AD6976D Datasheet

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AD6976D Features

CPU

- 32-bit DSP supports hardware Float Point Unit(FPU)
- Up to 160MHz programmable processor
- 64Vectored 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 >= 101dB
- Two channels 24-bit ADC , SNR >= 85dB
- Sampling rates of 8KHz/11.025KHz/16KHz/22.05KHz/ 24KHz/32KHz/44.1KHz/48KHz are supported
- Two 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 V5.3+BR+EDR+BLE specification
- Meet class2 and class3 transmitting power requirement
- Support GFSK and π/4 DQPSK all packet types
- Provides maximum +8dbm transmitting power
- receiver with minimum -94dBm sensitivity
- Fast AGC for enhanced dynamic range
- Supports a2dp\avctp\avdtp\avrcp\hfp\spp\smp\att\gap \gatt\rfcomm\sdp\l2cap profile
- a2dp 1.3.2\avctp 1.4\avdtp 1.3\ avrcp 1.6.2\ hfp 1.8 \spp 1.2\rfcomm 1.1\pnp 1.3\ hid 1.1.1\sdp core5.3\l2cap core 5.3

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 hard ware IIC interface supports host and device mode
- Built-in Cap Sense Key controller
- Two Built-in low power Cap Sense Keys
- 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

- QFN32(4mm*4mm)

Temperature

- Operating temperature: -40℃ to +85℃
- Storage temperature: -65℃ to +150℃

Applications

- Bluetooth TWS headsets

1、Pin Definition

1.1 Pin Assignment

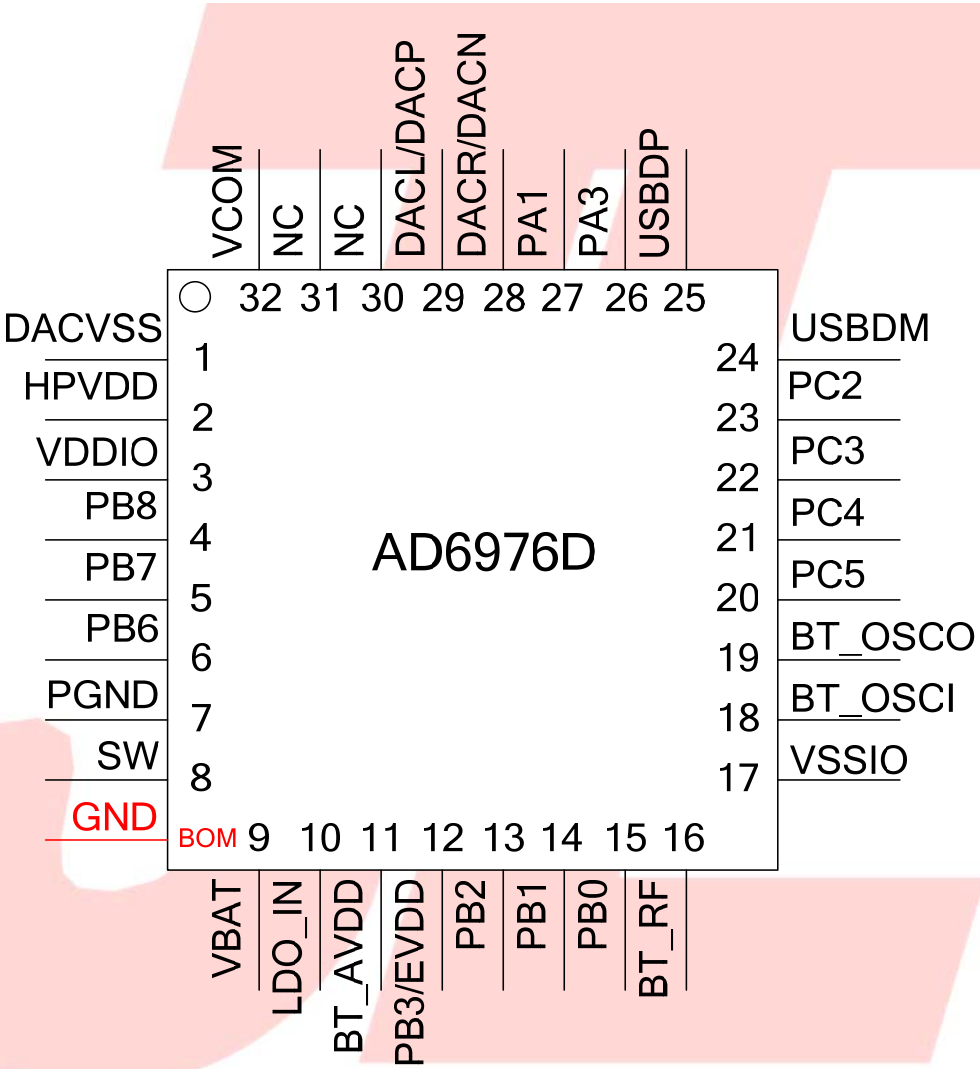


Figure 1-1 AD6976D Package Diagram

1.2 Pin Description

Table 1-1 AD6976D Pin Description

PIN NO.	Name	I/O Type	Drive (mA)	Function	Other Function
1	DACVSS	P	/		Analog Ground
2	HPVDD	P	/		Headphone AMP Power
3	VDDIO	P	/		IO Power 3.3v
4	PB8	I/O	8/24	GPIO	MIC1：MIC1 Input Channel； UART0RXB：Uart0 Data Input(B)； CAP4：Timer4 Capture；
5	PB7	I/O	8/24	GPIO	MIC_BIAS1：MIC1 Bias Output； UART0TXB：Uart0 Data Output(B);
6	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;
7	PGND	P	/		DCDC Ground
8	SW	P	/		DCDC switch output, connected to inductor
9	VBAT	P	/		Power Supply, connect to battery
10	LDO_IN	P	/		Charge Power Input; UART0TXC：Uart0 Data Output(C); UART0RXC：Uart0 Data Input(C); PWM3：Timer3 PWM Output； CAP1：Timer1 Capture;
11	BT_AVDD	P	/	GPIO	BT Power
12	PB3	I/O	8/24	GPIO	
	EVDD	P	/		EVDD：Supply volte to peripherals
13	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
14	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
15	PB0	I/O	8	GPIO	SPI2_DIC：SPI2 Data In(C);

				(High Voltage Input)	ALNK_MCLK(B)：ALNK1 Master Clock(B); TMR4：Timer4 Clock Input;
16	BT_RF	/	/		BT Antenna
17	VSSIO	P	/		Ground
18	BT_OSCI	I	/		BTOSC In
19	BT_OSCO	O	/		BTOSC Out
20	PC5	I/O	8/24	GPIO	UART2RXD：Uart2 Data Input(D); SPI1DOB：SPI1 Data Out(B); ALNK_DAT3(B)：Audio Link Data3(B); IIC_SDA_B：IIC SDA(B)； ADC5：ADC Input Channel 5；
21	PC4	I/O	8/24	GPIO	UART2TXD：Uart2 Data Output(D); SPI1CLKB：SPI1 Clock(B); ALNK_DAT2(B)：Audio Link Data2(B); IIC_SCL_B：IIC SCL(B)； ADC4：ADC Input Channel 4； PWM4：Timer4 PWM Output；
22	PC3	I/O	8/24	GPIO	UART0RXD：Uart0 Data Input(D); SPI1DIB：SPI1 Data In(B); ALNK_LRCK(B)：Audio Link Word Select(B); IIC_SDA_C：IIC SDA(C)； TMR3：Timer3 Clock Input;
23	PC2	I/O	8/24	GPIO	ALNK_SCLK(B)：Audio Link Serial Clock(B); IIC_SCL_C：IIC SCL(C)； UART0TXD：Uart0 Data Output(D); TMR1：Timer1 Clock Input;
24	USBDM	I/O	4	USB Negative Data	UART1RXD：Uart1 Data Input(D)； IIC_SDA_A：IIC SDA(A)； ADC11：ADC Input Channel 11；
25	USBDP	I/O	4	USB Positive Data	UART1TXD：Uart1 Data Output(D)； IIC_SCL_A：IIC SCL(A)； ADC10：ADC Input Channel 10；
26	PA3	I/O	8/24	GPIO	UART2TXA：Uart2 Data Output(A); ADC0：ADC Input Channel 0； PWM1：Timer1 PWM Output； Touch0：Touch Input Channel 0;
27	PA1	I/O	8/24	GPIO	MIC0：MIC0 Input Channel ; PWM0：Timer0 PWM Output； UART1TXC：Uart1 Data Output(C)；
28	DACR/DACN	O	/		DAC Right Channel Different DAC Negative Channel

29	DACL/DACP	O	/		DAC Left Channel Different DAC Positive Channel
30	NC				
31	NC				
32	VCOM	P	/		DAC reference voltage

2、Electrical Characteristics

2.1 Absolute Maximum Ratings

Table 2-1

Symbol	Parameter	Min	Max	Unit
Topt	Operating 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
$V_{3.3IO}$	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
EVDD	Voltage output	_	1.1	_	V	BT_AVDD=1.25V, 1mA loading
	Loading current	_	_	5	mA	EVDD=1.1V@BT_AVDD=1.25v
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_{Charge}	Charge Voltage	4.15	4.2	4.25	V	LDO_IN＞4.5V

		4.30	4.35	4.40	V	LDO_IN＞4.65V
I_{Charge}	Charge Current	20		200	mA	Charge current at fast charge mode
I_{Trikl}	Trickle Charge Current	20	45	70	mA	$V_{BAT}<V_{Trikl}$

2.4 IO Input/Output Electrical Logical Characteristics

Table 2-4

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

2.5 Internal Resistor Characteristics

Table 2-5

Port	**General Output**	**High Drive**	**Internal Pull-Up Resistor**	**Internal Pull-Down Resistor**	**Comment**
PA1~PA3 PC2~PC5 PB3~PB3 PB6~PB8	8mA	24mA	10K	10K	1、PB1 default pull up 2、USBDM & USBDP default pull down 3、internal pull-up/pull-down resistance | accuracy ±20%
PB0	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		Vrms	
Dynamic Range		90		dB	1KHz/-60dB 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℃, Power Supply VBAT=5V 2441MHz
RF Power Control Range			20		dB	
20dB Bandwidth			950		KHz	
Adjacent Channel Transmit Power	+2MHz		-40		dBm	
	-2MHz		-38		dBm	
	+3MHz		-44		dBm	
	-3MHz		-35		dBm	

Enhanced Data Rate **Table 2-9**

Parameter		Min	Typ	Max	Unit	Test Conditions
Relative Power			-1		dB	25℃, Power Supply VBAT=5V 2441MHz
π/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	

2.8.2 Receiver

Basic Data Rate **Table 2-10**

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

2.8.3 BLE Transmitter

1M Data Rate **Table 2-12**

Parameter		Min	Typ	Max	Unit	Test Conditions
Sensitivity			-94		dBm	25℃, Power Supply VBAT=5V 2441MHz
RF Transmit Power			7	9	dB	
In-band Spurious Emission	+2MHz		-42	-20	dB	
	-2MHz		-34	-20	dB	
	+3MHz		-46	-30	dB	
	-3MHz		-36	-30	dB	
Modulation	Δf1 avg	225	247			

Characteristics	Δf2 99%	185	236			
	Δf1avg/Δf2av	0.8	0.9			
Carrier Frequency Offset		-150	+/-10	+150	KHz	
Frequency Drift		-50	+/-5	+50	KHz	
Frequency Drift Rate		-20	3	+20	KHz/50us	

2M Data Rate **Table 2-13**

Parameter		Min	Typ	Max	Unit	Test Conditions
Sensitivity			-94		dBm	
RF Transmit Power			7	9	dB	
Adjacent Channel Transmit	+2MHz		-46	-20	dB	
	-2MHz		-38	-20	dB	
	+3MHz		-53	-30	dB	25℃, Power Supply VBAT=5V 2441MHz
	-3MHz		-42	-30	dB	
Frequency Deviation	Δf1 avg	450	520			
	Δf2 99%	370	500			
	Δf1avg/Δf2av	0.8	0.9			
Carrier Frequency Offset		-150	+/-10	+150	KHz	
Frequency Drift		-50	+/-5	+50	KHz	
Frequency Drift Rate		-20	+/-3	+20	KHz/50us	

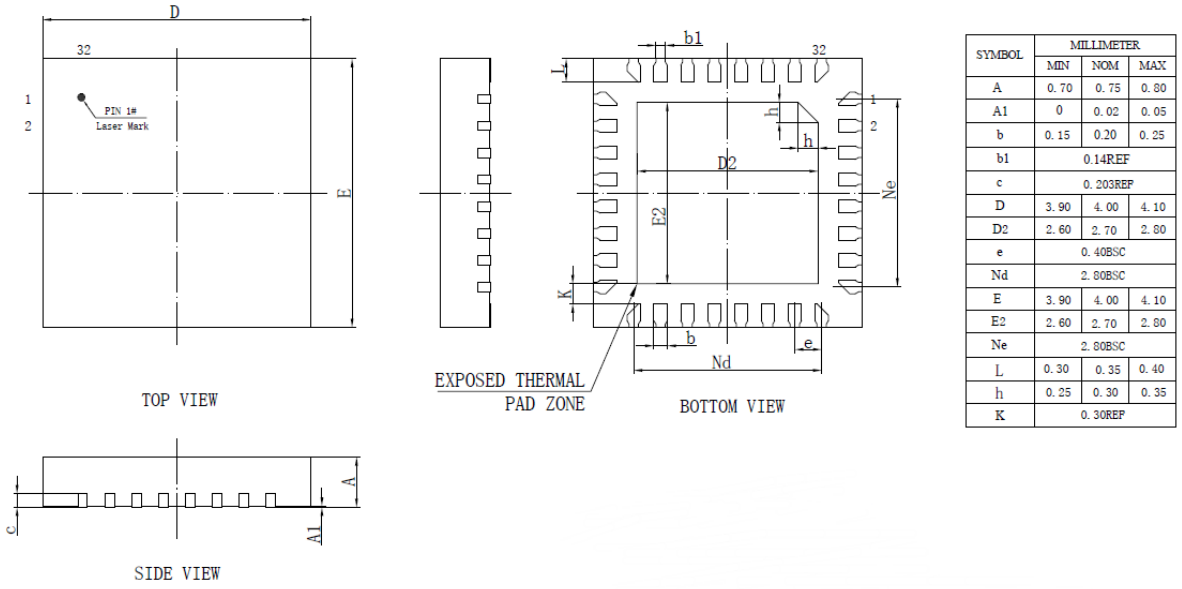
2.9 ESD Protection

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

3、Package Information

3.1 QFN32_4.0x4.0



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.15	0.20	0.25
b1		0.14REF	
c		0.203REF	
D	3.90	4.00	4.10
D2	2.60	2.70	2.80
e		0.40BSC	
Nd		2.80BSC	
E	3.90	4.00	4.10
E2	2.60	2.70	2.80
Ne		2.80BSC	
L	0.30	0.35	0.40
h	0.25	0.30	0.35
K		0.30REF	

Figure 3-1 AD6976D Package

4、Solder-Reflow Condition

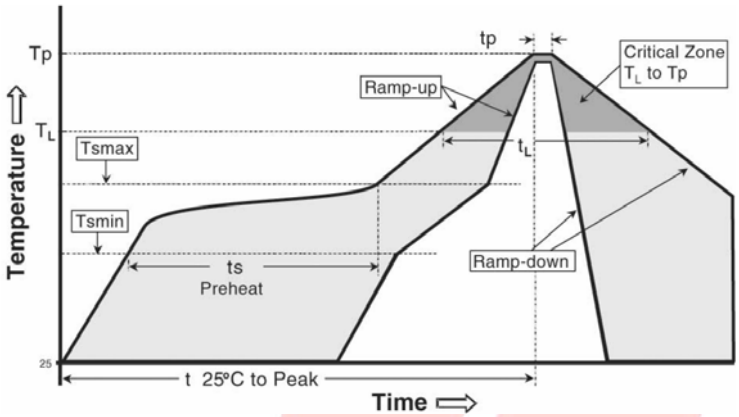


Figure 5-1 Classification Reflow Profile

Classification Profiles **Table 5-1**

Profile Feature		Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat /Soak	Temperature Min (T_{smin})	100℃	150℃
	Temperature Max (T_{smax})	150℃	200℃
	Time (ts) from (T_{smin} to T_{smax})	60-120 seconds	60-180 seconds
Average ramp-up rate (T_{smax} to T_p)		3℃/second max	3℃/second max
Liquidous temperature (T_L) Time (t_L) maintained above T_L		183℃ 60-150 seconds	217℃ 60-150 seconds
Peak package body temperature (T_p)		See Table 5-2	See Table 5-3
Time within 5℃ of actual Peak Temperature (tp)[2]		10-30 seconds	20-40 seconds
Ramp-down rate (T_p to T_L)		6℃/second max	6℃/second max
Time 25℃ 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℃ of actual peak temperature (tp) specified for the reflow profiles is a “supplier” minimum and “user” maximum.

SnPb - Classification Temperature **Table 5-2**

Package Thickness	Volume mm^3 < 350	Volume mm^3 ⩾ 350
<2.5 mm	240 +0/-5℃	225 +0/-5℃
⩾2.5 mm	225 +0/-5℃	225 +0/-5℃

Pb-free - Classification Temperature **Table 5-3**

Package Thickness	Volume mm^3 < 350	Volume mm^3 350 - 2000	Volume mm^3 > 2000
< 1.6mm	260℃	260℃	260℃
1.6 mm - 2.5mm	260℃	250℃	245℃
> 2.5mm	250℃	245℃	245℃

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
2021.07.12	V2.2	Add Bluetooth LE characteristics Update Bluetooth characteristics，Charge characteristics, Audio characteristics
2021.08.10	V2.3	Update Bluetooth and profile Visions
2022.01.10	V2.4	Add Chip ESD Protection Characteristics
2022.05.16	V3.0	Update DAC PIN Define，Audio ADC characteristics Add Chip Solder-Reflow Condition