP)

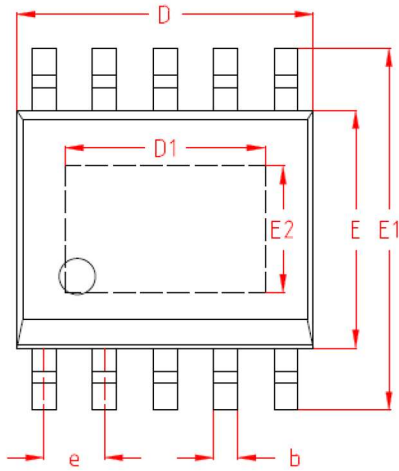
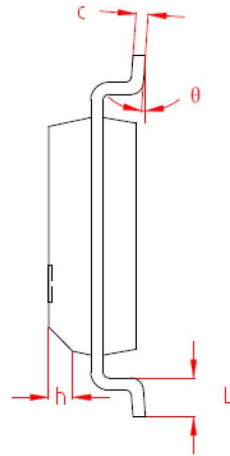
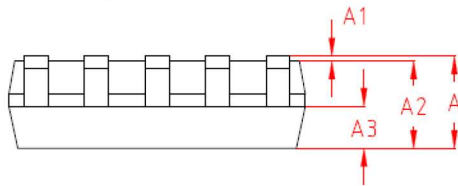




■ PACKAGE OUTLINE
SQE (QFN3×3-16L)


Symbol	Dimension in Millimeters (mm)	
	Min.	Max.
A	0.700	0.900
A1	0.000	0.050
A3	0.203(REF)	
D	2.900	3.100
E	2.900	3.100
D1	1.600	1.800
E1	1.600	1.800
k	0.200MIN	
b	0.180	0.300
e	0.500TYP	
L	0.300	0.500

SPE (SSOP10L-PP)

 TOP VIEW
 正视图

 SIDE VIEW
 侧视图

 SIDE VIEW
 侧视图


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

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