AC7065E Datasheet

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Version 2.0

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Revision History

Date	Revision	Description
2024.04.01	V1.0	Initial Release
2024.04.25	V1.1	Update Datasheet Format And Content
2024.07.30	V1.2	Update Pin Description Update FM Characteristics
2024.09.27	V1.3	Update Pin Description(Update FMIP IO Type)
2025.01.16	V2.0	Update Features_Bluetooth Update Block Diagram

Table of Contents

Revision History **1**
Table of Contents **2**
AC7065E Features **3**
1 Block Diagram **4**
2 Pin Definition **5**
2.1 Pin Assignment 5
2.2 Pin Description 6
3 Electrical Characteristics **9**
3.1 Absolute Maximum Ratings 9
3.2 ESD Ratings 9
3.3 PMU Characteristics 9
3.4 Battery Charge 10
3.5 IO Characteristics 10
3.6 Audio DAC Characteristics 11
3.7 Audio ADC Characteristics 13
3.8 BT Characteristics 14
3.9 FM Characteristics 15
4 Package Information **16**
4.1 SSOP24 16
5 IC Marking Information **17**
6 Solder-Reflow Condition **18**

AC7065E Features

SYSTEM

- 32-bit Single-core DSP 192MHz
- With IEEE754 Single precision FPU
- Support FFT/MATRIX/MATH
- 1 x I-cache
- Support EMU
- On-chip SRAM 152kbyte
- Support MMU
- Support MPU
- Built-In Flash
- 24MHz crystal oscillator
- 32.768kHz crystal oscillator
- Internal RC oscillator,PLL

DSP Audio Processing

- SBC/AAC codec
- mSBC voice codec supported for BT phone
- PLC for voice processing
- Single MIC ENC
- Multi-band DRC
- Multi-band EQ
- Support spatial sound

Audio

- 2 x 16bit DAC
  - SNR 108dB
  - Noise 6uVrms
  - Supports differential mode
  - Sampling rate 8~96kHz
- 1 x 16bit ADC
  - SNR 98dB
  - Sampling rate 8~48kHz
  - Support AMUX
- I^2S AUDIO Master/Slave interface

Bluetooth

- Dual-mode BT6.0 with LE Audio (DN Q332415)
- Support AoA/AoD
- Support LE audio BIS/CIS
- Support long range BLE
- Maximum transmitting power 10dBm
- Receiver sensitivity
  - -93dBm @BR
  - -92dBm @EDR Π/4 DQPSK
  - -84dBm @EDR 8DPSK

FM

- FM RX,Support Mono/Stereo
- Receiver sensitivity 10 dBuV

Peripherals

- 1 x Full speed USB
- 1 x SD host controller
- 4 x Multi-function 16bit timer
- 2 x UART interface
- 1 x I^2C Master/Slave interface
- 2 x SPI Master/Slave interface
- 1 x QDEC
- 4 x MCPWM
- 1 x 10bit ADC(11 Channel)
- 12 x GPIO Support function remapping

PMU

- Integrated battery charger up to 300mA
- Support temperature sensor
- VPWR range 4.5V to 5.5V
- VBAT range 2.7V to 4.5V
- IOVDD range 2.7V to 3.6V

Packages

- SSOP24

Temperature

- Operating temperature
  TC = -20℃ to +85℃(standard range)
  TC = -40℃ to +105℃(extended range)
- Storage temperature -65℃ to +150℃

Applications

- Bluetooth live sound card
- Bluetooth soundbar

1 Block Diagram

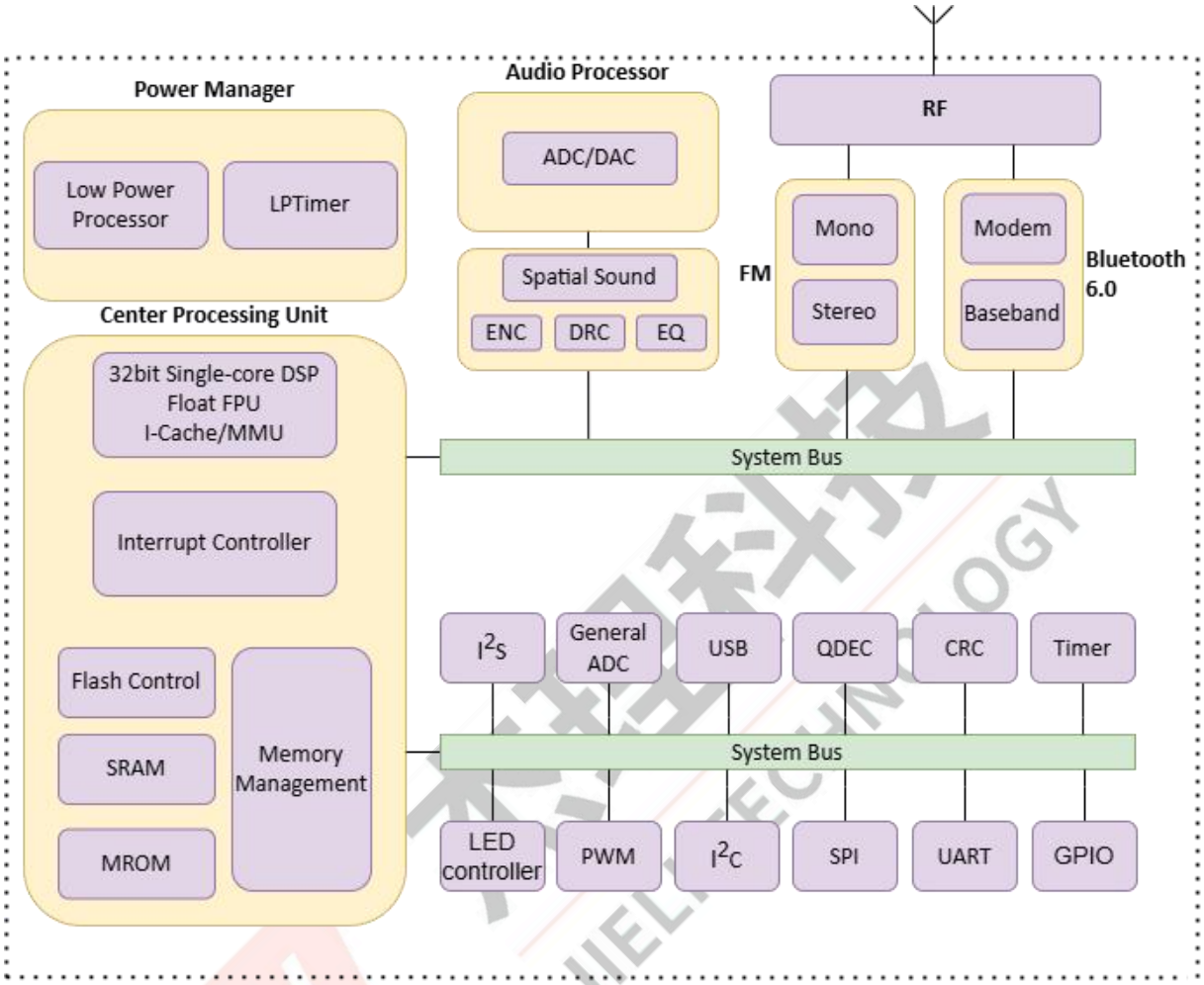


Figure 1-1 AC7065E Block Diagram

2 Pin Definition

2.1 Pin Assignment

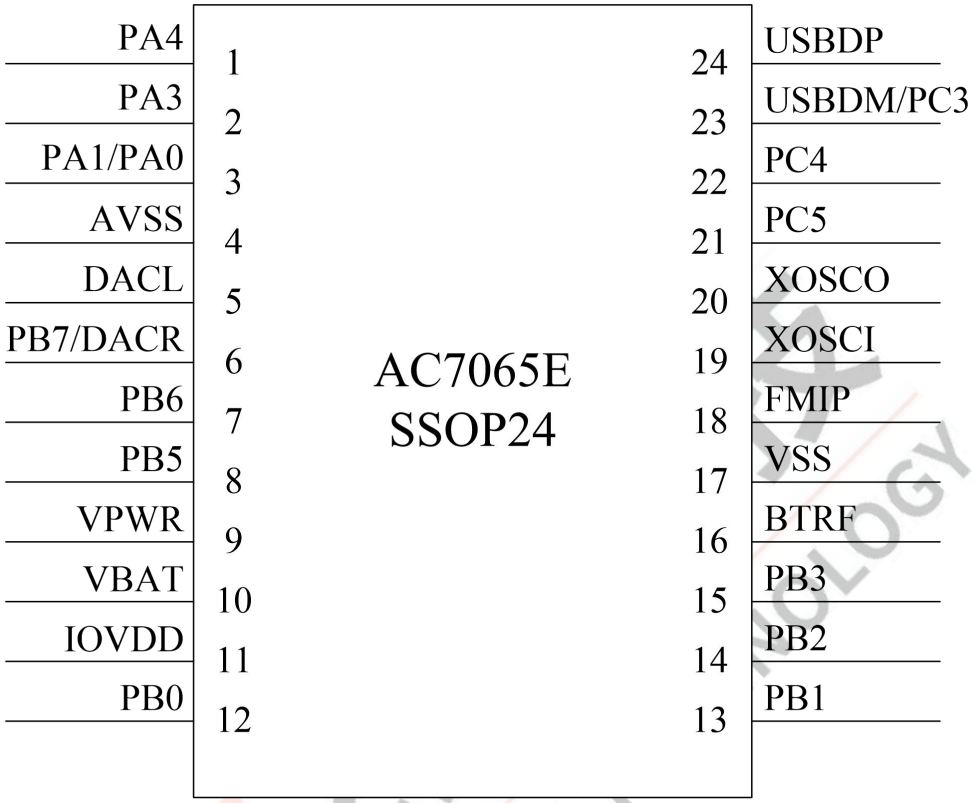


Figure 2-1 AC7065E Pin Assignment

2.2 Pin Description

Table 2-2-1 AC7065E Pin Description

Pin No.	Name	Type	IO Initial State	Description
1	PA4	I/O	Z	ADC3(ADC Input Channel 3) AUX2(Audio ADC Input) SPI1 DATA1(A) I^2S LRCK(A) I^2S Data3(B)
2	PA3	I/O	Z	ADC2(ADC Input Channel 2) AUX1(Audio ADC Input) SPI1 DATA0(A) I^2S SCLK(A) I^2S Data2(B)
3	PA1	I/O	Z	ADC1(ADC Input Channel 1) MIC(Audio ADC Input) I^2S Data1(A)
	PA0	I/O	Z	ADC0(ADC Input Channel 0) MICBIAS(MIC Bias Output) I^2S Data0(A) I^2S Data0(B) Clockout0
4	AVSS	G	--	Audio Ground
5	DACL	O	--	Left Channel DAC Output
6	DACR	O	--	Right Channel DAC Output
	PB7	I/O	Z	ADC9(ADC Input Channel 9) SPI0 DATA0(B) SPI1 DATA0(C) I^2C SDA(C) Q-decoder DATA1
7	PB6	I/O	Z	ADC8(ADC Input Channel 8) AUX0(Audio ADC Input) SPI0 CLK(B) SPI1 CLK(C) I^2C SCL(C) TIMER3 CLK
8	PB5	I/O	Z	ADC5(ADC Input Channel 5) SD Power SPI0 DATA1(B) SPI1 DATA1(C)

Pin No.	Name	Type	IO Initial State	Description
9	VPWR	I/O	Z	Charge Power Input UART0 TX(C) UART0 RX(C) TIMER3 PWM TIMER1 Capture
10	VBAT	P	--	Battery Input
11	IOVDD	P	--	IO Power
12	PB0	I/O	Z	UART0 TX(B)
13	PB1	I/O	200kΩ Pull-up	Hold down 0 to reset UART0 RX(B) TIMER2 CLK
14	PB2	I/O	Z	ADC6(ADC Input Channel 6) 32.768k Crystal Oscillator Input TIMER0 Capture
15	PB3	I/O	Z	AUX3(Audio ADC Input) 32.768k Crystal Oscillator Output TIMER2 PWM
16	BTRF	RF	--	Bluetooth RF Antenna
17	VSS	G	--	Ground
18	FMIP	RF	--	FM Postive Input
19	XOSCI	I	--	Crystal Oscillator Input
20	XOSCO	O	--	Crystal Oscillator Output
21	PC5	I/O	Z	ADC12(ADC Input Channel 12) SPI1 DATA0(B) I^2C SDA(B) TIMER1 CLK
22	PC4	I/O	Z	ADC11(ADC Input Channel 11) SPI1 CLK(B) I^2C SCL(B) TIMER1 PWM
23	PC3	I/O	Z	ADC10(ADC Input Channel 10) SPI1 Data1(B) SPI1 Data1(D) UART0 TX(D) UART0 RX(D) TIMER2 Capture
	USBDM	I/O	15kΩ Pull-down	ADC14(ADC Input Channel 14) USB Negative Data SPI1 DATA0(D) I^2C SDA(A)

Pin No.	Name	Type	IO Initial State	Description
24	USBDP	I/O	15kΩ Pull-down	ADC13(ADC Input Channel 13) USB Positive Data SPI1 CLK(D) I^2C SCL(A)

Note

1.IO initial state abbreviations Z--High resistance, H--High level, L--Low level, X--May be changed during power on.

2.Timer, UART0 and QDEC functions also can be remapped to any I/O.

3.MCPWM, UART1, SD functions can be remapped to any I/O.

Table 2-2-2 Pin Types Description

Pin Type	Description	Pin Type	Description
P	Power	I/O	Input or Output
G	Ground	I	Input
RF	RF antenna	O	Output

3 Electrical Characteristics

3.1 Absolute Maximum Ratings

Table 3-1 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
Topt	Operating temperature	-20	+85	℃
Tstg	Storage temperature	-65	+150	℃
VBAT	Supply Voltage	-0.3	4.5	V
VPWR		-0.3	6.0	V
IOVDD		-0.3	3.6	V
GPIO	Input voltage of GPIO (except PB0)	-0.3	3.6	V
HVTIO	Input voltage of HVT-IO (PB0)	-0.3	6.0	V

Note

1.Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device.

3.2 ESD Ratings

Table 3-2 ESD Ratings

Parameter	Typ	Test pin	Reference standard
Human Body Mode	±4kV	All pins	JEDEC EIA/JESD22-A114
Machine Mode	±400V	All pins	JEDEC EIA/JESD22-A115
Charge Device Model	±2kV	All pins	JEDEC EIA/JESD22-C101F

3.3 PMU Characteristics

Table 3-3 PMU Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
VPWR	Power supply	--	4.5	5.0	5.5	V
VBAT	Power supply	--	2.7	3.7	4.5	V
Operating mode						
Symbol	**Parameter**	**Conditions**	**Min**	**Typ**	**Max**	**Unit**
IOVDD	Voltage output	--	--	3.0	--	V
	Loading current	IOVDD=3.0V@VBAT = 3.7V	--	--	250	mA
Low Power mode						
Symbol	**Parameter**	**Conditions**	**Min**	**Typ**	**Max**	**Unit**
IOVDD	Loading current	IOVDD=3.0V@VBAT = 3.7V	--	--	10	mA

3.4 Battery Charge

Table 3-4 Charger Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
VPWR	Charge Input Voltage	VBAT+0.1V	5.0	5.5	V
CV	CV Mode Voltage Accuracy	4.175	4.2	4.225	V
		4.325	4.35	4.375	V
CC	CC Mode Current	20	--	300	mA
I_{end}	End Of Charge Current	2	--	30	mA
V_{Trikl}	Trickle Charge Voltage	--	3.0	--	V

3.5 IO Characteristics

Table 3-5 IO Characteristics

Input Characteristics						
Symbol	**Parameter**	**Conditions**	**IO**	**Min**	**Max**	**Unit**
V_{IL}	Low-Level Input Voltage	IOVDD = 3.0V	PA0,PA1,PA3,PA4 PB0~PB3,PB5~PB7 PC3~PC5 USBDP USBDM VPWR	-0.3	1.4	V
V_{IH}	High-Level Input Voltage	IOVDD = 3.0V	PA0,PA1,PA3,PA4 PB1~PB3,PB5~PB7 PC3~PC5 USBDP USBDM	1.7	3.3	V
		IOVDD = 3.0V	PB0 VPWR	1.7	5.5	V
Output Characteristics						
Symbol	**Parameter**	**Conditions**	**IO**	**Typ**		**Unit**
$\lvert I_{OL} \rvert$	Output Current	IOVDD = 3.0V Voutput = 0.3V	PA0,PA1,PA3,PA4 PB1~PB3,PB5~PB7 PC3~PC5	2(HD=0) 6(HD=1) 20(HD=2) 24(HD=3)		mA
		IOVDD = 3.0V Voutput = 0.3V	VPWR	2		mA
		IOVDD = 3.0V Voutput = 0.3V	PB0 USBDP USBDM	8		mA
$\lvert I_{OH} \rvert$	Output Current	IOVDD = 3.0V Voutput = 2.7V	PA0,PA1,PA3,PA4 PB1~PB3,PB5~PB7 PC3~PC5	2(HD=0) 6(HD=1) 20(HD=2)		mA

				45(HD=3)	
		IOVDD = 3.0V Voutput = 2.7V	VPWR	2	mA
		IOVDD = 3.0V Voutput = 2.7V	PB0 USBDP USBDM	8	mA
Internal Resistance Characteristics					
Symbol	**Parameter**	**Conditions**	**IO**	**Typ**	**Unit**
R_{pu}	Pull-up Resistance	IOVDD = 3.0V	PA0,PA1,PA3,PA4 PB0,PB2,PB3 PB5~PB7 PC3~PC5	10k	Ω
		IOVDD = 3.0V	PB1 VPWR	200k	Ω
		IOVDD = 3.0V	USBDP	1.5k	Ω
		IOVDD = 3.0V	USBDM	180k	Ω
R_{pd}	Pull-down Resistance	IOVDD = 3.0V	PA0,PA1,PA3,PA4 PB0~PB3,PB5~PB7 PC3~PC5 VPWR	10k	Ω
		IOVDD = 3.0V	USBDP USBDM	15k	Ω

Note

1.Internal pull-up/pull-down resistance accuracy ±20%

3.6 Audio DAC Characteristics

Table 3-6 Stereo DAC Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Resolution	--	--	16	--	bit
Sample Rate	--	8	--	96	kHz
SNR①	Differential Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	108	--	dB
	Single-ended Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	97	--	dB

Parameter	Conditions	Min	Typ	Max	Unit
Dynamic Range	Differential Mode Fin=1kHz@-60dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	102	--	dB
	Single-ended Mode Fin=1kHz@-60dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	94	--	dB
THD+N	Differential Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	-85	--	dB
	Single-ended Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	-80	--	dB
Noise Floor	Differential Mode B/W=20Hz~20kHz A-Weighted load=10kΩ	--	13	--	uVrms
	Single-ended Mode B/W=20Hz~20kHz A-Weighted load=10kΩ	--	16	--	uVrms
Noise Floor with MUTE	Differential Mode B/W=20Hz~20kHz A-Weighted load=10kΩ	--	6	--	uVrms
	Single-ended Mode B/W=20Hz~20kHz A-Weighted load=10kΩ	--	12	--	uVrms
Stereo Crosstalk	Single-ended Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=10kΩ	--	-110	--	dB
Max Output Power	Differential Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=16Ω	--	82	--	mW

Parameter	Conditions	Min	Typ	Max	Unit
	THD+N＜0.1%				
	Single-ended Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted load=16Ω THD+N＜0.1%	--	33	--	mW

Note

1.①SNR is the ratio of output level with a 1kHz full-scale input to output level with MUTE on

3.7 Audio ADC Characteristics

Table 3-7 Audio ADC Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Resolution	--	--	16	--	bit
Sample Rate	--	8	--	48	kHz
SNR	Differential input Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted ADC gain=0dB	--	98	--	dB
	Single-ended input Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted ADC gain=0dB	--	94	--	dB
Dynamic Range	Differential input Mode Fin=1kHz@-60dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted ADC gain=0dB	--	98	--	dB
	Single-ended input Mode Fin=1kHz@-60dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted ADC gain=0dB	--	94	--	dB
THD+N	Differential input Mode Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted ADC gain=0dB	--	-90	--	dB
	Single-ended input Mode	--	-80	--	dB

Parameter	Conditions	Min	Typ	Max	Unit
	Fin=1kHz@0dBFS Fs=44.1kHz B/W=20Hz~20kHz A-Weighted ADC gain=0dB				
Analogue Gain	--	-6	--	21	dB
Max Input Level	Differential input Mode ADC gain=0dB	--	2	--	Vrms
	Single-ended input Mode ADC gain=0dB	--	1	--	Vrms

3.8 BT Characteristics

3.8.1 Transmitter

Table 3-8-1 Transmitter characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Maximum RF Transmit Power	BR	--	8	10	dBm
Maximum RF Transmit Power	EDR Π/4 DQPSK EDR 8DPSK	--	8	--	dBm
Relative Transmit Power	EDR Π/4 DQPSK EDR 8DPSK	--	-3	--	dB
Maximum RF Transmit Power	BLE-1Mbps	--	8	--	dBm

3.8.2 Receiver

Table 3-8-2 Receiver characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Sensitivity	BR	--	-93	--	dBm
	EDR Π/4 DQPSK	--	-92	--	dBm
	EDR 8DPSK	--	-84	--	dBm
	BLE-1Mbps	--	-96	--	dBm
	BLE-2Mbps	--	-93	--	dBm

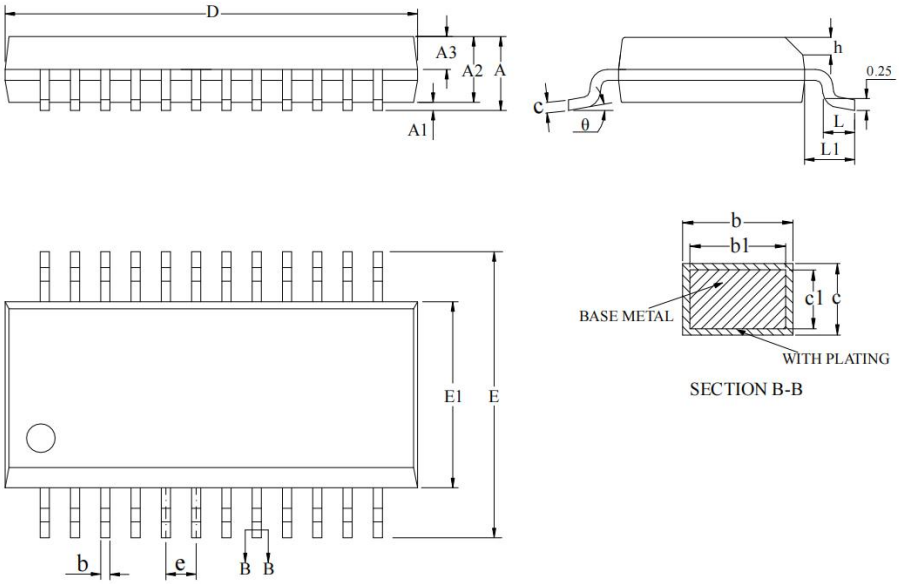
3.9 FM Characteristics

Table 3-9 FM Characteristics

Parameter	Conditions	Min	Typ	Max	Unit
Frequency range	--	64	--	108	MHz
RF Mono sensitivity	(S+N)/N=26dB	--	10	--	dBuV
Mono Audio SNDR	--	--	65	--	dB
Stereo Audio SNDR	--	--	55	--	dB
Stereo channel separation	--	--	40	--	dB

4 Package Information

4.1 SSOP24



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	0.15	0.25
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.23	—	0.31
b1	0.22	0.25	0.28
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	0.635BSC		
h	0.30	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

Figure 4-1 AC7065E Package

5 IC Marking Information

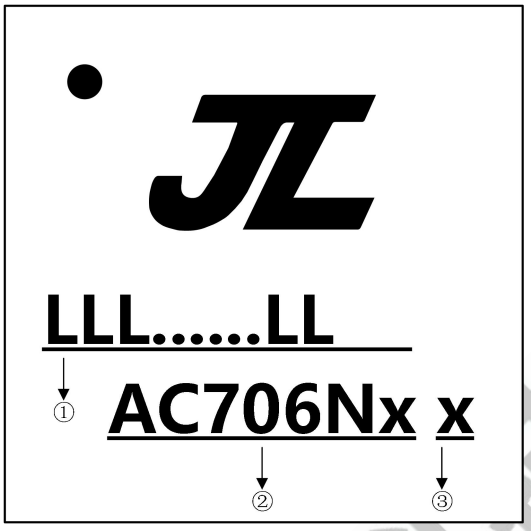


Figure 5-1 AC7065E Package Outline

① LLL……LL LOT No. , It contains 7 to 18 alphanumerics

② AC706Nx Chip Model

③ x Built-in flash size

0 No Flash Memory

2 2Mbit Flash

4 4Mbit Flash

8 8Mbit Flash

6 16Mbit Flash

3 32Mbit Flash

6 Solder-Reflow Condition

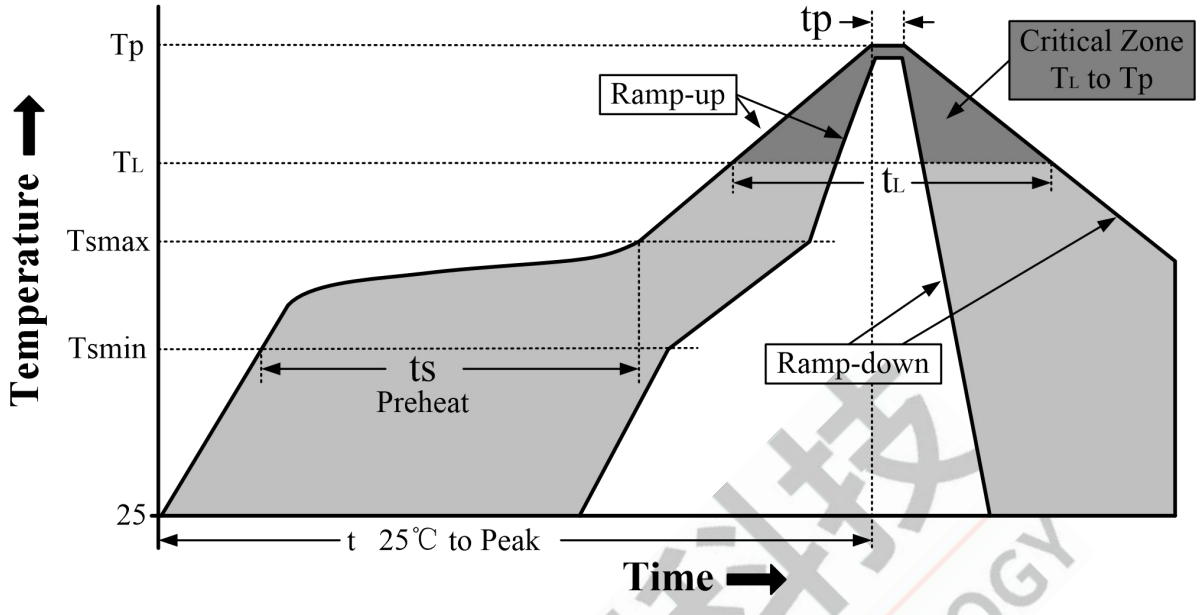


Figure 6-1 Classification Reflow Profile

Table 6-1 Classification Profiles

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 6-2	See Table 6-3
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

2.Time within 5℃ of actual peak temperature (tp) specified for the reflow profiles is a “supplier” and “user” maximum.

Table 6-2 SnPb Classification Temperature

Package Thickness	Volume mm³ < 350	Volume mm³ ≥ 350
<2.5 mm	240 +0/-5℃	225 +0/-5℃
≥2.5 mm	225 +0/-5℃	225 +0/-5℃

Table 6-3 Pb-free - Classification Temperature

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℃

Note

1.*Tolerance The device manufacturer/supplier shall assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0℃.For example 260℃+0℃)at the rated MSL level.