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# **AK1051D Mobile Multimedia Application Processor Specification**

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## Document Revision History

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| 2.0.0   | <b>Initial release</b>                                    | July, 2017     |
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| 2.2.0   | <b>Section 1</b><br>Modified the introduction of AK1051D. | March, 2018    |

## About This Manual

This document is the electrical and mechanical specification data sheet for the AK1051D processor. This specification contains mechanical data, package signal locations, and electrical specifications (simulated).

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## Definitions, Acronyms, and Abbreviations

Unless otherwise specified, all the acronyms and abbreviations used in this manual are defined hereunder.

|      |   |
|------|---|
| ADC  | Analog to Digital Converter   |
| AHB  | Advanced High-performance Bus   |
| ASIC | Application-Specific Integrated Circuit, refers to all the functional blocks of the processor |
| CMOS | Complimentary Metal-Oxide Semiconductor   |
| CRC  | Cyclic Redundancy Check   |
| DAC  | Digital to Analog Converter   |
| DMA  | Direct Memory Access  |
| DTE  | Data Terminal Equipment   |
| ECC  | Error Correction Code   |
| FIFO | First In First Out  |
| GPIO | General Purpose Input/Output  |
| I2C  | Two Wire Interface  |
| JTAG | Joint Test Action Group   |
| LCD  | Liquid Crystal Display  |
| LSB  | Least Significant Bit   |
| MMC  | Multimedia Card   |
| MMU  | Memory Management Unit  |
| MSB  | Most Significant Bit  |
| PCM  | Pulse Code Modulation   |
| PGA  | Programmable Gain Amplifier   |
| PWM  | Pulse-Width Modulator   |
| PLL  | Phase Locked Loop   |
| RAM  | Random Access Memory  |
| ROM  | Read Only Memory  |
| SD   | Secure Digital  |
| UART | Universal Asynchronous Receiver/Transmitter   |
| USB  | Universal Serial Bus  |
| XTAL | Crystal   |

# 1 Introduction

AK1051D is an Anyka's highly integrated and cost effective system-on-chip solution based on Bluetooth 5.0/4.2/3.0/2.1+EDR. Positioning at Bluetooth applications such as Bluetooth stereo speakers, earphones, AK1051D satisfies the market with high performance, low cost, and low power consumption.

AK1051D uses ARM926EJ-S core and integrates audio codec, Bluetooth RF, Bluetooth baseband, USB 2.0 Host/Slave controller, power management unit (PMU), and 512KB SPI Flash into a single chip, offering high multimedia performance and high system integration at reduced power consumption and cost of bill-of-materials (BOM). A set of peripheral interfaces, including UART, IrDA, TWI, and USB2.0, feature AK1051D with high extensibility and flexibility.

## 1.1 Features

- ARM926EJ-S core, 16KB I cache and 4KB D cache
- Up to 200MHz CPU CLK and 100MHz system operating frequency
- Bluetooth Baseband
- Bluetooth RF
- Advanced power management module
- Supports little-endian only
- Software TWI
- Three ADCs, 2 Sigma-Delta ADC for voice/music recording; 1 SAR ADC for analog keypad, battery measurement, and general purpose
- Two Built-in Sigma-Delta DACs
- Headphone driver output
- Two UARTs: UART0 and UART2
- Built-in SPI NOR Flash
- One USB2.0 Full-Speed Host & Slave interface
- 10 GPIOs, all shared with other pins
- On-chip PLL
- Four PWM outputs
- Three General Purpose timers

- One Watchdog timer
- Two bootstrap modes: SPI NOR Flash Boot and USB Mass Storage Boot
- Package: 32-pin QFN

## 1.2 Applications

- Bluetooth stereo earphones
- Bluetooth stereo speakers

## 1.3 Product Documentation

The following document(s) is (are) required for a complete description of the AK1051D and are necessary to design properly with the device.

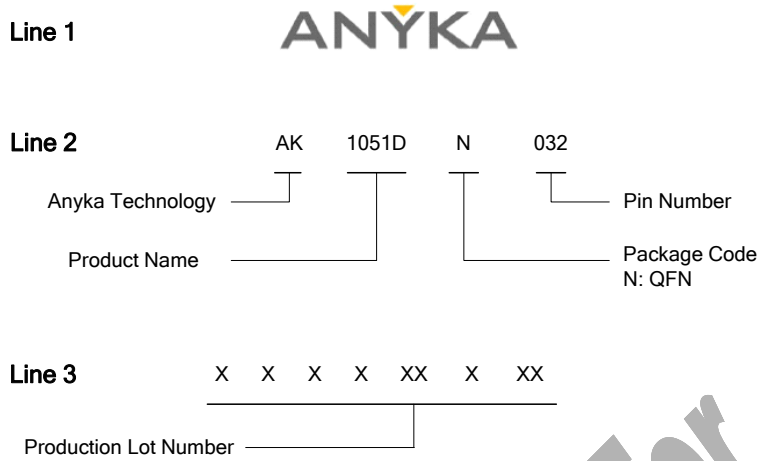
- *AK1051D Programmer's Guide*

## 1.4 Ordering Information

| PART NUMBER | PACKAGE TYPE | OPERATING VOLTAGE        | ORDER NUMBER |
|-------------|--------------|--------------------------|--------------|
| AK1051DN032 | 32-PIN QFN   | I/O: 3.3V,<br>core: 1.2V | -            |

## 1.5 Part Number Information

As shown in Figure 1-1, the Part Number information consists of three lines. The first line symbolizes ANYKA; the second line indicates the product ID, while the third line is production lot number, which is reserved by the producer for specific purposes.



**Figure 1-1 Part Number Information**

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## 2 Signals and Connections

### 2.1 Pin Definitions

Table 2-1 identifies and describes the AK1051D signals that are assigned to package pins. I: input; O: output; IO: input/output; PWR: power supply; GND: ground; A: analog; D: digital. PU: pull-up; PD: pull-down.

Table 2-1 AK1051D Functional Pin Definitions

| PIN | PIN NAME                                   | TYPE  | WAKEUP | RESET             | PIN MUX   | DESCRIPTION  |
|-----|--|-------|--------|-------------------|-----------|--|
| 1   | USB_DP                                     | IO/A  | NO     | -                 | -         | USB Data pin (Data+)   |
| 2   | VDD33                                      | PWR/A | NO     | -                 | -         | 3.3V IO power supply   |
| 3   | VDD12                                      | PWR/A | NO     | -                 | -         | 1.2V power supply for core and PLL   |
| 4   | GPIO[6]/<br>UART0_TXD                      | IO/D  | YES    | GPIO[6],<br>I/PU  | GPIO[6]   | General purpose input/output port with wakeup function. GPIO[6] is specially used as a boot mode select pin during system startup. |
|     |  |       |        |                   | UART0_TXD | Transmit pin of UART0  |
| 5   | GPIO[7]/<br>UART0_RXD/<br>IrDA_RX/<br>PWM1 | IO/D  | YES    | GPIO[7],<br>I/PU  | GPIO[7]   | General purpose input/output port with wakeup function   |
|     |  |       |        |                   | UART0_RXD | Receive pin of UART0   |
|     |  |       |        |                   | IrDA_RX   | IrDA data input  |
| 6   | GPIO[11]/<br>PWM5/<br>UART2_TXD            | IO/D  | YES    | GPIO[11],<br>I/PU | GPIO[11]  | General purpose input/output port with wakeup function   |
|     |  |       |        |                   | PWM5      | Pulse-Width Modulated output signal  |
|     |  |       |        |                   | UART2_TXD | Transmit pin of UART2  |
| 7   | GPIO[22]/<br>PWM3/<br>UART2_RXD            | IO/D  | YES    | GPIO[22],<br>I/PU | GPIO[22]  | General purpose input/output port with wakeup function   |
|     |  |       |        |                   | PWM3      | Pulse-Width Modulated output signal  |
|     |  |       |        |                   | UART2_RXD | Receive pin of UART2   |
| 8   | GPIO[24]/<br>PWM0/<br>AIN1                 | IO/AD | YES    | GPIO[24],<br>I/PD | GPIO[24]  | General purpose input/output port with wakeup function   |
|     |  |       |        |                   | PWM0      | Pulse-Width Modulated output signal  |
|     |  |       |        |                   | AIN1      | A/D input node for general purpose analog input, it could be used for analog keypad input  |
| 9   | AIN0/<br>GPIO[10]                          | I/AD  | YES    | AIN0              | AIN0      | A/D input node for general purpose analog input, it could be used for analog keypad input. This pin supports wakeup function.      |
|     |  |       |        |                   | GPIO[10]  | General purpose input/output port  |
| 10  | LineIn_RN/<br>MIC0_P                       | I/AD  | NO     | LineIn_RN         | LineIn_RN | Line-in right channel input (negative) to ADC2   |
|     |  |       |        |                   | MIC0_P    | Microphone0 right channel input (positive) to ADC2   |
| 11  | LineIn_RP/                                 | I/AD  | NO     | LineIn_RP         | LineIn_RP | Line-in right channel input (positive) to ADC2   |

| PIN | PIN NAME             | TYPE  | WAKEUP | RESET     | PIN MUX   | DESCRIPTION  |
|-----|----------------------|-------|--------|-----------|-----------|--|
|     | MIC0_N               |       |        |           | MIC0_N    | Microphone0 right channel input (negative) to ADC2   |
| 12  | MIC1_P/<br>GPI[5]    | I/AD  | NO     | MIC1_P    | MIC1_P    | Microphone1 left channel input (positive) to ADC3  |
|     |                      |       |        |           | GPI[5]    | General purpose input port   |
| 13  | MIC1_N/<br>GPI[6]    | I/AD  | NO     | MIC1_N    | MIC1_N    | Microphone1 left channel input (negative) to ADC3  |
|     |                      |       |        |           | GPI[6]    | General purpose input port   |
| 14  | VDD_MIC              | IO/A  | NO     | -         | VDD_MIC   | 3.0V microphone bias output  |
| 15  | VCM3                 | IO/A  | NO     | -         | VCM3      | 3.0V reference voltage for audio codec   |
| 16  | LineIn_LN/<br>GPI[0] | I/AD  | NO     | LineIn_LN | LineIn_LN | Line-in left channel input (negative) to ADC3  |
|     |                      |       |        |           | GPI[0]    | General purpose input port   |
| 17  | LineIn_LP/<br>GPI[1] | I/AD  | NO     | LineIn_LP | LineIn_LP | Line-in left channel input (positive) to ADC3  |
|     |                      |       |        |           | GPI[1]    | General purpose input port   |
| 18  | VCM2/<br>RESET       | IO/A  | NO     | -         | VCM2      | 1.5V audio codec common mode voltage. It is recommended to connect to a 4.7uF capacitor between this pin and GND |
|     |                      |       |        |           | RESET     | Reset pin, active low  |
| 19  | HP_RP                | O/A   | NO     | -         | -         | Right channel of headphone output (positive)   |
| 20  | HP_RN                | O/A   | NO     | -         | -         | Right channel of headphone output (negative).  |
| 21  | HP_LN                | O/A   | NO     | -         | -         | Left channel of headphone output (negative)  |
| 22  | HP_LP                | O/A   | NO     | -         | -         | Left channel of headphone output (positive)  |
| 23  | HPVDD                | PWR/A | NO     | -         | -         | 3.3V headphone power supply  |
| 24  | XTAL26MO             | O/A   | NO     | -         | -         | External 26MHz crystal output  |
| 25  | XTAL26MI             | I/A   | NO     | -         | -         | External 26MHz crystal input   |
| 26  | AVDD12_BT            | PWR/A | NO     | -         | -         | 1.2V power supply for Bluetooth module   |
| 27  | BT_TX/RX             | IO/A  | NO     | -         | -         | Bluetooth: radio signal (RX/TX)  |
| 28  | VCC33_RF             | PWR/A | NO     | -         | -         | 3.3V Bluetooth RF power supply   |
| 29  | ONOFF                | I/A   | YES    | -         | -         | System on/off signal   |
| 30  | VBAT                 | I/A   | NO     | -         | -         | Battery voltage input  |
| 31  | VIN_CHG              | I/A   | YES    | -         | -         | Voltage input of battery charger   |
| 32  | USB_DM               | IO/A  | NO     | -         | -         | USB Data pin (Data-)   |
| 33  | GND                  | GND   | NO     | -         | -         | Power ground. Connect this pin to the ground on the Printed Circuit Board.                                       |

**Notes:**

1. As shown in the **WAKEUP** column of the table above, YES denotes the corresponding GPIO or dedicated pin is a wakeup pin, which can be applied to wakeup the processor from standby. NO denotes the corresponding pin is not a wakeup pin.
2. The pull-up/pull-down resistance range of GPIOs or specified pins are shown in the following table. The pull-up/pull-down function attached to GPIOs can be enabled / disabled by software.

Table 2-2 Resistance range of pull-up and pull-down pins

| PIN NAME                    | PU/PD              | PU/PD RESISTOR                      |
|-----------------------------|--------------------|-------------------------------------|
| GPIO[7], GPIO[11], GPIO[22] | PU                 | 70KΩ ± 40%                          |
| GPIO[24]                    | PU/PD programmable | PU: 70KΩ ±40%<br>PD: 300KΩ ±40%     |
| USB_DP, USB_DM              | PU/PD programmable | PU: 1.5K +/- 15%<br>PD: 15K +/- 15% |
| GPIO[6], GPIO[10]           | PU                 | 62KΩ~ 112KΩ                         |

**Note: AIN0/GPIO[10] is open-drain output when it is worked as GPO. In this case, an external pull-up resistor is required to connect to VDD33/VBAT.**

3. Table 2-3 shows the drive strength of GPIOs and SPI pins.

Table 2-3 AK1051D GPIO Drive Strength (3.3V power supply)

| PARAMETER  | PIN  | DRIVE STRENGTH |         |         |
|--|--|----------------|---------|---------|
|  |  | MINIMUM        | TYPICAL | MAXIMUM |
| Low level output current<br>( $I_{ol}@VOL = 0.4V$ )  | GPIO[10](default as AIN0)                      | -              | -       | 1.5mA   |
|  | GPIO[24], GPIO[22], GPIO[11],<br>and GPIO[7:6] | -              | 6mA     | -       |
| High level output current<br>( $I_{oh}@VOH = 2.4V$ ) | GPIO[10](default as AIN0)                      | -              | -       | 1.5mA   |
|  | GPIO[24], GPIO[22], GPIO[11],<br>and GPIO[7:6] | -              | 10mA    | -       |

Table 2-4 classifies the AK1051D signals according to different modules.

Table 2-4 AK1051D Functional Pin Classification

| Module                               | PIN NAME    | Module            | PIN NAME                         |           |
|--------------------------------------|-------------|-------------------|----------------------------------|-----------|
| <b>1. System Control(3)</b>          | ONOFF       |                   | LINEIN_LP                        |           |
|                                      | XTAL26MI    |                   | LINEIN_LN                        |           |
|                                      | XTAL26MO    |                   | LINEIN_RP                        |           |
| <b>2. USB Interface(2)</b>           | USB_DM      |                   | LINEIN_RN                        |           |
|                                      | USB_DP      |                   | MIC1_P                           |           |
| <b>3. Bluetooth(1)</b>               | BT_TX/RX    |                   | MIC1_N                           |           |
| <b>4. IrDA(1)</b>                    | IrDA_RX     | UART0_TXD         |                                  |           |
| <b>5. PWM(4)</b>                     | PWM0        | UART0_RXD         |                                  |           |
|                                      | PWM1        | UART2_TXD         |                                  |           |
|                                      | PWM3        | UART2_RXD         |                                  |           |
|                                      | PWM5        |                   |                                  |           |
| <b>6. GPIO(10)</b>                   | GPIO[24]    | <b>8. UART(4)</b> | VBAT                             |           |
|                                      | GPIO[22]    |                   | VIN_CHG                          |           |
|                                      | GPIO[10:11] | <b>9. PMU (2)</b> | HPVDD                            |           |
|                                      | GPIO[6:7]   |                   | VDD12                            |           |
|                                      | GPI[5:6]    |                   | VDD33                            |           |
|                                      | GPI[0:1]    |                   | VCM3/VDD_MIC                     |           |
| <b>7. Audio Analog Interface(12)</b> | AIN0        |                   | <b>10. Power and Grounds (9)</b> | VCM2      |
|                                      | AIN1        |                   |                                  | AVDD12_BT |
|                                      | HP_LP       |                   |                                  | VCC33_RF  |
|                                      | HP_LN       | VSS               |                                  |           |
|                                      | HP_RN       | GND               |                                  |           |
|                                      | HP_RP       |                   |                                  |           |

## 2.2 Shared-pin List

In order to reduce pin numbers, many pins are shared by more than one function blocks that would not be implemented at the same time. The table below lists the shared pins. All the shared pins are configured by Shared-Pin Control Register.

Table 2-5 AK1051D Shared-pin List

| Shared-pin | MODULE  | PIN Name  | RESET     |
|------------|---------|-----------|-----------|
| 4          | GPIO    | GPIO[6]   | GPIO[6]   |
|            | UART    | UART0_TXD |           |
| 5          | GPIO    | GPIO[7]   | GPIO[7],  |
|            | UART    | UART0_RXD |           |
|            | IrDA    | IrDA_RX   |           |
|            | PWM     | PWM1      |           |
| 6          | GPIO    | GPIO[11]  | GPIO[11]  |
|            | PWM     | PWM5      |           |
|            | UART    | UART2_TXD |           |
| 7          | GPIO    | GPIO[22]  | GPIO[22]  |
|            | PWM     | PWM3      |           |
|            | UART    | UART2_RXD |           |
| 8          | GPIO    | GPIO[24]  | GPIO[24]  |
|            | PWM     | PWM0      |           |
|            | SAR ADC | AIN1      |           |
| 9          | SAR ADC | AIN0      | AIN0      |
|            | GPIO    | GPIO[10]  |           |
| 12         | Analog  | MIC1_P    | MIC1_P    |
|            | GPI     | GPI[5]    |           |
| 13         | Analog  | MIC1_N    | MIC1_N    |
|            | GPI     | GPI[6]    |           |
| 16         | Analog  | LineIn_LN | LineIn_LN |
|            | GPIO    | GPI[0]    |           |
| 17         | Analog  | LineIn_LP | LineIn_LP |
|            | GPIO    | GPI[1]    |           |

## 3 Electrical Specifications

### 3.1 Maximum Ratings

Stresses greater than those listed may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended period may affect reliability.

Table 3-1 AK1051D Maximum Ratings

| PARAMETER                               | SYMBOL         | MINIMUM | MAXIMUM | UNIT |
|---|----------------|---------|---------|------|
| VDD12 supply voltage relative to GND    | VDD12          | -0.3    | 1.4     | V    |
| VDD33 supply voltage relative to GND    | VDD33          | -0.3    | 4.0     | V    |
| AVDD_MIC supply voltage relative to GND | AVDD_MIC       | -0.3    | 4.0     | V    |
| AVCC supply voltage relative to GND     | AVCC           | -0.3    | 4.0     | V    |
| HPVDD supply voltage relative to GND    | HPVDD          | -0.3    | 4.0     | V    |
| VDD12_RF supply voltage relative to GND | VDD12_RF       | -0.3    | 1.4     | V    |
| VCC33_RF supply voltage relative to GND | VCC33_RF       | -0.3    | 4.0     | V    |
| VBAT supply voltage relative to GND     | VBAT           | -0.3    | 4.5     | V    |
| VIN_CHG supply voltage relative to GND  | VIN_CHG        | -0.3    | 5.5     | V    |
| Storage Temperature                     | T <sub>s</sub> | -40     | 125     | °C   |

### 3.2 Recommended Operating Range

Table 3-2 Recommended Operating Range

| PARAMETER                            | SYMBOL           | MINIMUM | TYPICAL | MAXIMUM | UNIT |
|--------------------------------------|------------------|---------|---------|---------|------|
| VDD12 supply voltage relative to GND | VDD <sup>2</sup> | 1.08    | 1.2     | 1.35    | V    |
| VDD33 supply voltage relative to GND | VDD33            | 2.97    | 3.30    | 3.63    | V    |

| PARAMETER                               | SYMBOL         | MINIMUM | TYPICAL | MAXIMUM | UNIT |
|---|----------------|---------|---------|---------|------|
| AVDD_MIC supply voltage relative to GND | AVDD_MIC       | 2.97    | 3.0     | 3.63    | V    |
| AVCC supply voltage relative to GND     | AVCC           | 2.85    | 3.0     | 3.1     | V    |
| HPVDD supply voltage relative to GND    | HPVDD          | 3.2     | 3.3     | 3.6     | V    |
| VDD12_RF supply voltage relative to GND | VDD12_RF       | 1.15    | 1.3     | 1.4     | V    |
| VCC33_RF supply voltage relative to GND | VCC33_RF       | 2.8     | 3.0     | 3.30    | V    |
| VBAT supply voltage relative to GND     | VBAT           | 3.5     | -       | 4.5     | V    |
| VIN_CHG supply voltage relative to GND  | VIN_CHG        | 3.5     | -       | 5.0     | V    |
| Operating Temperature Range             | T <sub>O</sub> | 0       |         | 75      | °C   |

**Notes:**

1. In normal mode, the recommended operating range of VDD12 is given in the table.
2. In standby mode, VDD12 is recommended to set at 1.1V to save power.

### 3.3 Electrical Characteristics of PMU

Table 3-3 Electrical Characteristics of LDO12

Typical values are at T<sub>A</sub> = +27°C and all Current Values are dynamic, unless other-wise noted.

| Symbol   | Parameter       | Conditions   | Min | Typ | Max  | Unit |
|--|-----------------|--|-----|-----|------|------|
| V <sub>in</sub>  | Input voltage   | -  | 2.5 | 3.3 | 3.7  | V    |
| V <sub>out</sub><br>(accuracy)                                 | Output voltage  | Default  | -3  | -   | +3   | %    |
| V <sub>out</sub>   | Output voltage  | -  | -   | 1.2 | 1.35 | V    |
| I <sub>out</sub>   | Output current  | -  | -   | 100 | 150  | mA   |
| Δ V <sub>out</sub> ,<br>Δ V <sub>out</sub> /Δ I <sub>out</sub> | Load regulation | T=27 °C, V <sub>in</sub> =3.3V,<br>@I <sub>out</sub> =1 to 100mA | -   | 38  | -    | mV   |
|  |                 |  | -   | 330 | -    | mΩ   |
| Δ V <sub>out</sub> ,<br>Δ V <sub>out</sub> /Δ V <sub>in</sub>  | Line regulation | I <sub>out</sub> =1mA<br>@V <sub>in</sub> =3.0V to 3.7V          | -   | 3   | -    | mV   |
|  |                 |  | -   | 0.2 | -    | %    |

| Symbol   | Parameter                  | Conditions                              | Min | Typ | Max | Unit          |
|----------|----------------------------|---|-----|-----|-----|---------------|
|          |                            | $I_{out}=100\text{mA}$                  | -   | 8   | -   | mV            |
|          |                            | @ $V_{in}=3.0\text{V}$ to $3.7\text{V}$ | -   | 0.5 | -   | %             |
| $I_{cc}$ | $V_{in}$ Quiescent Current | No load                                 | -   | 50  | -   | $\mu\text{A}$ |
| $I_{pd}$ | Power-down current         | -                                       | -   | 0.1 | -   | $\mu\text{A}$ |

Table 3-4 Electrical Characteristics of LDO33

Typical values are at  $T_A = +27^\circ\text{C}$  and all Current Values are dynamic, unless other-wise noted.

| Symbol  | Parameter                  | Conditions   | Min | Typ | Max | Unit             |
|---|----------------------------|--|-----|-----|-----|------------------|
| $V_{in}$  | Input voltage              | -  | 3.5 | 3.7 | 5.0 | V                |
| $V_{out}$<br>(accuracy)                               | Output voltage             | Default  | -3  | -   | +3  | %                |
| $V_{out}$   | Output voltage             | -  | -   | 3.3 | -   | V                |
| $I_{out}$   | Output current             | -  | -   | -   | 250 | mA               |
| $\Delta V_{out}$ ,<br>$\Delta V_{out}/\Delta I_{out}$ | Load regulation            | $T=27^\circ\text{C}$ , $V_{in}=3.8\text{V}$ ,<br>@ $I_{out}=1$ to $100\text{mA}$ | -   | 40  | -   | mV               |
|   |                            |  | -   | 340 | -   | $\text{m}\Omega$ |
| $\Delta V_{out}$ ,<br>$\Delta V_{out}/\Delta V_{in}$  | Line regulation            | $I_{out}=1\text{mA}$   | -   | 3   | -   | mV               |
|   |                            | @ $V_{in}=3.5$ to $5\text{V}$  | -   | 0.2 | -   | %                |
|   |                            | $I_{out}=250\text{mA}$   | -   | 10  | -   | mV               |
|   |                            | @ $V_{in}=3.5\text{V}$ to $5\text{V}$  | -   | 0.5 | -   | %                |
| $I_{cc}$  | $V_{in}$ Quiescent Current | No load  | -   | 50  | -   | $\mu\text{A}$    |
| $I_{pd}$  | Power-down current         | -  | -   | 0.1 | -   | $\mu\text{A}$    |



Table 3-5 Electrical Characteristics of LDO33RF

Typical values are at  $T_A = +27^\circ\text{C}$  and all Current Values are dynamic, unless other-wise noted.

| Symbol  | Parameter             | Conditions                            | Min | Typ | Max | Unit |
|---|-----------------------|---------------------------------------|-----|-----|-----|------|
| Vin   | Input voltage         | -                                     | 3.2 | 3.8 | 4.5 | V    |
| Vout<br>(accuracy)                                    | Output voltage        | Default                               | -3  | -   | 3   | %    |
| Vout  | Output voltage        | -                                     | -   | 3.0 | -   | V    |
| Iout  | Output current        | -                                     | -   | 50  | 80  | mA   |
| $\Delta V_{out}$ ,<br>$\Delta V_{out}/\Delta I_{out}$ | Load regulation       | T=27 °C, Vin=3.8V,<br>@Iout=1 to 50mA | -   | 10  | -   | mV   |
|   |                       |                                       | -   | 500 | -   | mΩ   |
| $\Delta V_{out}$ ,<br>$\Delta V_{out}/\Delta V_{in}$  | Line regulation       | Iout=1mA                              | -   | 5   | -   | mV   |
|   |                       | @Vin=3.8 to 4.5V                      | -   | 0.2 | -   | %    |
|   |                       | Iout = 50mA<br>@Vin=3.8V to 4.5V      | -   | 20  | -   | mV   |
|   |                       |                                       | -   | 0.5 | -   | %    |
| Icc   | Vin Quiescent Current | No load                               | -   | 50  | -   | μA   |
| Ipd   | Power-down current    | -                                     | -   | 0.1 | -   | μA   |

Table 3-6 Electrical Characteristics of LDO12RF

Typical values are at  $T_A = +27^\circ\text{C}$  and all Current Values are dynamic, unless other-wise noted.

| Symbol  | Parameter       | Conditions                             | Min | Typ | Max | Unit |
|---|-----------------|--|-----|-----|-----|------|
| Vin   | Input voltage   | -                                      | 2.5 | 3.3 | 3.7 | V    |
| Vout<br>(accuracy)                                    | Output voltage  | Default                                | -3  | -   | 3   | %    |
| Vout  | Output voltage  | -                                      | 1.1 | 1.3 | 1.4 | V    |
| Iout  | Output current  | -                                      | -   | 80  | 100 | mA   |
| $\Delta V_{out}$ ,<br>$\Delta V_{out}/\Delta I_{out}$ | Load regulation | T=27 °C, Vin=3.8V,<br>@Iout=1 to 100mA | -   | 38  | -   | mV   |
|   |                 |  | -   | 330 | -   | mΩ   |
| $\Delta V_{out}$ ,<br>$\Delta V_{out}/\Delta V_{in}$  | Line regulation | Iout=1mA<br>@Vin=3.3 to 3.7V           | -   | 3   | -   | mV   |
|   |                 |  | -   | 0.2 | -   | %    |

| Symbol          | Parameter                         | Conditions                     | Min | Typ | Max | Unit |
|-----------------|-----------------------------------|--------------------------------|-----|-----|-----|------|
|                 |                                   | I <sub>out</sub> =100mA        | -   | 8   | -   | mV   |
|                 |                                   | @V <sub>in</sub> =3.3V to 3.7V | -   | 0.5 | -   | %    |
| I <sub>cc</sub> | V <sub>in</sub> Quiescent Current | No load                        | -   | 50  | -   | μA   |
| I <sub>pd</sub> | Power-down current                | -                              | -   | 0.1 | -   | μA   |

### 3.4 DC Electrical Characteristics

Table 3-7 DC Electrical Characteristics

| PARAMETER                        | SYMBOL           | MINIMUM | TYPICAL | MAXIMUM                | UNIT |
|----------------------------------|------------------|---------|---------|------------------------|------|
| Input High Voltage               | V <sub>IH</sub>  | 2.0     | -       | V <sub>DD33</sub> +0.3 | V    |
| Input Low Voltage                | V <sub>IL</sub>  | -0.3    | -       | 0.8                    | V    |
| Output High Voltage              | V <sub>OH</sub>  | 2.4     | -       | -                      | V    |
| Output Low Voltage               | V <sub>OL</sub>  | -       | -       | 0.4                    | V    |
| Input Leakage Current            | I <sub>L</sub>   | -       | -       | ±1                     | μA   |
| Tri-state Output Leakage Current | I <sub>OZ</sub>  | -       | -       | ±1                     | μA   |
| Input capacitance                | C <sub>I</sub>   | -       | -       | 8                      | pF   |
| Output capacitance               | C <sub>O</sub>   | -       | -       | 8                      | pF   |
| Microphone Input Resistance      | R <sub>mic</sub> | -       | 5K      | -                      | Ω    |
| Headphone output load resistance | R <sub>HP</sub>  | -       | 32      | -                      | Ω    |

### 3.5 AC Electrical Characteristics

Table 3-8 32K/26M Oscillator Signal Timing

| PARAMETER            | MIN. | TYP. | MAX. | UNIT |
|----------------------|------|------|------|------|
| XTAL32K Startup Time | -    | 500  | -    | ms   |
| XTAL26M Startup Time | -    | 8    | -    | ms   |

### 3.6 Bluetooth RF Characteristics

Table 3-9 RF TX Characteristics

| PARAMETER                           | MIN.     | MIN.. | TYP. | MAX.   | REFERENCE  |
|-------------------------------------|----------|-------|------|--------|------------|
| Output Power                        | dBm      | -3    | 2    | 6      | -          |
| Power Control                       | dB       | -     | 24   | -      | >=16       |
| Frequency Range                     | GHz      | 2.4   | -    | 2.4835 | 2.4~2.4835 |
| Initial Carrier Frequency Tolerance | KHz      | -50   | -    | 50     | -75~75     |
| Carrier Frequency Drift             | KHz/50us | -     | 5    | 20     | <=20       |

Table 3-10 RF RX Characteristics

| PARAMETER           | UNIT | MIN. | TYP. | MAX. | REFERENCE |
|---------------------|------|------|------|------|-----------|
| Sensitivity         | dBm  | -    | -80  | -    | <=-70     |
| Maximum Input Level | dBm  | -20  | -    | -    | >=-20     |

### 3.7 Analog Interface Characteristics

Table 3-11 Analog Interface Characteristics

| PARAMETER                        | SYMBOL | MINIMUM | TYPICAL            | MAXIMUM | UNIT |
|----------------------------------|--------|---------|--------------------|---------|------|
| Microphone Input Resistance      | Rmic   | -       | 5K                 | -       | Ω    |
| Headphone output load resistance | RHP    | -       | External connected | -       | Ω    |

### 3.8 Power-down and Sniff Supply Current

Table 3-12 Power-down and Sniff Supply Current

| PARAMETER                         | MINIMUM | TYPICAL | MAXIMUM | UNIT |
|-----------------------------------|---------|---------|---------|------|
| Supply current in power down mode | -       | 0       | -       | μA   |
| Supply current in sniff mode      | -       | 1       | -       | mA   |

**Notes:**

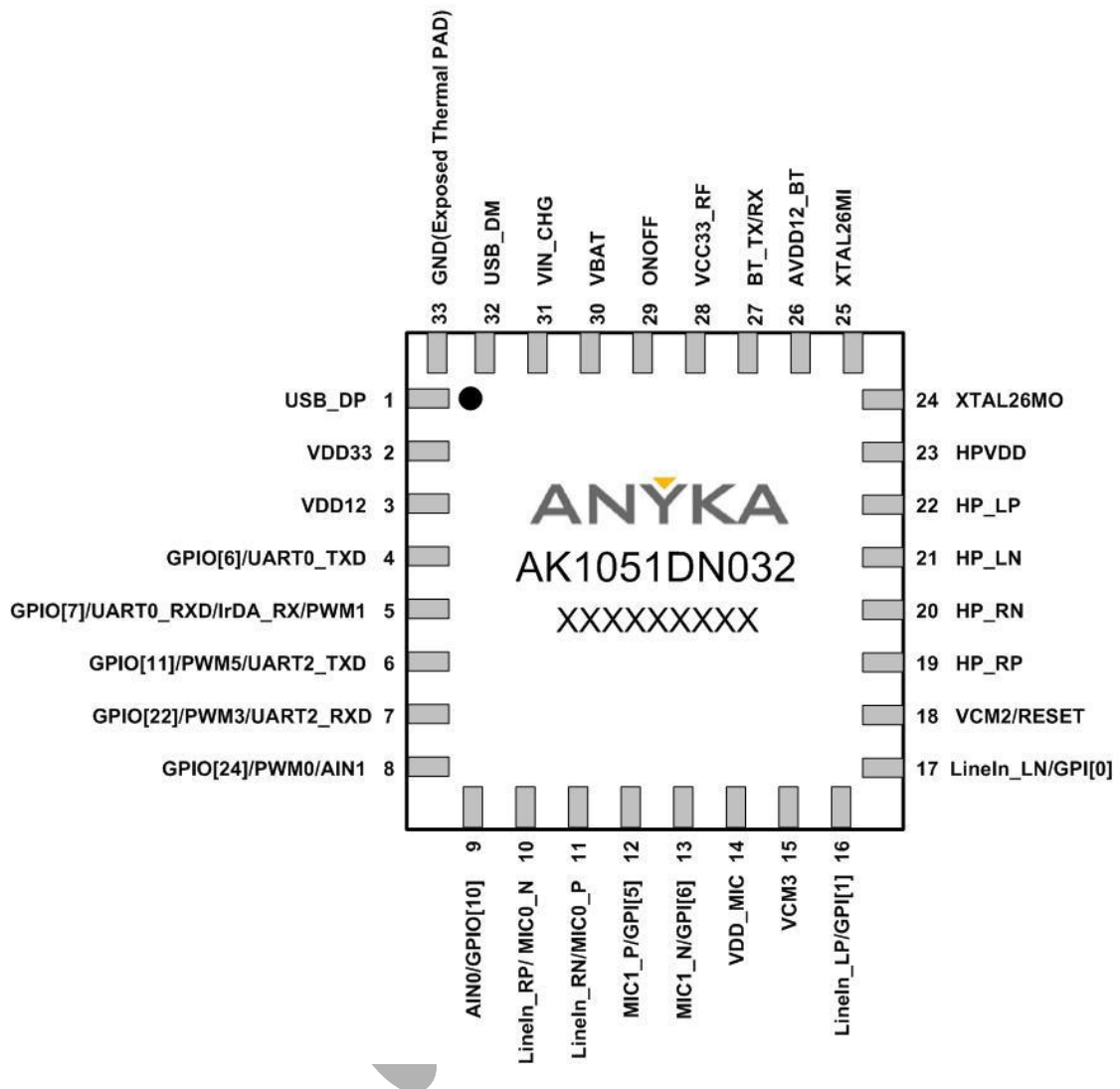
1. Power-down: All the modules are powered off.
2. Sniff: If Bluetooth module works in deep-sleep state of the sniff interval, the PLL is powered down and other modules (including CPU core) are clocked off. If Bluetooth module works in wakeup state of the sniff interval, Bluetooth module manages data transmission between slaves and masters, while other modules are clocked off.

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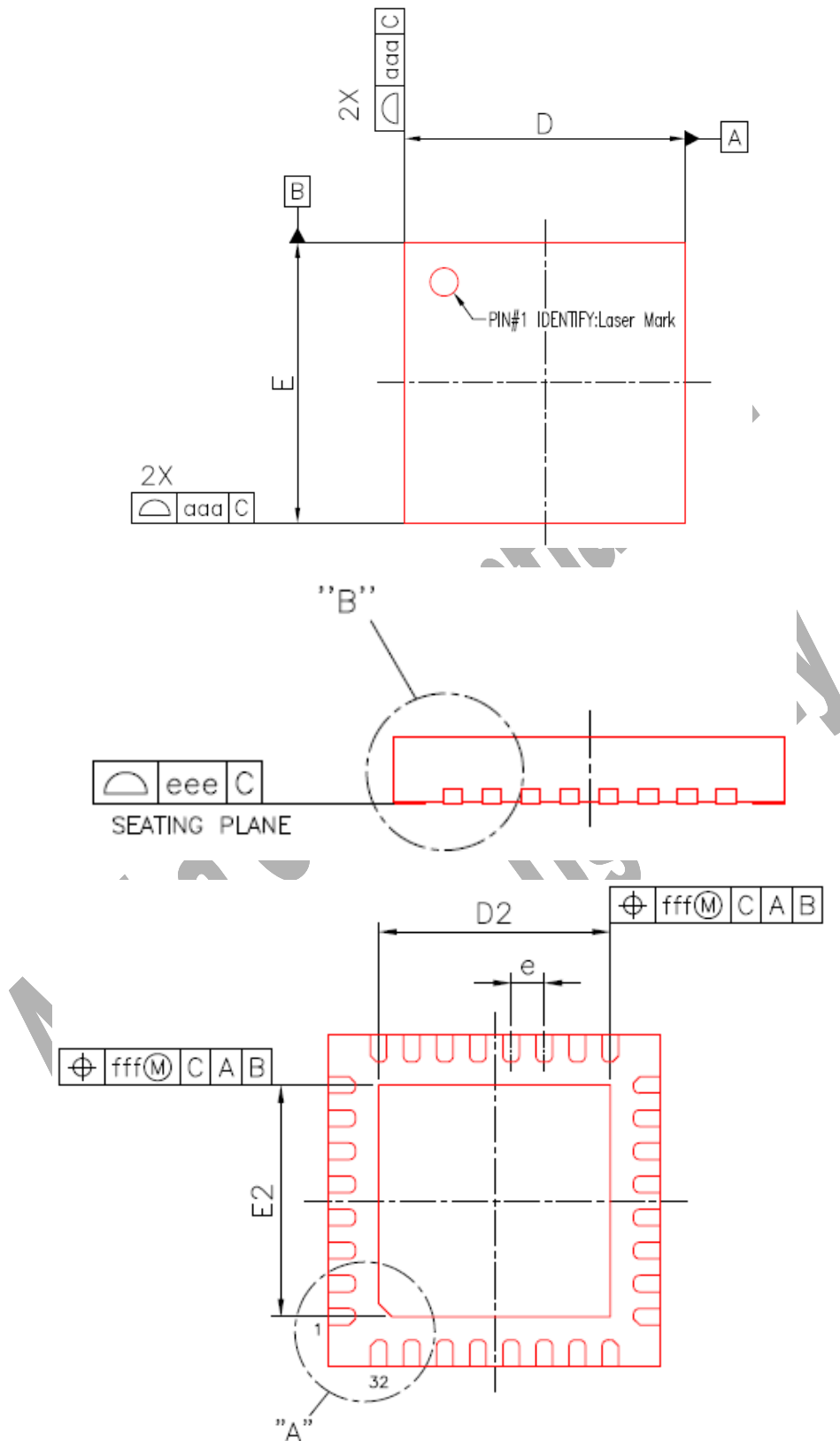
## 4 Package Information

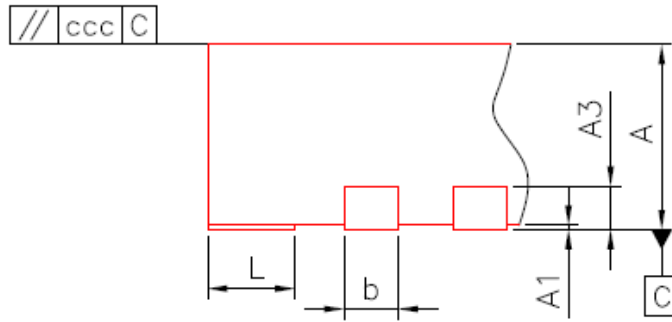
AK1051D is packaged in a 32-pin QFN with 5mm x 5mm x 0.85mm.

### 4.1 Pin Assignment

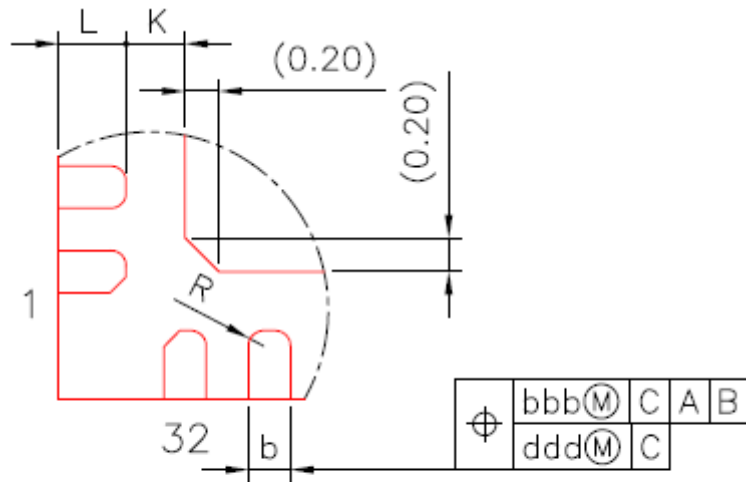


## 4.2 Package Information





DETAIL : "B"



DETAIL : "A"

| Symbol | DIMENSION (millimeter) |      |      |
|--------|------------------------|------|------|
|        | MIN                    | NOM  | MAX  |
| A      | 0.80                   | 0.85 | 0.90 |
| A1     | 0.00                   | 0.02 | 0.05 |
| A3     | 0.20REF                |      |      |
| b      | 0.18                   | 0.25 | 0.30 |
| D/E    | 5.00BSC                |      |      |
| D2/E2  | 3.35                   | 3.50 | 3.65 |
| e      | 0.50 BSC               |      |      |
| L      | 0.35                   | 0.40 | 0.45 |
| K      | 0.20                   | -    | -    |
| R      | 0.09                   | -    | -    |
| aaa    | 0.15                   |      |      |

| Symbol | DIMENSION (millimeter) |      |     |
|--------|------------------------|------|-----|
|        | MIN                    | NOM  | MAX |
| bbb    |                        | 0.10 |     |
| ccc    |                        | 0.10 |     |
| ddd    |                        | 0.05 |     |
| eee    |                        | 0.08 |     |
| fff    |                        | 0.10 |     |

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## 5 Reflow Profile

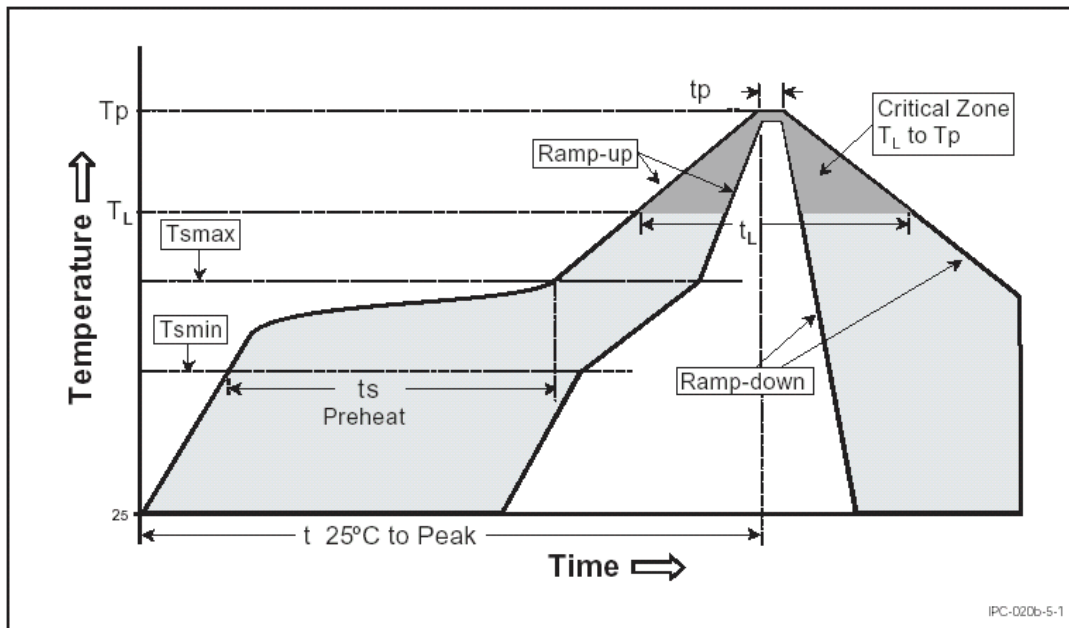


Figure 5-1 Recommended Reflow Profile

Table 5-1 Reflow Profile Condition

| Profile Feature   | Pb-Free Assembly                     |
|---|--------------------------------------|
| Average ramp-up rate<br>(T <sub>smax</sub> to T <sub>p</sub> )  | 2 °C/second max                      |
| Preheat<br>-Temperature Min(T <sub>smin</sub> )<br>-Temperature Max(T <sub>smax</sub> )<br>-Time (min to max) (t <sub>s</sub> ) | 150 °C<br>200 °C<br>60 - 180 seconds |
| Time maintained above:<br>-Temperature (T <sub>l</sub> )<br>-Time (t <sub>l</sub> )   | 217 °C<br>60 - 150 seconds           |
| Peak Temperature (T <sub>p</sub> )  | 245+5/-5 °C                          |
| Time within 5°C of actual Peak Temperature(t <sub>p</sub> )   | 30 seconds max                       |
| Ramp-down Rate  | 3°C/second max                       |

| Profile Feature               | Pb-Free Assembly |
|-------------------------------|------------------|
| Time 25°C to Peak Temperature | 8 minutes max    |

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

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## 6 Storage and Baking

1. Shelf life in sealed bag: 12 months at  $< 30^{\circ}\text{C}$  and  $< 60\%$  relative humidity (RH).
2. After bag is opened, device that will be subjected to reflow solder or other high temperature process must be:
  - a) Mounted within: 168 hours of factory conditions  $< 30^{\circ}\text{C}/60\%$  RH or
  - b) Stored at  $< 20\%$  RH.
3. Devices require bake, before mounting, if:
  - a) Humidity indicator card reads  $\geq 20\%$  when read at  $25\pm 5^{\circ}\text{C}$ ;
  - b) 2a or 2b are not met.
4. If baking is required, device may be baked for 12 hours at  $125^{\circ}\text{C}\pm 5^{\circ}\text{C}$ .

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