2.8W防削顶单声道D类音频功率放大器

2.8W Anti-Clipping Mono Class D Audio Power Amplifier

■ FEATURES

- Anti-Clipping Function, ACF
- Excellent EMI Suppression Performance
- Filter-less Modulation, Eliminating Output Filter
- Output Power

1.40W (VDD=3.6V, RL=4Ω, THD+N=10%)
2.80W (VDD=5.0V, RL=4Ω, THD+N=10%)

- Low quiescent current

2.65mA (VDD=3.6V)
3.25mA (VDD=5.0V)

- Low shutdown current：＜1μA
- Over Current Protection and Thermal Protection with Auto Recovery
- Low voltage malfunction prevention function included
- Pb-Free Packages, MSOP8L

- 防削顶失真功能(Anti-Clipping Function, ACF)
- 优异的全带宽EMI抑制性能
- 免滤波器数字调制，直接驱动扬声器
- 输出功率

1.40W (VDD=3.6V, RL=4Ω, THD+N=10%)
2.80W (VDD=5.0V, RL=4Ω, THD+N=10%)

- 低静态电流

2.65mA (VDD=3.6V)
3.25mA (VDD=5.0V)

- 低关断电流：＜1μA
- 过流保护及自动恢复功能，过热保护功能，欠压异常保护功能
- 无铅无卤封装, MSOP8L

■ APPLICATIONS

- Portable Speakers
- iphone/ipod/MP3 docking
- Tablet PC/Note Book
- Portable Gamers
- PDAs
- GPS
- PMP/MP4/MP5
- Smart phones

- 便携式音箱
- iphone/ipod/MP3 docking
- PMP/MP4/MP5播放器
- 便携式游戏机
- 掌上电脑PDAs
- USB音箱
- 平板电脑
- 导航仪GPS
- 手机

■ DESCRIPTION

HT6875 is a Low-EMI, Anti-Clipping, filter-less mono Class D audio power amplifier IC with maximum output power of 2.8W (5V power supply, 4Ω load, 10% THD+N). It has a high efficiency with class AB amplifier performance.

HT6875 features Anti-Clipping Function (ACF) which detects and suppresses output signal clippings due to the over level inputs of music or voice signals. The ACF function also can adapt the output clippings caused by power supply voltage down in battery applications. It improves acoustical quality considerably, gives great listening enjoyment, and prevents speaker from overload damaging.

HT6875 has excellent EMI radiation suppression characteristics. The radiation level is well below FCC Part15 Class B standards without any additive design. It keeps from interference with other EMI sensitive circuits, simplifies system design and lowers system cost.

HT6875 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.

HT6875 has the independent Shutdown function which can minimize the power consumption at standby function. As for protection function, over current protection function for speaker output terminals, over temperature protection function, and low supply voltage malfunction preventing function are also prepared.

HT6875是一款低EMI的，防削顶失真的，单声道免滤波D类音频功率放大器。在5V电源，10% THD+N，4Ω负载条件下，输出2.8W功率，在各类音频终端应用中维持高效率并提供AB类放大器的性能。

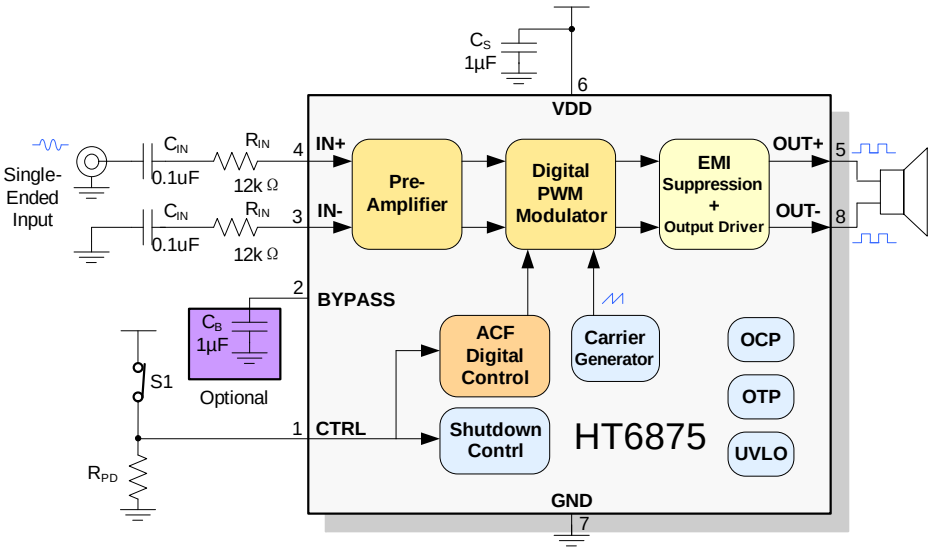
HT6875的最大特点是防削顶失真（ACF）输出控制功能，可检测并抑制由于输入音乐、语音信号幅度过大所引起的输出信号削顶失真（破音），也能自适应地防止在电池应用中由电源电压下降所造成的输出削顶，显著提高音质，创造非常舒适的听音享受，并保护扬声器免受过载损坏。同时芯片具有ACF-Off 模式。

HT6875具有独有的电磁辐射（EMI）抑制技术和优异的全带宽低辐射性能，辐射水平在不加任何辅助设计时仍远在FCC Part15 Class B标准之下，不仅避免了干扰其他敏感电路还降低了系统设计难度。

HT6875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，HT6875内置的关断功能使待机电流最小化，还集成了输出端过流保护、片内过温保护和电源欠压异常保护等功能。

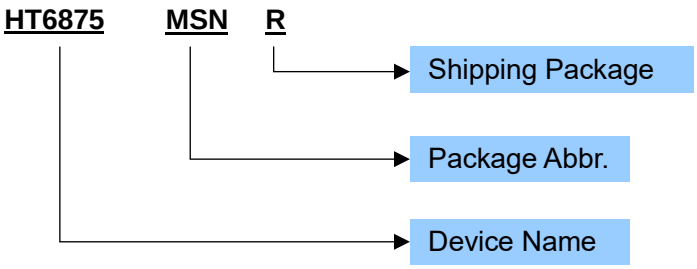
■ TYPICAL APPLICATION



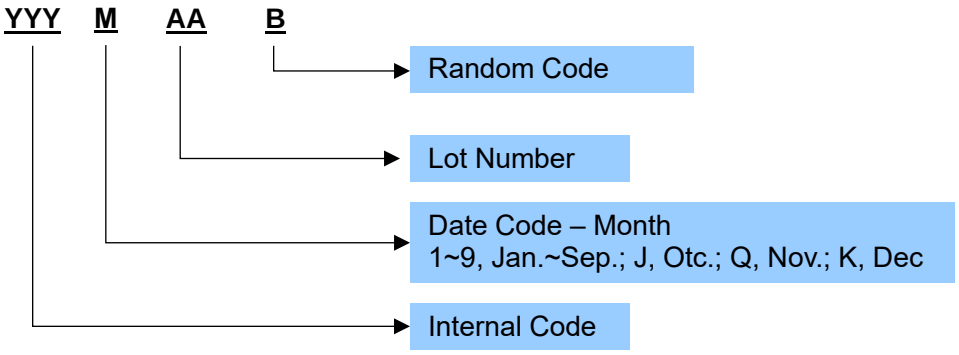
■ ORDERING INFORMATION

Part Number	Package Type	Package Abbr.	Marking	Shipping Package / MOQ
HT6875MSNR	MSOP8	MSN	HT6875 YYYMAAB[1]	Tape and Reel (R) / 5000pcs

Part Number

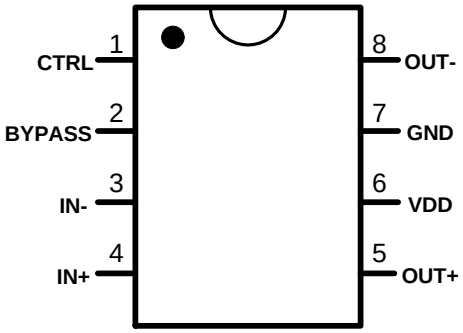


Production Tracking Code



[1] YYYMAAB is production tracking code

■ TERMINAL CONFIGURATION



Top View

Top View

■ TERMINAL FUNCTION

Terminal No.	Name	I/O[1]	Description
1	CTRL	I	Shutdown and ACF control terminal. ACF模式和关断模式控制端
2	BYPASS	A	Analog reference terminal. 模拟参考电压
3	IN-	A	Negative input terminal (differential -). 反相输入端（差分-）
4	IN+	A	Positive input terminal (differential +). 同相输入端（差分+）
5	OUT+	O	Positive output terminal (differential +). 同相输出端（BTL+）
6	VDD	Power	Power supply. 电源
7	GND	GND	Ground. 地
8	OUT-	O	Negative output terminal (differential -).反相输出端（BTL-）

[1] I: Input; O: Output; A: Analog Terminal

■ SPECIFICATIONS[1]

● Absolute Maximum Ratings [2]

PARAMETER	Symbol	MIN	TYP	Max.	Unit
Power supply terminal voltage range	V_{DD}	-0.3		6.5	V
Input terminal voltage range (IN+, IN-)	V_{IN}	V_{SS}－0.6		V_{DD}＋0.6	V
Input terminal voltage range (except IN+, IN-)	V_{IN}	V_{SS}－0.3		V_{DD}＋0.3	V
Operating Ambient Temperature	T_A	-40		85	℃
Junction Temperature	T_J	-40		150	℃
Storage Temperature	T_{STG}	-50		150	℃

● Recommended Operating Conditions

PARAMETER	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Power Supply Voltage [3]	VDD		2.5		6	V
Operating Ambient Temperature	Ta	t_{SD} (Min.)=50ms	-20	25	85	℃
		t_{SD} (Min.)=80ms	-30			
Speaker Impedance	R_L			4		Ω

● DC Characteristics

V_{SS}=0V, V_{DD}=2.5V~6.5V, Ta= -40ºC~85ºC, unless otherwise specified.

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
VDD power supply start-up threshold voltage	V_{UVLH}			2.10		V
VDD power supply shut-down threshold voltage	V_{UVLL}			1.90		V
ACF-OFF mode threshold voltage for terminal CTRL	V_{MOD1}		1.55		V_{DD}	V
ACF1mode threshold voltage for terminal CTRL	V_{MOD2}		0.9		1.25	V
SD mode threshold voltage for terminal CTRL	V_{MOD4}		V_{SS}		0.20	V
Quiescent current	I_{DD}	VDD=3.6V, No signal input		2.65		mA
		VDD=5.0V, No signal input, No load		3.25		
Consumption current in shutdown mode	I_{SD}	CTRL=V_{SS}, Ta=25℃		0.01	1	μA
Voltage of terminal BYPASS	V_{BYPASS}			V_{DD}/2		V

[1] Depending on parts and PCB layout, characteristics may be changed.
[2] Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.
[3] The rising time of VDD should be longer than 1μs.

Analog Characteristics

V_{SS}=0V, V_{DD} =5V, Ta=25ºC, C_{IN}=1uF, R_{IN}=15 kΩ, ACF-Off mode, unless otherwise specified.

Item	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Power	P_O	R_L=4Ω, V_{DD}=3.6V	f=1kHz, THD+N=1%		1.10		W
		R_L=4Ω, V_{DD}=5.0V			2.30		
		R_L=8Ω, V_{DD}=3.6V			0.70		
		R_L=8Ω, V_{DD}=5.0V			1.40		
		R_L=4Ω, V_{DD}=3.6V	f=1kHz, THD+N=10%		1.40		
		R_L=4Ω, V_{DD}=5.0V			2.80		
		R_L=8Ω, V_{DD}=3.6V			0.85		
		R_L=8Ω, V_{DD}=5.0V			1.70		
Total Harmonic Distortion plus Noise (BW: 20kHz)	THD+N	R_L=4Ω, P_O=1W, f=1kHz			0.04		%
Output Noise	V_N	f=20Hz~20kHz, A加权, Av=26dB			100		μV_{rms}
Signal /Noise Ratio	SNR	A-Filter, Av=26dB,THD+N = 1%			90		dB
Power Supply Rejection ratio	PSRR	f=1kHz			-70		dB
Efficiency	η	R_L=4Ω+22uH, THD+N = 1%			83		%
		R_L=8Ω+22uH, THD+N = 1%			90		%
Output Offset Voltage	V_{OS}				±1		mV
System Gain	Av_0	R_{IN}=12 kΩ			27		dB
ACF maximum attenuation gain	Aa			-10		0	dB

AC Characteristics

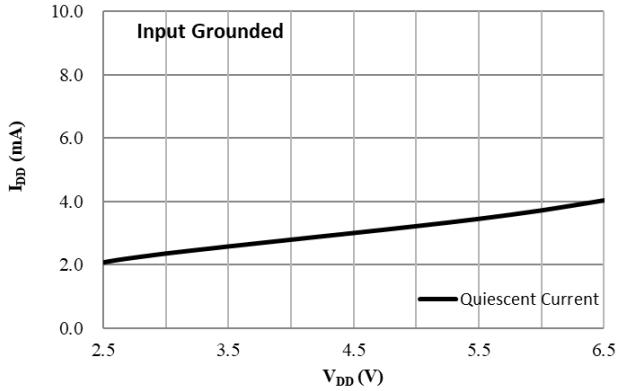
V_{SS}=0V, V_{DD} =2.5 to 6.5V, Ta=－30℃~85℃, unless otherwise specified.

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Start-up time (or wake up from shutdown mode)	t_{STUP}			100		ms
Wake-up mode setting time	t_{WK}		35			ms
Shutdown setting time	t_{SD}	T_a(Min.)= -20℃	50			ms
		T_a(Min.)= -30℃	80			
Each mode setting time (Except shutdown)	t_{MOD}		0.1			ms
Carrier clock frequency	f_{PWM}			450		KHz

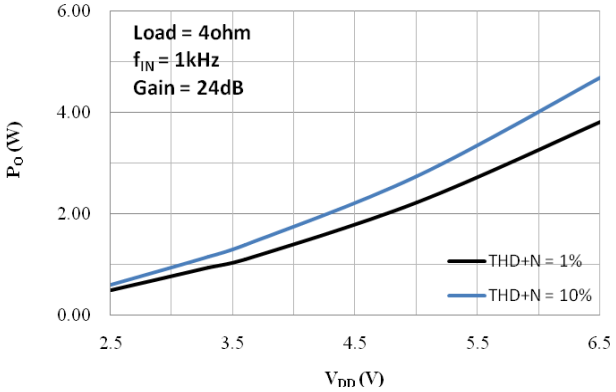
■ TYPICAL OPERATING CHARACTERISTICS

VDD = 5V, Load = 4ohm, R_{IN} = 15k, C_{IN} = 1uF, f_{IN} = 1kHz, unless otherwise specified.

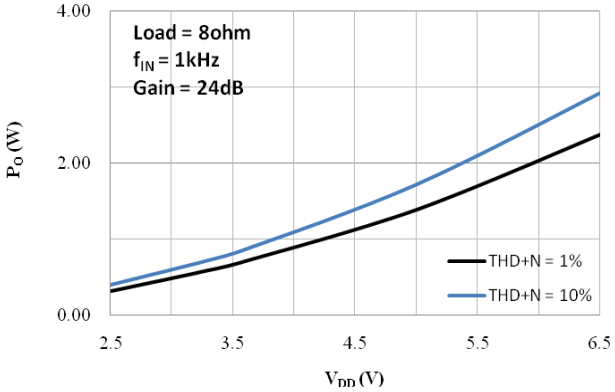
V_{DD} vs I_{DD}



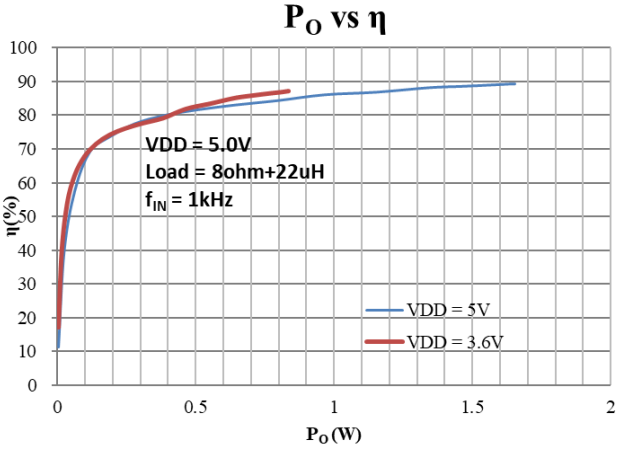
V_{DD} vs P_O



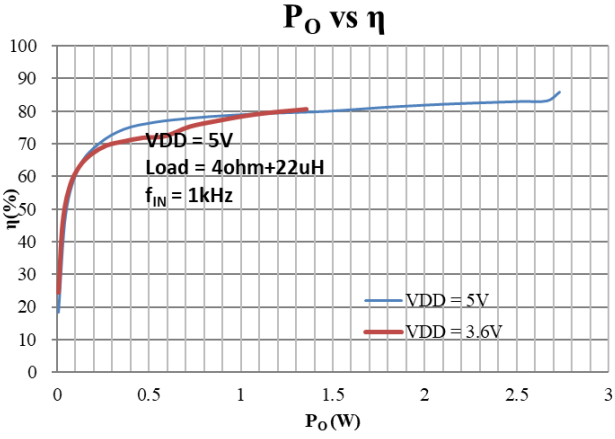
V_{DD} vs P_O

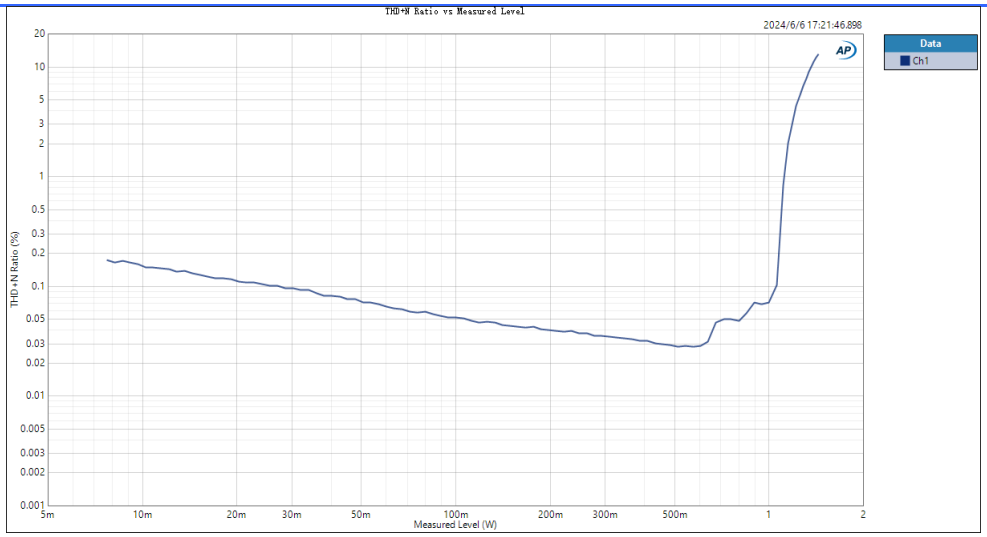


P_O vs η

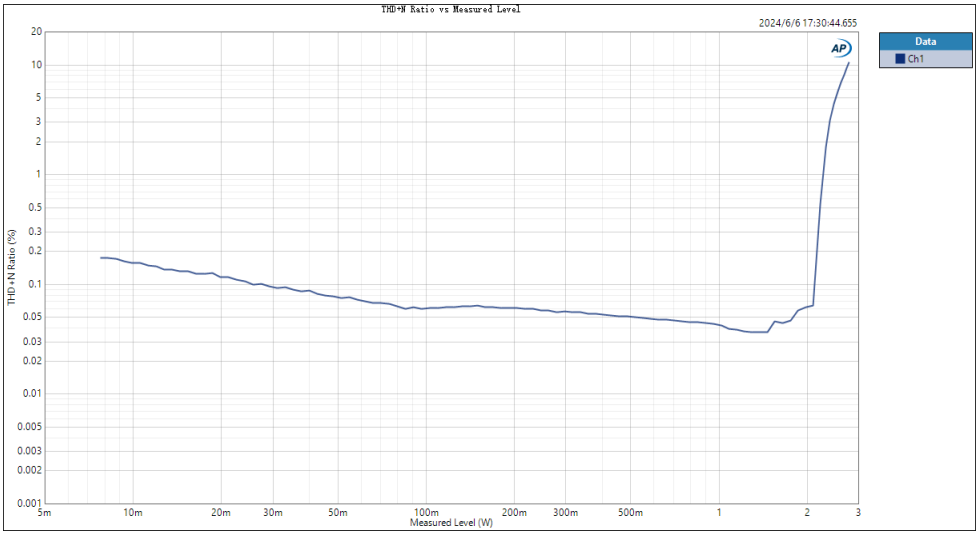


P_O vs η

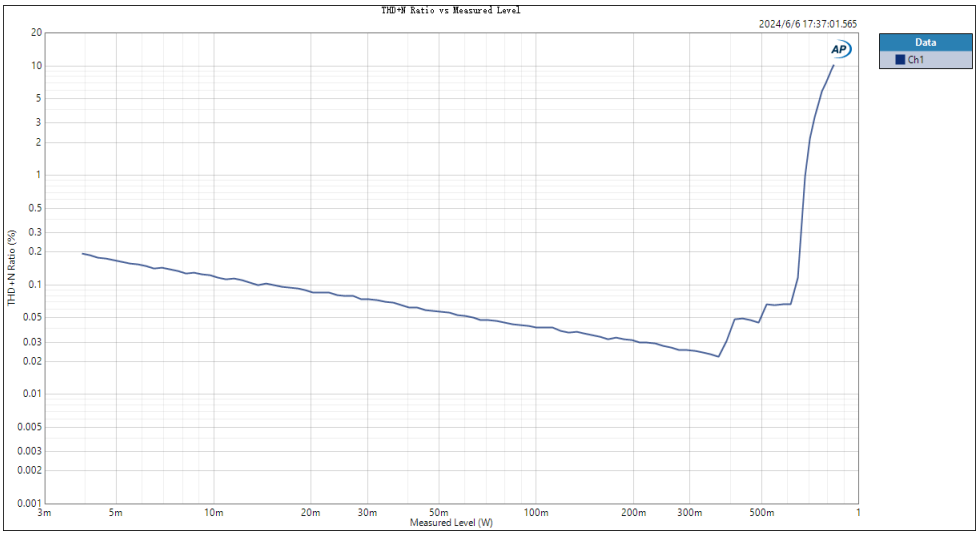




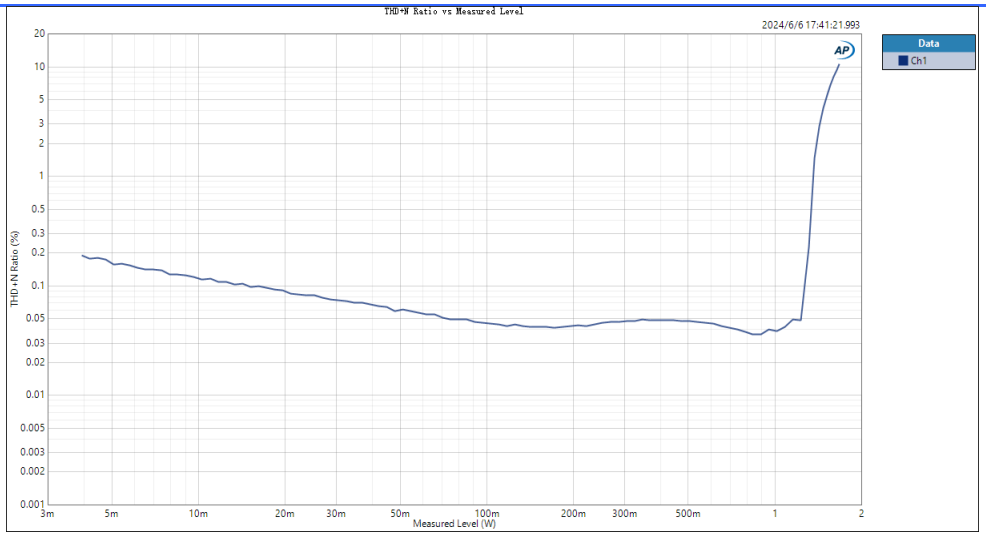
VDD = 3.6V, Load = 4ohm, f_{IN} = 1kHz
THD+N vs Po



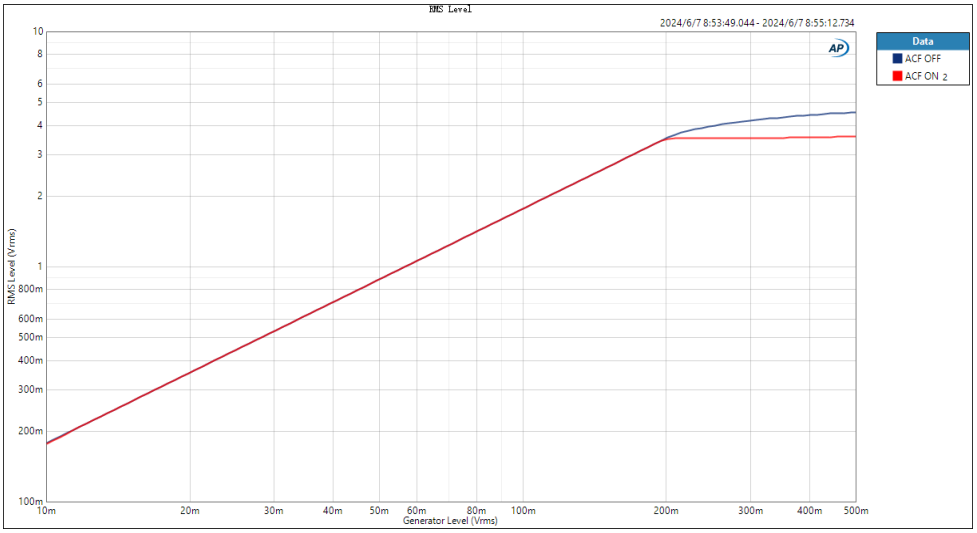
VDD = 5V, Load = 4ohm, f_{IN} = 1kHz
THD+N vs Po



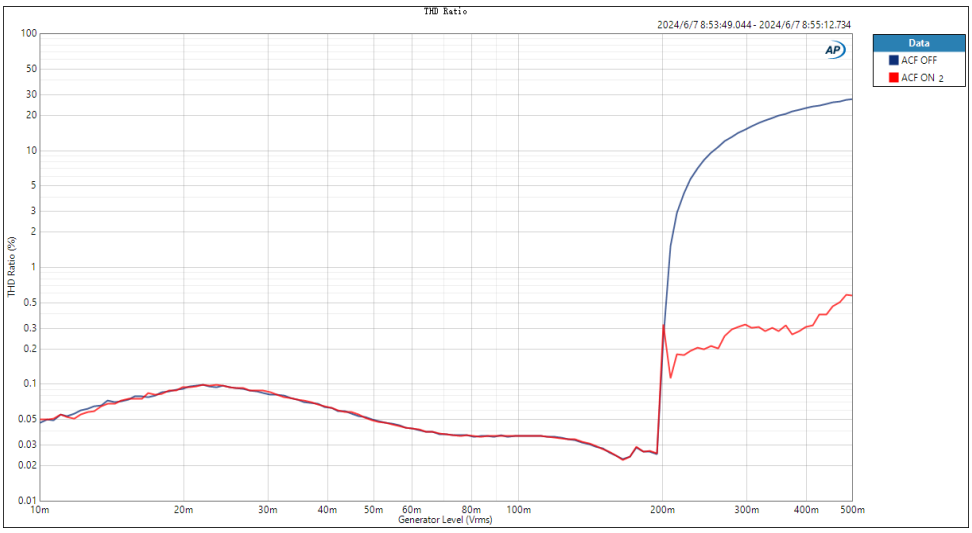
VDD = 3.6V, Load = 8ohm, f_{IN} = 1kHz
THD+N vs Po



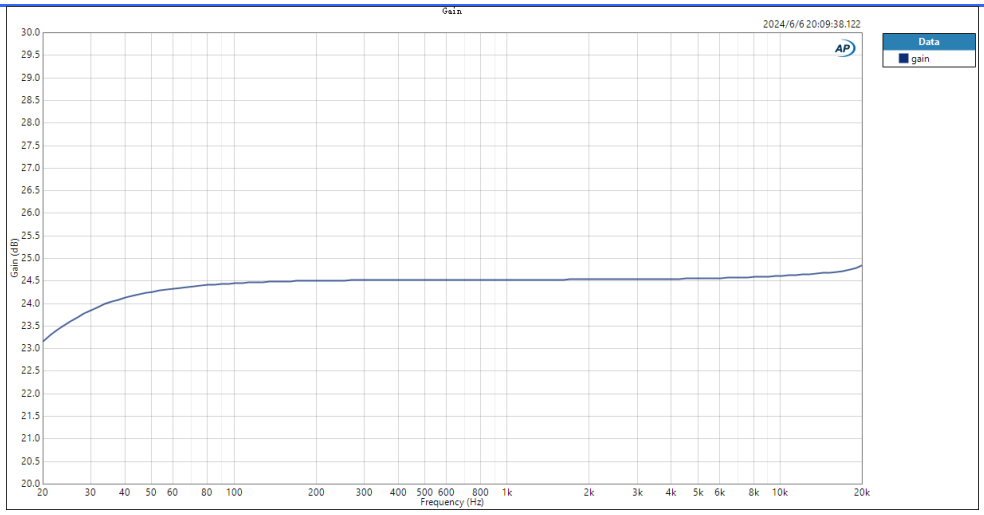
VDD = 5V, Load = 8ohm, f_{IN} = 1kHz
THD+N vs Po



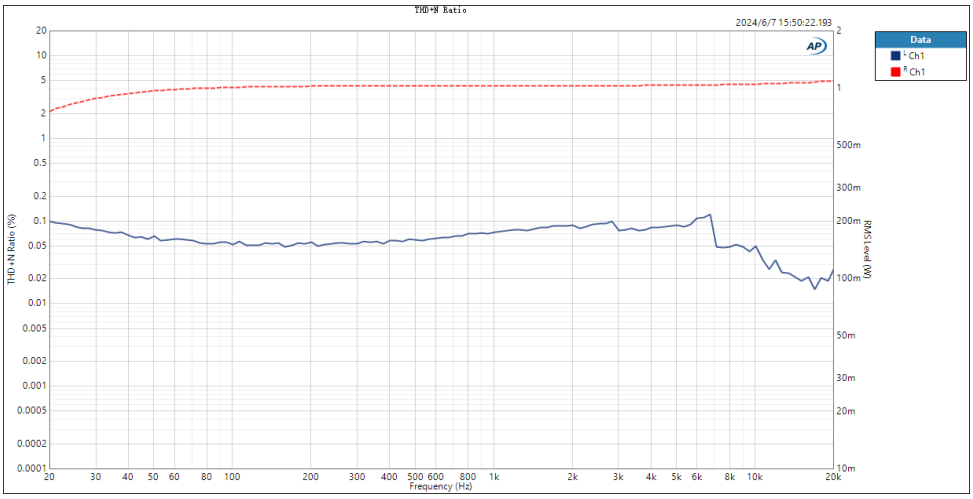
VDD = 5V, Load = 4ohm, f_{IN} = 1kHz
V_{OUT} vs V_{IN}



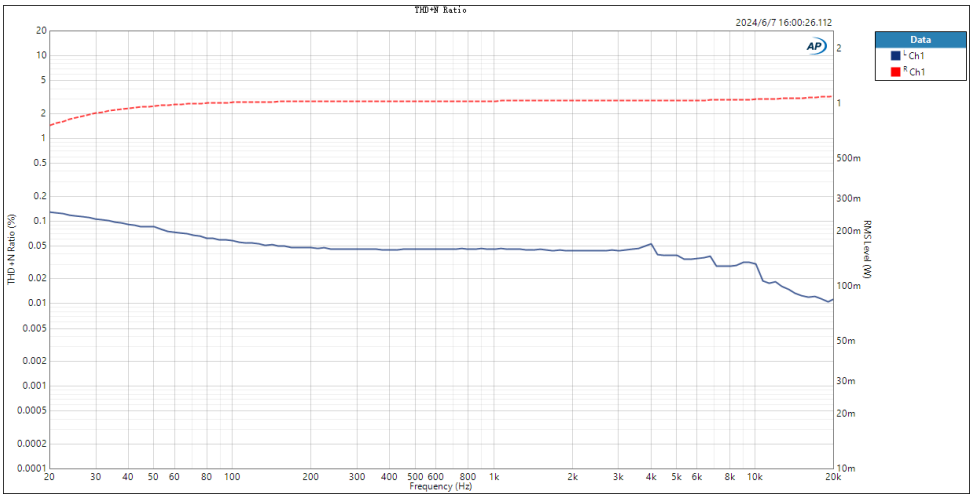
VDD = 5V, Load = 4ohm, f_{IN} = 1kHz, THD+N vs f_{IN}



VDD = 3.6V, Load = 4ohm, Po = 1W
THD+N vs f_{IN}



VDD = 5V, Load = 4ohm, f_{IN} = 1kHz, R_{IN} = 15k, C_{IN} = 1uF, Gain vs f_{IN}



VDD = 5V, Load = 4ohm, Po = 1W
THD+N vs f_{IN}

■ APPLICATION INFORMATION

1 Analog Signal Input Configuration

HT6875 is an amplifier with analog input (single-ended or differential), PWM pulse output, and maximum output of 4.7W (R_L=4Ω) × 1ch.

For a differential input between IN+ and IN- pins, signals input via DC-cut capacitors (C_{IN}). The input signal gain is calculated by $Av=\frac{285k}{R_{IN}+0.95k}$. And, the low pass cut-off frequency of input signal, can be calculated by $f_c = \frac{1}{(2\pi R_{IN} C_{IN})}$.

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

HT6875 接受模拟差分或单端音频信号输入，产生 PWM 脉冲输出信号驱动扬声器。

对差分输入，通过隔直电容 C_{IN} 和输入电阻 R_{IN} 分别输入到 IN+和 IN-端。系统增益$Av=\frac{285k}{R_{IN}+0.95k}$，输入 RC 高通滤波器的截止频率$f_c = \frac{1}{(2\pi R_{IN} C_{IN})}$。

对单端输入，则通过 CIN 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 Av 和截止频率 fc 与差分输入时相同。

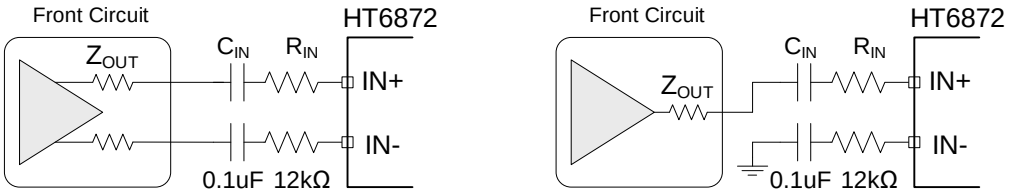


Figure 1 (1) Differential Input; (2) Single-ended Input

2 CTRL Terminal Mode Control

The CTRL terminal has a built-in pull-down resistor 385kΩ. Three operating mode, ACF, ACF-Off and SD (shutdown), could be implemented while different Setting Voltages input via CTRL terminal (see Table 1).

CTRL 端内置下拉电阻 385kΩ，在 CTRL 端输入不同电压值，能实现 3 种工作模式，即防削顶模式（ACF），防削顶功能关闭模式（ACF-Off）和芯片关断模式（SD），详见下表。

Table 1 Different Mode Setting Voltages of CTRL Terminal

Item	Symbol	Min.	Typ.	Max.	Unit
ACF-Off mode setting threshold	V_{MOD1}	1.55		V_{DD}	V
ACF1 on mode setting threshold	V_{MOD2}	0.9	1.1	1.25	V
SD mode setting threshold	V_{MOD4}	V_{SS}		0.20	V

3 CTRL Mode Function Detail

3.1 ACF Mode

In ACF modes, HT6875 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 HT6875 also follows to the clips of the output waveform due to the decrease in the power-supply voltage.

在 ACF 模式下，当电路检测到输入信号幅度过大而产生输出削顶时，HT6875 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，HT6875 也能自动衰减输出增益，实现与 VDD 下降值相匹配的最大限度无削顶输出水平。。

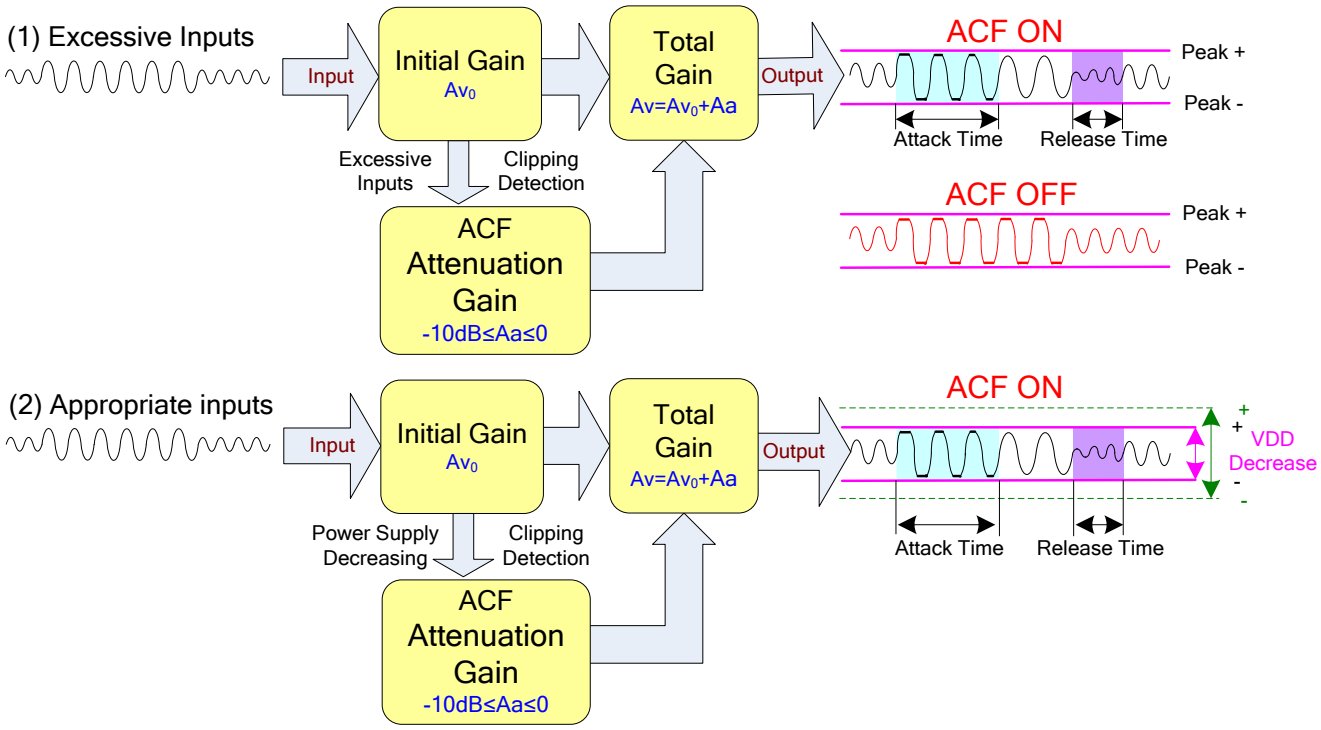


Figure 2 the ACF Function Operation Outline

The Attack time of ACF Function is a time interval until system gain falls to target attenuation gain -3dB when a big enough signal inputs. And, the Release Time is a time from target attenuation gain to not working of ACF. The maximum attenuation gain is 10dB.

ACF ON 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，从 ACF 启动对放大器的增益调整，直到增益从 Av0 衰减至距目标衰减增益 3dB 时的时间间隔；释放时间（Release time）指从产生削顶的输入条件消失，到增益退出衰减状态恢复到 Av0 的时间间隔。HT6875 的最大衰减增益为 10dB。

ACF 模式启动时间和释放时间（见下表）。

Table 2 Protection Suite Error Handling Summary

ACF mode	Attack time	Release time
ACF1	72ms	720ms

3.2 ACF OFF Mode

n ACF-Off mode, ACF function is disenabled. HT6875 will not detect output clipping and the system gain is kept to be Av=Av0. The audio quality would worsen due to clipping distortion.

在 ACF-Off 模式下，ACF 功能被关闭，HT6875 不对输出削顶条件作检测，也不对系统增益作自动调整操作，系统增益保持为 Av=Av0=23.5dB 恒定不变。HT6875 可能因输出存在破音失真而音质变坏。

3.3 SD Mode

In shutdown mode, HT6875 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（内部通过高阻接地）。

4 Pop-Click Noise Reduction

The Pop-Click Noise Reduction Function of HT6875 works in the cases of Power-on, Power-off, Shutdown on, and Shutdown off. To achieve a more excellent noise reduction performance, it is recommended to use a DC-cut capacitor (C_{IN}) of 0.1μF or less.

Besides, POP noise can be minimal according to the following procedure of shutdown control.

・During power-on, Shutdown mode is not cancelled until the power supply is stabilized enough.

・Before Power-off, set Shutdown mode fist.

HT6875 内置控制电路实现了独创的杂音抑制效果，有效地抑制住了系统在上电、下电、关断及其唤醒操作过程中出现的瞬态咔嗒-噼噗（Click-Pop）噪声。

为达到更优异的咔嗒-噼噗声消除效果，一般情况下，建议采用 0.1μF 或更小的隔直电容 C_{IN}。同时 POP 噪声还可通过下列上电、下电时关断模式的时序控制措施来达到杂声微乎其微的效果：

・电源上电时，保持关断模式，等电源足够稳定后再解除关断模式。

・电源下电时，提前设为关断模式。

5 Protection Function

HT6875 has the protection functions such as Over-current Protection function, Thermal Protection function, and Low voltage Malfunction Prevention function.

HT6875 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。

5.1 Over-current Protection function

When a short circuit occurs between one output terminal and Ground, VDD, 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 is 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，可自动恢复正常工作。

5.2 Thermal Protection function

When excessive high temperature of HT6875 (150℃) 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℃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。

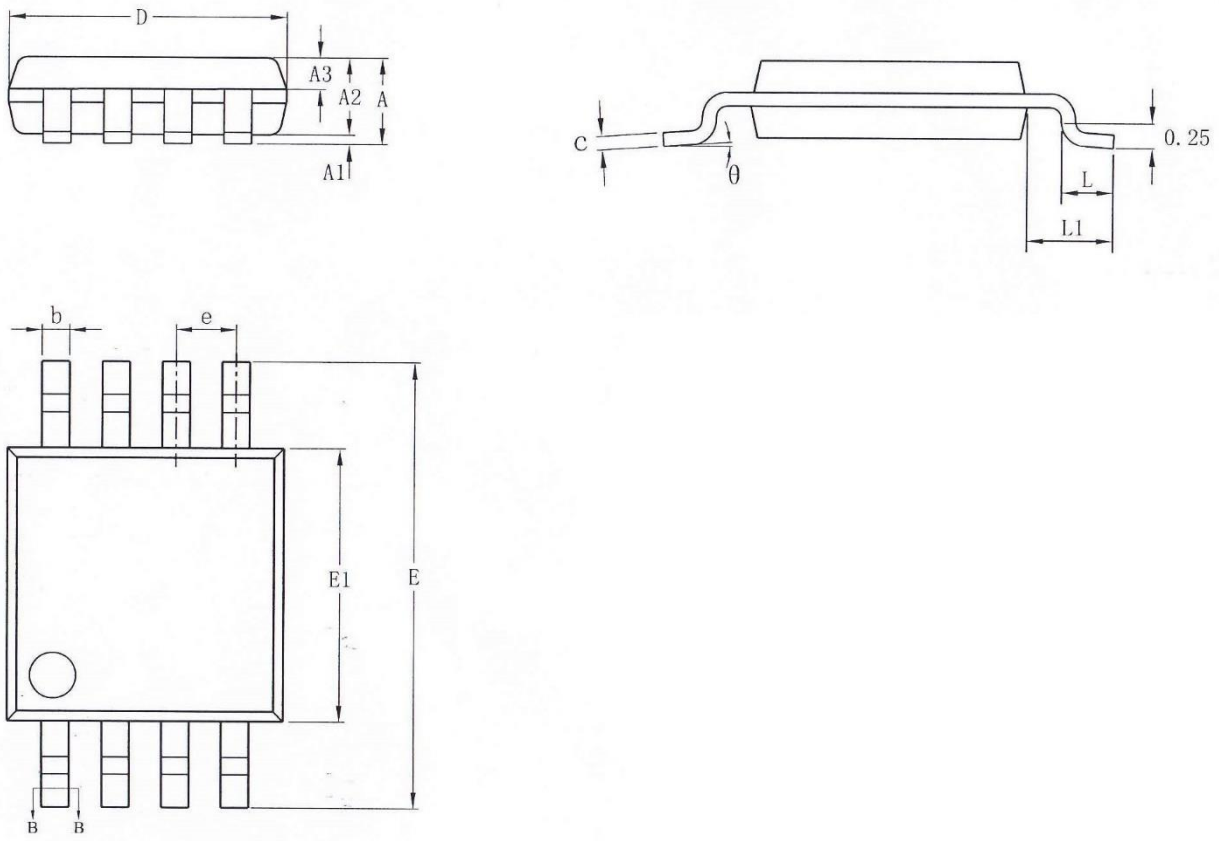
5.3 Low voltage Malfunction Prevention function

This is the function to establish the low voltage protection mode when VDD terminal voltage becomes lower than the detection voltage (VUVLL) for the low voltage malfunction prevention. And the protection mode is canceled when VDD terminal voltage becomes higher than the threshold voltage (VUVLH). In the low voltage protection mode, the differential output pin becomes Weak Low state (a state grounded through high impedance). HT6871 will start up within the start-up time (TSTUP) when the low voltage protection mode is cancelled.

当检测到电源端 VDD 低于 VUVLL（1.9V），启动欠压保护，输出端为弱低电平状态（内部通过高阻接地）；当检测到 VDD 高于 VUVLH（2.1V），保护模式自动解除，经启动时间 TSTUP 后进入正常工作状态。

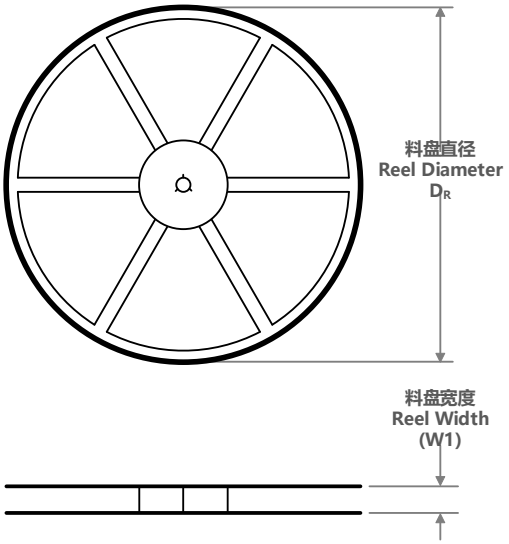
■ PACKAGE OUTLINE

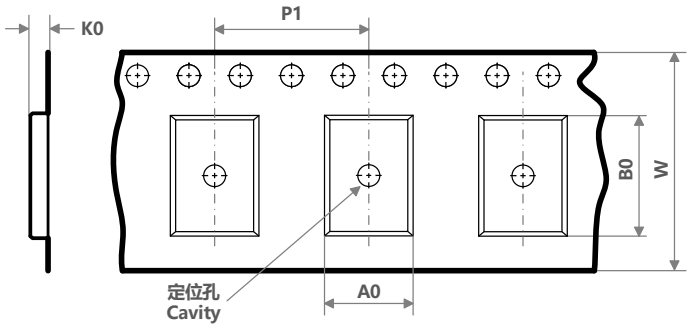
MSN (MSOP8)



Symbol	Dimensions in Millimeters		
	Min.	NOM	Max.
A	-	-	1.10
A1	0.05	-	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.28	-	0.36
b1	0.27	0.30	0.33
c	0.15	-	0.19
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.70	4.90	5.10
E1	2.90	3.00	3.10
e	0.65BSC		
L	0.40	-	0.70
L1	0.95REF		
θ	0	-	8°

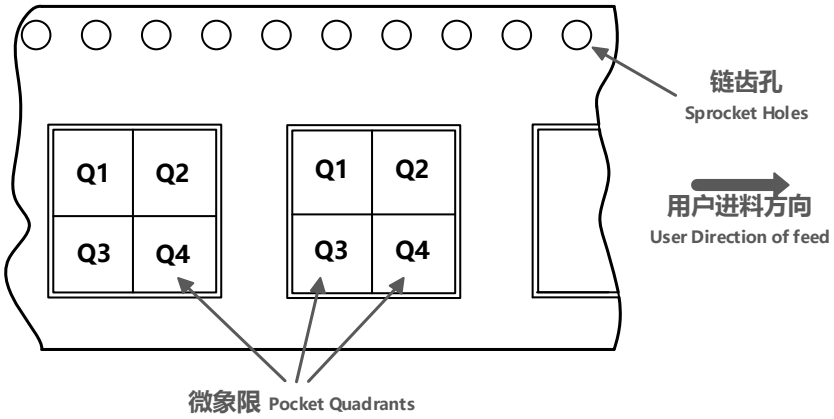
■ TAPE AND REEL INFORMATION





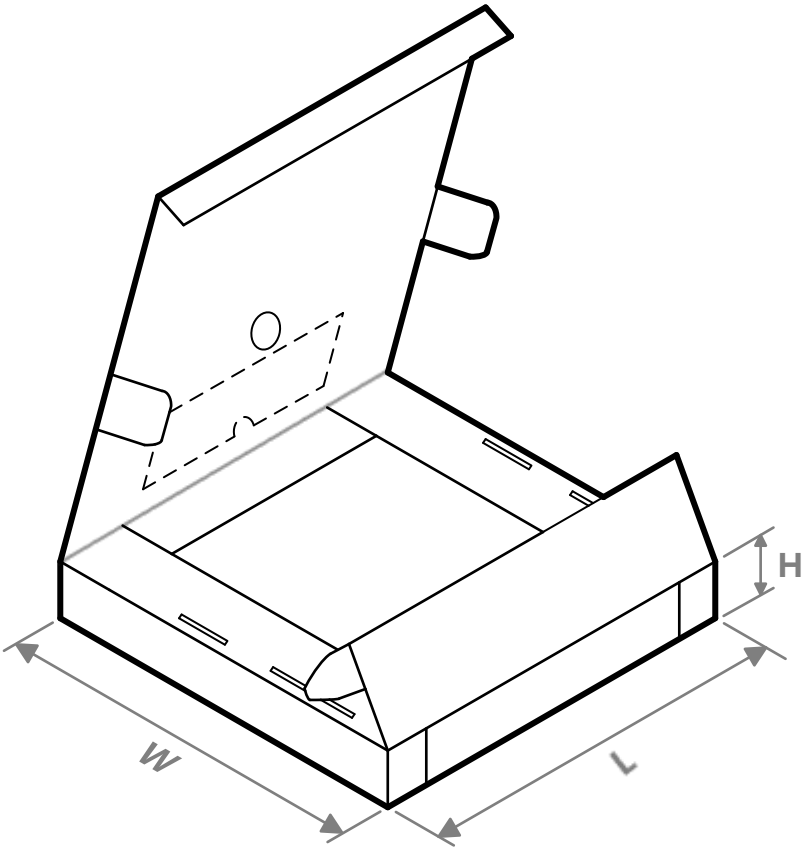
A0	Dimension designed to accommodate the component width; 料槽宽度
B0	Dimension designed to accommodate the component length; 料槽长度
K0	Dimension designed to accommodate the component thickness; 料槽厚度
W	Overall width of the carrier tape; 载带整体宽度
P1	Pitch between successive cavity centers; 相邻槽中心间距

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
HT6875MSNR	MSOP	MSN	8	5000	330	TBD	TBD	TBD	TBD	TBD	TBD	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)
HT6875MSNR	MSOP	MSN	8	5000	TBD	TBD	TBD

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