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# **AD6973D Datasheet**

**Zhuhai Jieli Technology Co.,LTD**

**Version: 3.1**

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# AD6973D4 Features

## CPU

- 32-bit DSP supports hardware Float Point Unit(FPU)
- Up to 160MHz programmable processor
- 64 Vectored interrupts
- 8 Levels interrupt priority

## DSP Audio Processing

- SBC, AAC Audio decodes supported for BT audio
- mSBC voice codec supported for BT phone
- Supports MP2, MP3, WMA, APE, FLAC, AAC, MP4, M4A, WAV, AIF, AIFC audio decoding
- Packet Loss Concealment (PLC) for voice processing
- Acoustic echo cancellation/suppression (AEC,AES)
- Single/Dual analog/digital MIC Environmental Noise Cancellation (ENC)
- Multi-band DRC limiter
- 20-band EQ configuration for voice Effects

## Audio Codec

- Two channels 24-bit DAC, SNR  $\geq$  101dB
- Two channels 24-bit ADC , SNR  $\geq$  85dB
- Sampling rates of 8KHz/11.025KHz/16KHz/22.05KHz/24KHz/32KHz/44.1KHz/48KHz are supported
- One analog MIC amplifier, build-in MIC bias generator
- Supports two PDM digital MIC inputs
- One channel Stereo analog MUX
- Supports cap-less, single-ended, and differential mode at the DAC path
- Supports 16ohm and 32ohm Speaker loading

## Bluetooth

- Compliant with Bluetooth V5.4+BR+EDR+BLE specification

(QDID: 223418)

- Meet class2 and class3 transmitting power requirement
- Support GFSK and  $\pi/4$  DQPSK all packet types
- Provides maximum +8dbm transmitting power
- receiver with minimum -94dBm sensitivity
- Fast AGC for enhanced dynamic range
- Support a2dp\avctp\avdtp\avrcp\hfp\spp\smpl\att\gap\gatt\rfcomm\sdpl2cap profile
- a2dp 1.4\avctp 1.4\avdtp 1.3\ avrtp 1.6.2\hfp 1.8 \spp 1.2\rfcomm 1.2\pnp 1.3\hid 1.1.1\sdpl core5.4\l2cap core 5.4

## Peripherals

- One full speed USB 2.0 OTG controller
- Six multi-function 32-bit timers, support capture and PWM mode
- Three full-duplex basic UART, support DMA mode
- One hardware IIC interface supports host and device mode
- Two Built-in low power Cap Sense Keys
- Built-in Cap Sense Key controller
- 10-bit ADC for analog sampling
- External wake up/interrupt on all GPIOs

## PMU

- Low voltage LDO and DC-DC for internal digital and analog circuit supply
- 2uA current consumption in the soft-off mode
- Built-in LDO and DC-DC for the core, I/O, Bluetooth and flash
- VBAT is 2.2V to 4.5V
- VDDIO is 2.2V to 3.4V

## Packages

- QFN20(3mm\*3mm)

### Temperature

- Operating temperature: -40°C to +85°C
- Storage temperature: -65°C to +150°C

### Applications

- Bluetooth TWS headsets
- 2.4G wireless MIC



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# 1、 Pin Definition

## 1.1 Pin Assignment

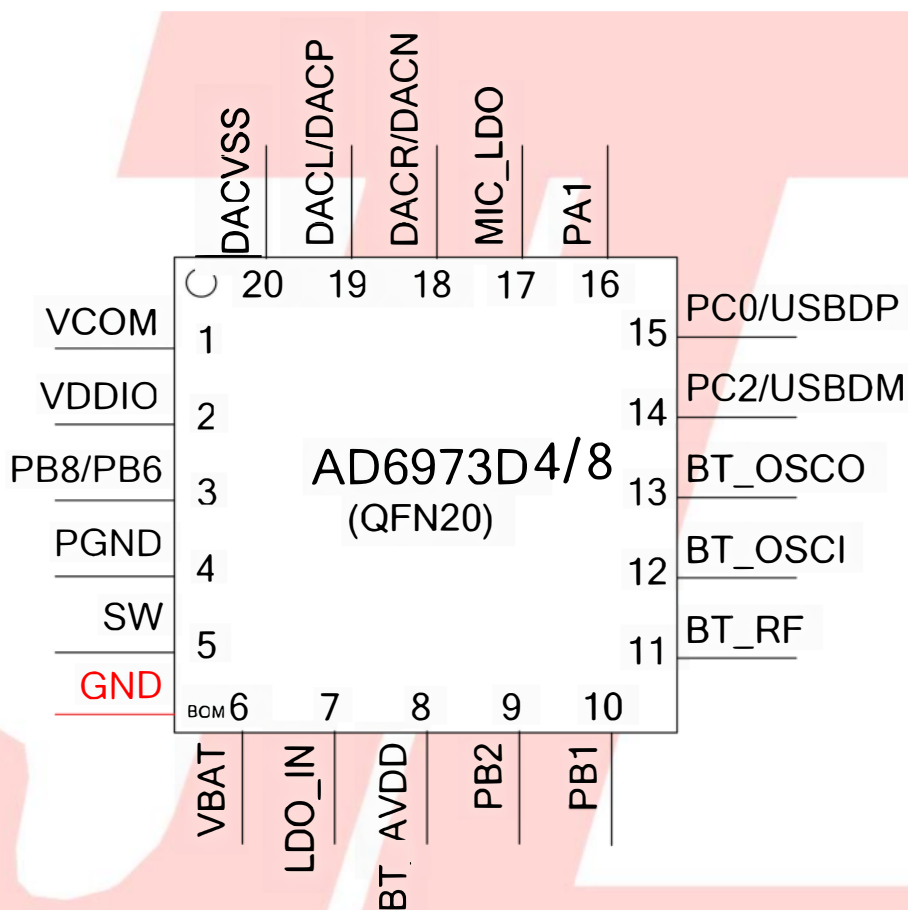


Figure 1-1 AD6973D Package Diagram

## 1.2 Pin Description

Table 1-1 AD6973D Pin Description

PIN NO.	Name	I/O Type	Drive (mA)	Function	Other Function
1	VCOM	P	/		DAC reference voltage
2	VDDIO	P	/		IO Power 3.3v
3	PB8	I/O	8/24	GPIO	MIC1: MIC1 Input Channel; UART0RXB: Uart0 Data Input(B); CAP4: Timer4 Capture;
	PB6	I/O	8/24	GPIO	UART1RXA: Uart1 Data Input(A); PWM2: Timer2 PWM Output; ADC9: ADC Input Channel 9; Touch7: Touch Input Channel 7;
4	PGND	P	/		DCDC Ground
5	SW	P	/	DCDC output	DCDC switch output, connected to inductor
6	VBAT	P	/		connect to battery
7	LDO_IN	P	/		Charge Power Input; UART0TXC: Uart0 Data Output(C); UART0RXC: Uart0 Data Input(C); PWM3: Timer3 PWM Output; CAP1: Timer1 Capture;
8	BT_AVDD	P	/		BT Power
9	PB2	I/O	8/24	GPIO	UART2RXC: Uart2 Data Input(C); SPI2DOC: SPI2 Data Out(C); CAP5: Timer5 Capture; ADC7: ADC Input Channel 7; LP_TH1: Low Power Touch Channel 1
10	PB1	I/O	8/24	GPIO (pull up)	Long Press Reset; SPI2CLKC: SPI2 Clk(C); UART2TXC: Uart2 Data Output(C) ADC6: ADC Input Channel 6; LP_TH0: Low Power Touch Channel 0
11	BT_RF	/	/		BT Antenna
12	BT_OSCI	I	/		BTOSC In
13	BT_OSCO	O	/		BTOSC Out
14	PC2	I/O	8/24		IIC_SCL_C: IIC SCL(C); UART0TXD: Uart0 Data Output(D); TMR1: Timer1 Clock Input;

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	USBDM	I/O	4	USB Negative Data	UART1RXD: Uart1 Data Input(D); IIC_SDA_A: IIC SDA(A); ADC11: ADC Input Channel 11;
15	USBDP	I/O	4	USB Positive Data	UART1TXD: Uart1 Data Output(D); IIC_SCL_A: IIC SCL(A); ADC10: ADC Input Channel 10;
	PC0	I/O	8	GPIO	UART1TXB: Uart1 Data Output(B);
16	PA1	I/O	8/24	GPIO	MIC0: MIC0 Input Channel ; PWM0: Timer0 PWM Output; UART1TXC: Uart1 Data Output(C);
17	MIC_LDO	P	/		MIC Power
18	DACR/DACN	O	/		DAC Right Channel Different DAC Negative Channel
19	DACL/DACP	O	/		DAC Left Channel Different DAC Positive Channel
20	DACVSS	P	/		Analog Ground

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## 2、Electrical Characteristics

### 2.1 Absolute Maximum Ratings

Table 2-1

Symbol	Parameter	Min	Max	Unit
Tamb	Ambient Temperature	-40	+85	°C
Tstg	Storage temperature	-65	+150	°C
VBAT	Supply Voltage	-0.3	4.5	V
LDO_IN	Charger Voltage	-0.3	6	V
V <sub>3.3IO</sub>	3.3V IO Input Voltage	-0.3	3.6	V

Note : The chip can be damaged by any stress in excess of the absolute maximum ratings listed below

### 2.2 PMU Characteristics

Table 2-2

Symbol	Parameter	Min	Typ	Max	Unit	Test Conditions
VBAT	Voltage Input	2.2	3.7	4.2	V	
LDO_IN	Charger supply Voltage	4.5	5.0	5.5	V	
Normal mode						
VDDIO	Voltage output	–	3.0	–	V	VBAT = 4.2V, 10mA loading
	Loading current	–	–	100	mA	VDDIO=3V@VBAT = 4.2V
BT_AVDD	Voltage output	–	1.3	–	V	VDDIO=3.0V, 10mA loading
	Loading current	–	–	60	mA	BT_AVDD=1.25V@VDDIO=3.0v
LP mode						
VDDIO	Loading current			5	mA	VDDIO=3V@VBAT = 4.2V

### 2.3 Battery Charge

Table 2-3

Symbol	Parameter	Min	Typ	Max	Unit	Test Conditions
LDO_IN	Charge Input Voltage	4.5	5	5.5	V	–
V <sub>Charge</sub>	Charge Voltage	4.15	4.2	4.25	V	LDO_IN>4.5V
		4.30	4.35	4.40	V	LDO_IN>4.65V

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$I_{\text{Charge}}$	Charge Current	20		200	mA	Charge current at fast charge mode
$I_{\text{Trickl}}$	Trickle Charge Current	20	45	70	mA	$V_{\text{BAT}} < V_{\text{Trickl}}$

## 2.4 IO Input/Output Electrical Logical Characteristics

Table 2-4

IO input characteristics						
Symbol	Parameter	Min	Typ	Max	Unit	Test Conditions
$V_{\text{IL}}$	Low-Level Input Voltage	-0.3	—	$0.3 * V_{\text{DDIO}}$	V	$V_{\text{DDIO}} = 3.3\text{V}$
$V_{\text{IH}}$	High-Level Input Voltage	$0.7 * V_{\text{DDIO}}$	—	$V_{\text{DDIO}} + 0.3$	V	$V_{\text{DDIO}} = 3.3\text{V}$
IO output characteristics						
$V_{\text{OL}}$	Low-Level Output Voltage	—	—	0.33	V	$V_{\text{DDIO}} = 3.3\text{V}$
$V_{\text{OH}}$	High-Level Output Voltage	2.7	—	—	V	$V_{\text{DDIO}} = 3.3\text{V}$

## 2.5 Internal Resistor Characteristics

Table 2-5

Port	General Output	High Drive	Internal Pull-Up Resistor	Internal Pull-Down Resistor	Comment
PA1, PB1,PB2, PB6,PB8, PC2	8mA	24mA	10K	10K	1、PB1 default pull up 2、USBDM & USBDP default pull down 3、internal pull-up/pull-down resistance   accuracy $\pm 20\%$
PC0	8mA	-	10K	10K	
USBDP	4mA	—	1.5K	15K	
USBDM	4mA	—	180K	15K	

## 2.6 DAC Characteristics

Table 2-6

Parameter	Min	Typ	Max	Unit	Test Conditions
Frequency Response	20	—	20K	Hz	1KHz/0dB 10Kohm loading With A-Weighted Filter
THD+N	—	-80	—	dB	
S/N	—	101	—	dB	
Crosstalk	—	-80	—	dB	
Output Swing	—	0.45	—	V <sub>rms</sub>	
Dynamic Range	—	90	—	dB	1KHz/-60dB

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					10Kohm loading With A-Weighted Filter
DAC Output Power	–	4	–	mW	32ohm loading

## 2.7 ADC Characteristics

Table 2-7

Parameter	Min	Typ	Max	Unit	Test Conditions
Dynamic Range		85		dB	Fsample=44.1kHz Fin=1KHz 2mVpp Input
S/N	–	85	–	dB	Fsample=44.1kHz Fin=1KHz 1.2Vpp Input
THD+N	–	-60	–	dB	
Crosstalk	–	-80	–	dB	

## 2.8 BT Characteristics

### 2.8.1 Transmitter

#### Basic Data Rate

Table 2-8

Parameter	Min	Typ	Max	Unit	Test Conditions
RF Transmit Power		6	8	dBm	25°C, Power Supply VBAT=5V 2441MHz
RF Power Control Range		20		dB	
20dB Bandwidth		950		KHz	
Adjacent Channel	+2MHz		-40	dBm	
	-2MHz		-38	dBm	
Transmit Power	+3MHz		-44	dBm	
	-3MHz		-35	dBm	

#### Enhanced Data Rate

Table 2-9

Parameter	Min	Typ	Max	Unit	Test Conditions
Relative Power		-1		dB	25°C, Power Supply VBAT=5V 2441MHz
$\pi/4$ DQPSK Modulation Accuracy	DEVM RMS		6	%	
	DEVM 99%		10	%	
	DEVM Peak		15	%	
Adjacent Channel	+2MHz		-40	dBm	
	-2MHz		-38	dBm	
Transmit Power	+3MHz		-44	dBm	
	-3MHz		-35	dBm	

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## 2.8.2 Receiver

### Basic Data Rate

Table 2-10

Parameter		Min	Typ	Max	Unit	Test Conditions
Sensitivity			-92		dBm	25°C, Power Supply VBAT=5V 2441MHz
Co-channel Interference Rejection			-13		dB	
Adjacent Channel	+1MHz		+5		dB	
	-1MHz		+2		dB	
	+2MHz		+37		dB	
Interference Rejection	-2MHz		+36		dB	
	+3MHz		+40		dB	
	-3MHz		+35		dB	

### Enhanced Data Rate

Table 2-11

Parameter		Min	Typ	Max	Unit	Test Conditions
Sensitivity			-94		dBm	25°C, Power Supply VBAT=5V 2441MHz
Co-channel Interference Rejection			-13		dB	
Adjacent Channel	+1MHz		+5		dB	
	-1MHz		+2		dB	
	+2MHz		+37		dB	
Interference Rejection	-2MHz		+36		dB	
	+3MHz		+40		dB	
	-3MHz		+35		dB	

## 2.9 ESD Protection

Parameter	Typ.	Test pin	Reference standard
Human Body Mode	±4KV	All pins	JEDEC EIA/JESD22-A114
Machine Mode	±200V	All pins	JEDEC EIA/JESD22-A115
Charge Device Model	±1KV	All pins	JEDEC EIA/JESD22-C101F
Latch up	±200mA	All GPIO pins	JEDEC STANDARD NO.78E
	1.5xVopmax	All power pins	

Note : 1.5xVopmax = 1.5 times maximum operating voltage

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### 3、 Package Information

#### 3.1 QFN20\_3.0x3.0

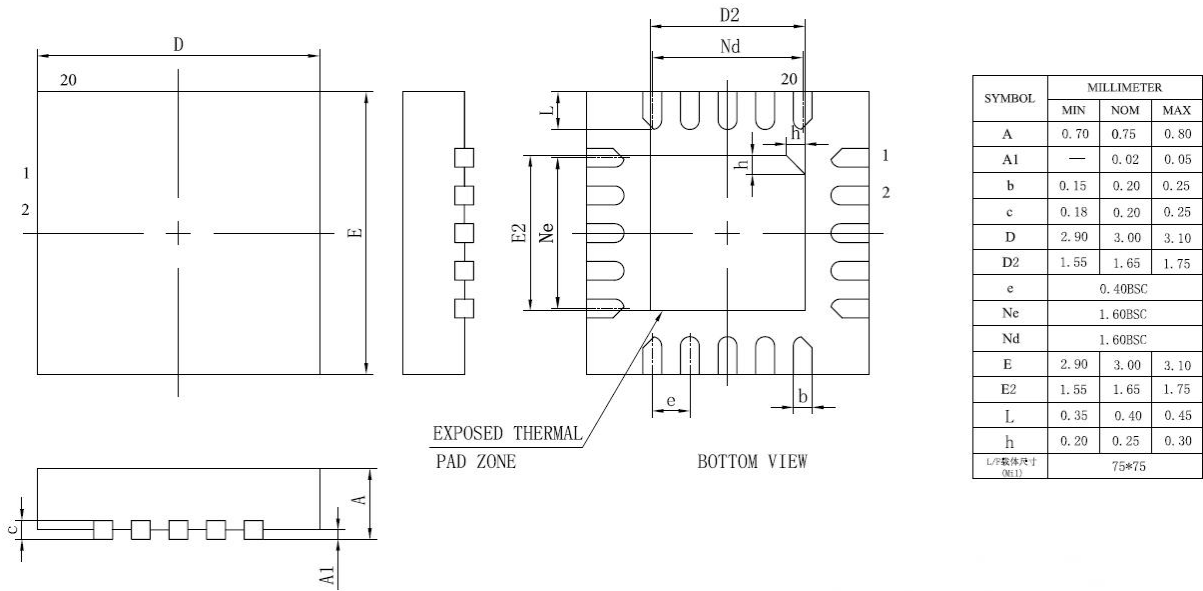


Figure 3-1 AD6973D Package

## 4、 Solder-Reflow Condition

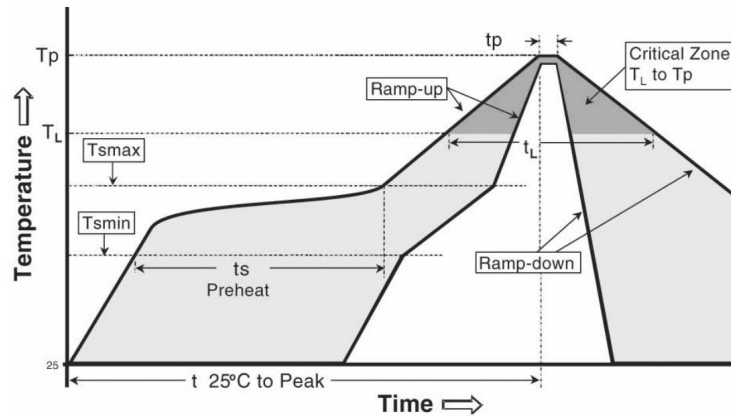


Figure 5-1 Classification Reflow Profile

### Classification Profiles

Table 5-1

Profile Feature		Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat /Soak	Temperature Min ( $T_{smin}$ )	100°C	150°C
	Temperature Max ( $T_{smax}$ )	150°C	200°C
	Time ( $t_s$ ) from ( $T_{smin}$ to $T_{smax}$ )	60-120 seconds	60-180 seconds
Average ramp-up rate ( $T_{smax}$ to $T_p$ )		3°C/second max	3°C/second max
Liquidous temperature ( $T_L$ )		183°C	217°C
Time ( $t_L$ ) maintained above $T_L$		60-150 seconds	60-150 seconds
Peak package body temperature ( $T_p$ )		See Table 5-2	See Table 5-3
Time within 5°C of actual Peak Temperature ( $t_p$ ) <sup>2</sup>		10-30 seconds	20-40 seconds
Ramp-down rate ( $T_p$ to $T_L$ )		6°C/second max	6°C/second max
Time 25°C to peak temperature		6 minutes max	8 minutes max

Note 1: All temperatures refer to topside of the package, measured on the package body surface.

Note 2: Time within 5°C of actual peak temperature ( $t_p$ ) specified for the reflow profiles is a “supplier” minimum and “user” maximum.

### SnPb - Classification Temperature

Table 5-2

Package Thickness	Volume mm <sup>3</sup> < 350	Volume mm <sup>3</sup> ≥ 350
<2.5 mm	240 +0/-5°C	225 +0/-5°C
≥2.5 mm	225 +0/-5°C	225 +0/-5°C

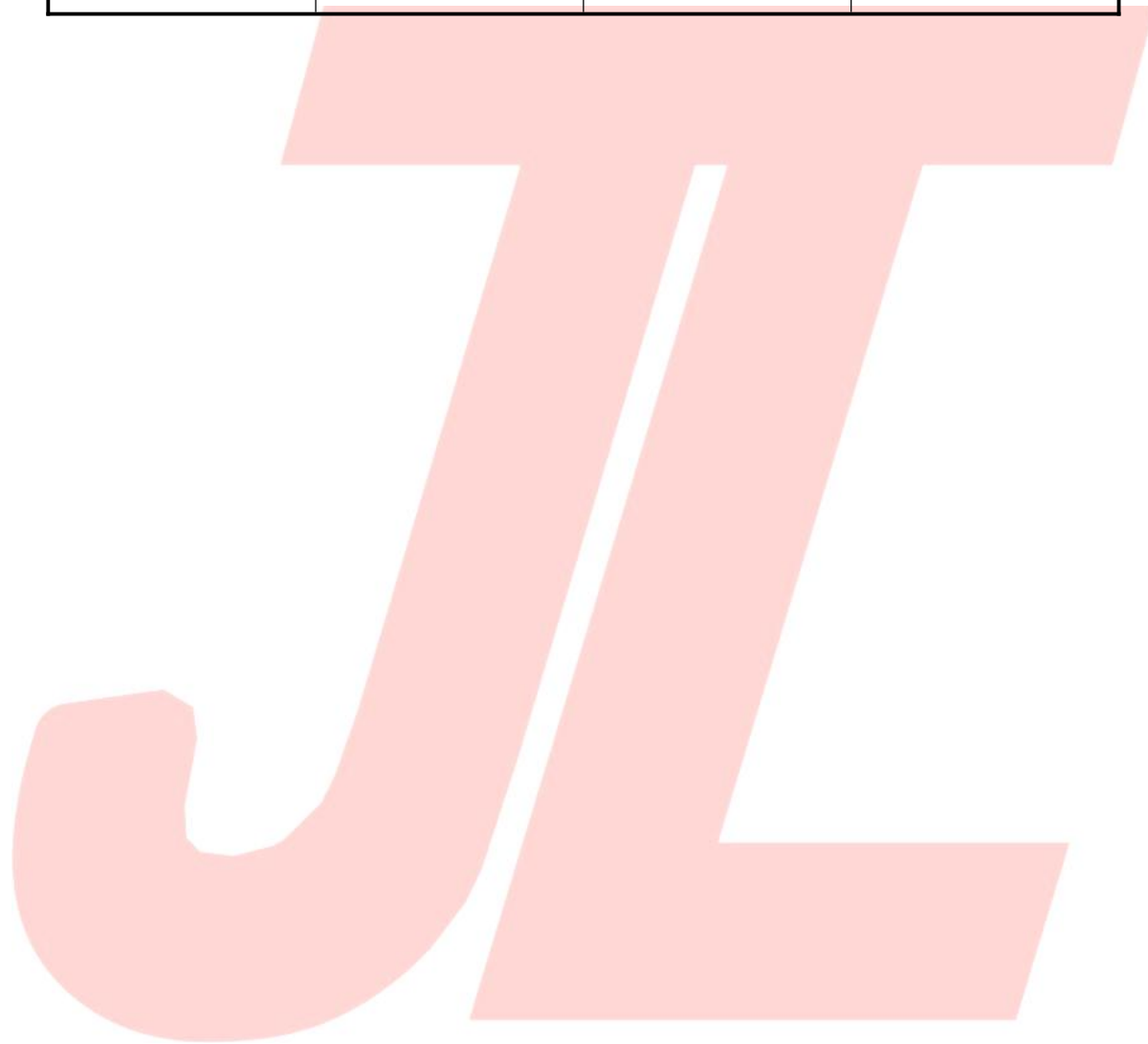
### Pb-free - Classification Temperature

Table 5-3

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<b>Package Thickness</b>	<b>Volume mm<sup>3</sup> &lt; 350</b>	<b>Volume mm<sup>3</sup> 350 - 2000</b>	<b>Volume mm<sup>3</sup> &gt; 2000</b>
< 1.6mm	260°C	260°C	260°C
1.6 mm - 2.5mm	260°C	250°C	245°C
> 2.5mm	250°C	245°C	245°C

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## 5、 Revision History

Date	Revision	Description
2020.08.18	V2.0	Initial Release
2020.10.12	V2.1	Update PMU characteristics Add Bluetooth profiles version number
2021.07.21	V2.2	Update Bluetooth characteristics, Charge characteristics, Audio characteristics
2021.08.09	V2.3	Update Package Information
2021.10.22	V2.4	Update Bluetooth Vision and profiles
2022.01.10	V2.5	Add Chip ESD Protection Characteristics
2022.05.16	V3.0	Update DAC PIN Define, Audio ADC characteristics Add Chip Solder-Reflow Condition
2023.10.20	V3.0	Update AD6973D BT_Features &Applications