CI2312 Datasheet

High Performance AI Speech BLE Chip

TSSOP24

Length:7.8mm

Width:6.4mm

Thickness:1.2mm

• Brain Neural Network Processing Unit (BNPU)

– BNPU V3 support DNN \ TDNN \ RNN \ CNN and other neural networks and parallel vector operations. It can realize speech recognition, voiceprint recognition, command word self-learning, voice detection, deep learning noise reduction and other functions

• CPU and Storage

– CPU frequency up to 240 MHz

– 1 MBytes of Flash memory inside

– Built-in 640KBytes SRAM

– Built-in 512bit eFuse for application encryption

• Audio Codec

– High performance low power audio ADC, SNR ≥ 95dB

– Low-power audio DAC, SNR ≥ 95dB

•   Audio interfaces

– One Dual-channel PDM interface

• ADC and PWM

– Two channel 12bit SAR ADC

– Three PWM interfaces

• GPIO

– Seven high-speed GPIOs with response rates

• Reset and power management

– Build-in PMU

– PMU input voltage range: 3.6V to 5.5V

– Power-on Reset (POR)

– Power Voltage Detector (PVD)

• Clock

–16MHz external crystal oscillator

• Communication interface

– One IIC interface

– Two UART interfaces, supporting 5V communication and maximum 3Mbps rate

• Timer and Watch dog

– Four 32-bit timers, Two watch dogs

• Wireless

– GFSK modulation mode, 1Mbps mode of receiving sensitivity up to -90dbm

– Maximum transmit output power up to +8dBm

– Supports BLE broadcasting

– Fast channel switching, multi-channel frequency modulation algorithm can be realized

up to 20MHz

– Five of the GPIOs support 5V input

Catalogue

1 Description

1.1 Functional overview

CI2312 is a new generation of high-performance neural network intelligent speech chip developed by Chipintelli. It integrates the brain neural network processor BNPU V3 and CPU core developed by Chipintelli. The system frequency can reach 240MHz, the built-in SRAM is up to 640KByte, and the integrated PMU power management unit. Integrated dual-channel high-performance low-power Audio Codec and multi-channel UART, IIC, PWM, GPIO, PDM and other peripheral control interfaces, integrated 2.400~2.483GHz universal ISM band wireless transceiver chip, embedded baseband communication protocol. The chip only needs a small number of peripheral devices such as resistors and capacitors to realize various intelligent voice product hardware solutions, which is a low-cost wireless system solution.

CI2312 uses industrial design standards, with high environmental reliability, chip operating temperature range between -40°C to +85°C, in line with MSL3 humidity sensitivity level, in line with IEC 61000-4-2 4KV contact discharge test standards, in line with FCC electromagnetic compatibility standards, Comply with ROHS and REACH environmental standards.

CI2312 adopts the 3-generation BNPU technology of Chipintelli, which supports DNN\TDNN\RNN\CNN and other neural networks and parallel vector operations, and can realize the functions of speech recognition, voice print recognition, command word self-learning, speech detection and deep learning noise reduction, with strong echo cancellation and environmental noise suppression ability. The chip solution also supports Chinese, English, Japanese and other global languages, and can be widely used in household appliances, lighting, toys, wearable devices, industrial, automotive and other product fields to achieve voice interaction and control and various intelligent voice solution applications.

1.2 Chip Specifications

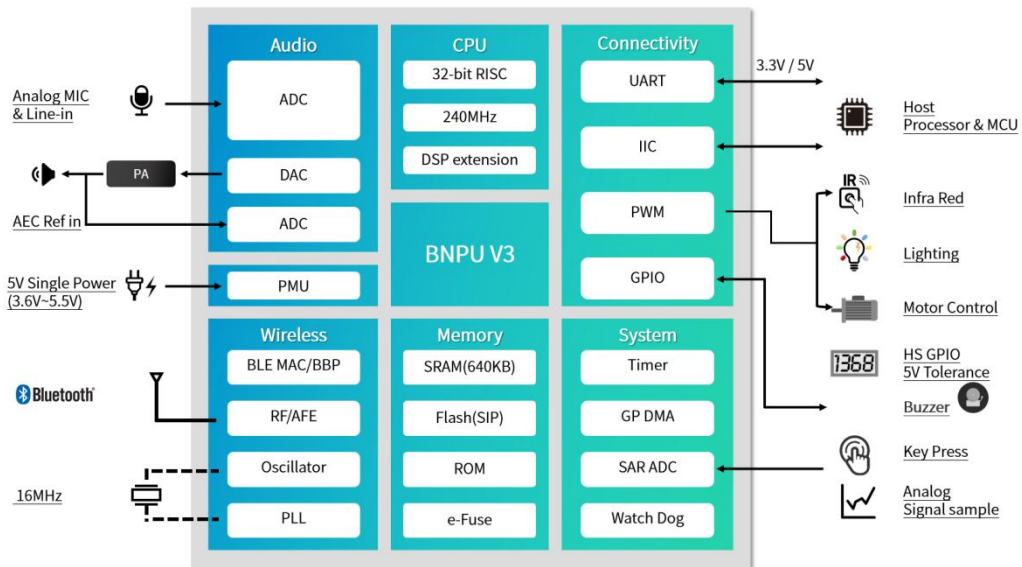CI2312 chip function block diagram is shown as follows:

Figure 1-1 Block diagram of the chip functions

■ **Wireless features**

    - Transmission mode (0dBm) working current 17mA; Receiving mode working current 18mA; Shutdown current 2uA.

    - High performance RF design adopts GFSK modulation mode, and the receiving sensitivity of 1Mbps mode can reach -90dbm; Maximum output power +8dBm

    - Supports BLE broadcasting

    - Fast channel switching, can achieve multi-channel frequency modulation algorithm

■ **Brain Neural Network Processing Unit (BNPU)**

    – BNPU V3 support DNN \ TDNN \ RNN \ CNN and other neural networks and parallel vector operations. It can realize speech recognition, voiceprint recognition, command word self-learning, voice detection, deep learning noise reduction and other functions

■ **CPU**

    - 32-bit high-performance CPU with a maximum operating frequency of 240MHz

    - 32-bit single-period multiplier, supporting DSP expansion acceleration

■ **Storage**

    - Built-in 640KB SRAM

    - Built-in 512bit eFuse

    - Built-in 2MB Flash

■ **Audio interface**

    - Built-in high performance low power Audio Codec module, support dual-channel ADC sampling and single-channel DAC playback

    - Supports Automatic Level Control (ALC)

    - support 8 kHz / 16 kHz / 24 kHz / 32 kHz, 44.1 kHz, 48 kHz sampling rate

    - Supports one PDM interface for connecting to one or two digital MEMS microphones

■ **Power management unit PMU**

    - Built-in 3 high-performance Ldos, no need to add a power chip, only a small amount of peripheral resistance container

    - Support 5V power supply direct input, the minimum power supply range supports 3.6V input, the maximum power supply range supports 5.5V input

■ **Clock**

    -16MHz external crystal oscillator

■ **SAR ADC**

    - 2 12bit SAR ADC input channels, sampling frequency up to 1MHz

■ **Peripherals and timers**

    - Two UART ports, supporting a maximum of 3 baud rate

    - 1 IIC interface, which can be expanded by external IIC devices

    - 3-channel PWM interface, light control and motor applications can be driven directly

    - Built-in four groups of 32-bit timers

    - Built-in 1 Independent watchdog (IWDG)

    - Built-in 1 set of window watchdog (WWDG)

■ **GPIO**

    - Supports seven GPIO ports and can be used as the main control IC

    - Each GPIO port can be configured with the interrupt function

    - Some GPIOs support direct communication of wide-voltage 5V level signals without external level conversion

■ **Software development support**

    - provide complete software development kit, application example and speech development platform online production firmware, and other functions, for details, please visit：

https://aiplatform.chipintelli.com

■ **Firmware burning and protection**

    - Supports UART upgrade and firmware protection

■ **EMC and ESD**

    - Good EMC design, support FCC standards

    - Internal ESD enhanced design, can pass 4KV contact discharge test

■ **ROHS and REACH**

- The use of environmentally friendly materials to support ROHS and REACH testing

■ **Package and operating temperature range**

- Package form: TSSOP24, the size is 7.8mm long, 6.4mm wide, 1.2mm high

- Working environment temperature: -40℃ to 85℃

2   Pin Diagram and Function Description

2.1   Pin Diagram
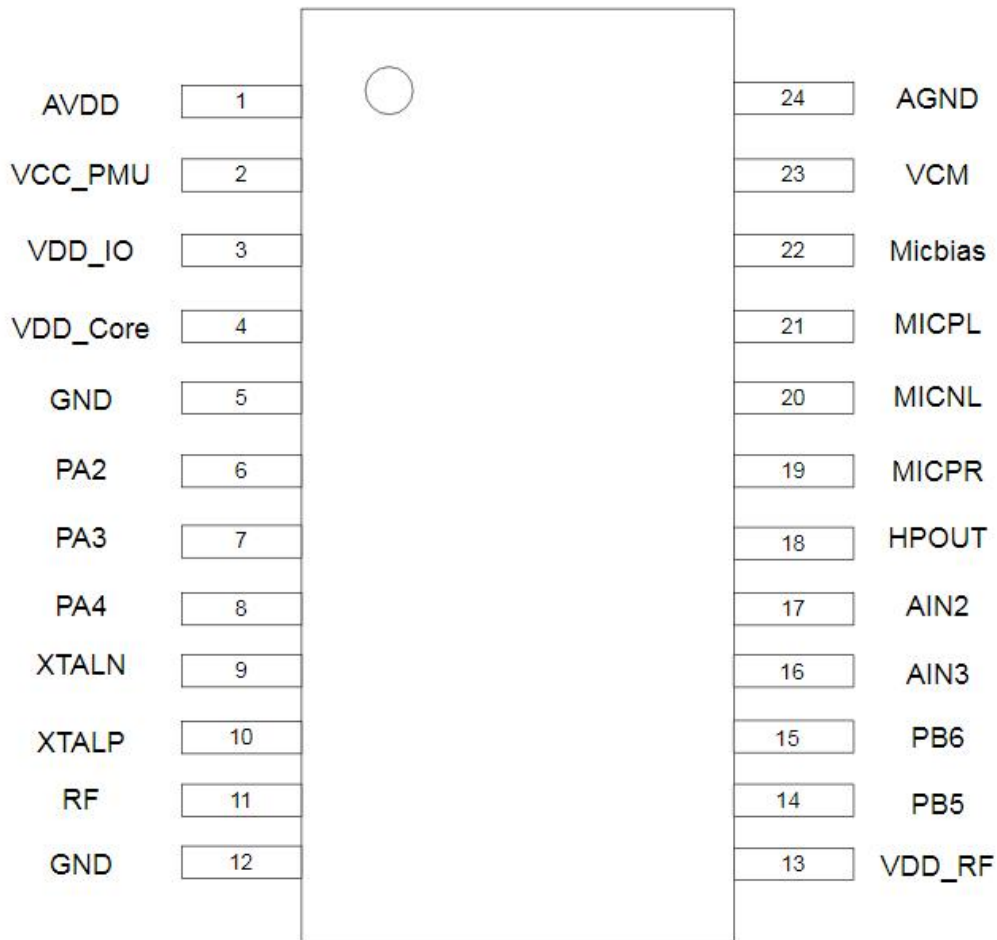
2.2   Pin descriptions

Table 2-1 Pin descriptions

Pin number	Pin Name	Type	IO 5V withstand voltage	IO Power-on Default status	Pin reuse and function description

1	AVDD	P	-	-	The 3.3V analog LDO output pin is also an analog power supply input pin with an external 4.7uF capacitor.
2	VIN5V	P	-	-	VIN5V is the PMU power input pin. The normal input voltage ranges from 3.6V to 5.5V. A 4.7uf input capacitor is externally connected. The maximum input voltage of this pin is 6.5V. Please note that this pin requires the addition of overvoltage and surge protection, such as TVS and 4.7 ohm resistance, to prevent surge impact.
3	VDD33	P	-	-	3.3V LDO output pin, external 4.7uF capacitor
4	VDD11	P	-	-	The 1.1V LDO output pin is also the core power supply input pin with 4.7uF capacitor
5	GND	P	-	-	Ground
6	PA2	IO	√	IN，T+D	1. GPIO PA2（Default power-on status） 2. IIS_SDI 3. IIC_SDA 4. UART1_TX 5. PWM0
7	PA3	IO	√	IN，T+D	1. GPIO PA3（Default power-on status） 2. IIS_LRCLK 3. IIC_SCL 4. UART1_RX1 5. PWM1
8	PA4	IO	√	IN，T+D	1. GPIO PA4（Default power-on status）/PG_EN（Determine whether to program according to the level state during power-on, and start the programming function at high power times） 2. IIS_SDO 3. PWM2
9	XTALN	I	-	-	Crystal oscillator pin negative
10	XTALP	I	-	-	Crystal oscillator pin positive
11	RF	-	-	-	RF antenna
12	GND	P	-	-	Ground
13	VDDRF	P	-	-	1. VDD_RF is the Bluetooth power input pin. Input voltage is 3.3V. A 4.7uf input capacitor is externally connected.
14	PB5	IO	√	IN，T+U	1. GPIO PB5（Default power-on status） 2. UART0_TX 3. IIC_SDA 4. PWM1
15	PB6	IO	√	IN，T+U	1. GPIO PB6（Default power-on status） 2. UART0_RX

					3. IIC_SCL 4. PWM2
16	AIN3	IO	-	IN，T+U	1. Reserve（Default power-on status） 2. GPIO PC3 3. PWM1 4. PDM_DAT 5. SAR ADC input channel 3
17	AIN2	IO	-	IN，T+U	1. Reserve（Default power-on status） 2. GPIO PC4 3. PWM0 4. PDM_CLK 5. SAR ADC input channel 2
18	HPOUT	O	-	-	DAC output
19	MICPR	I	-	-	Right Microphone P input
20	MICNL	I	-	-	Left Microphone N input
21	MICPL	I	-	-	Left Microphone P input
22	MICBIAS	O	-	-	Microphone bias output
23	VCM	O	-	-	VCM Output
24	AGND	P	-	-	Analog ground

Symbol definition:

I input

O output

IO bidirectional

P Power and ground

T+D triplet pull-down

T+U three-state pull-up

OUT Indicates the default power-on output

IN Specifies the default value for power-on

All I/O drive capabilities can be configured, and pull-down resistors can be configured.

2.3 Alternate functions

Table 2-2 Alternate functions

Pin Name	Function 1	Function2	Function 3	Function4	Function5	Analog Function	Specific Function
PA2	PA2	IIS_SDI	IIC_SDA	UART1_TX	PWM0	-	
PA3	PA3	IIS_LRCLK	IIC_SCL	UART1_RX	PWM1	-	
PA4	PA4	IIS_SDO	-	-	PWM2	-	PG EN Note1
PB5	PB5	UART0_TX	IIC_SDA	PWM1	-	-	
PB6	PB6	UART0_RX	IIC_SCL	PWM2	-	-	
AIN2	-	PC4	-	PWM0	PDM_CLK	AIN2	
AIN3	-	PC3	-	PWM1	PDM_DAT	AIN3	

Note1：P12-pa4 (PG_EN) of the chip is automatically pull-up by default. When the power-on is judged to be high, the chip automatically enters the upgrade mode when an upgrade signal is detected on UART0 during power-on. At this time, the matching upgrade tool can be used to program the Nor Flash inside the chip. If no upgrade signal is detected on UART0, it will enter the normal working mode.

3 Electrical Characteristics

Table 3-1 Lists the electrical characteristics

| Symbol	Description	Min.	Typical	Max.	Unit
VIN5V	PMU input pin voltage generally 5V	3.6	5	5.5	V
AVDD	Analog and Codec supply voltages	2.97	3.3	3.63	V
VDD33	Chip IO supply voltage	2.97	3.3	3.63	V
VDD11	Chip core power supply voltage	0.99	1.1	1.22	V
VDDRF	Bluetooth supply voltage	1.9	3.3	3.6	V
V_{IH}	Output high voltage，3.0V ≤ VDD33 ≤ 3.6V	0.7×VDD33	-	-	V
V_{IL}	Output low voltage，3.0V ≤ VDD33 ≤ 3.6V	-	-	0.3×VDD33	V
V_{OL}	Output low voltage @IOL = 12mA	-	-	0.4	V
V_{OH}	Output high voltage @IOH = 20mA	2.4	-	-	V
I5VIO	IO (5V withstand voltage) Output 3.3V drive current	5	-	23	mA
I33VIO	IO (3.3V withstand voltage) Output 3.3V drive current	12	-	26	mA
ΣIVDD	Sum of all IO currents of the chip	-	-	180	mA
Pde	5V power supply, chip 1.1V external DC-DC chip power supply, the total power consumption of 5V input during normal recognition (ambient temperature TA = 25 °C)	70	-	150	mW
Pdi	5V is used to power the chip, the chip uses internal PMU, and the total power consumption of 5V input during normal recognition (ambient temperature TA = 25 °C)	145	-	250	mW
TA Note1	The chip uses an external crystal oscillator to adapt to the operating environment temperature	-40	-	+85	°C
T_{ST}	The chip stores ambient temperature	-55	-	+150	°C

Note2：16MHz 10ppm crystal oscillator is required for chip operation.

4 Wireless characteristics

Parameter	Symbol	Conditions	MIN	TYP	MAX	UNIT
Current in power down	Ipd	Register retention	-	2	-	uA
Current in standby	Istb	Crystal on	-	40	-	uA
Current in TX 0dBm	Itx	PA under 0dBm	-	15	-	mA
Current in RX 2Mbps	Irx	RX mode	-	17	-	mA
Operation frequency	Freq	-	2400	-	2525	MHz
PLL frequency step	Delta F	-	-	-	1	MHz
Freq deviation@1Mbps	Df	-	-	-	250	KHz
Freq deviation@2Mbps	Df	-	-	-	320	KHz

The above power consumption data is measured when VDDRF is equal to 3.3V

5 Packaging Information
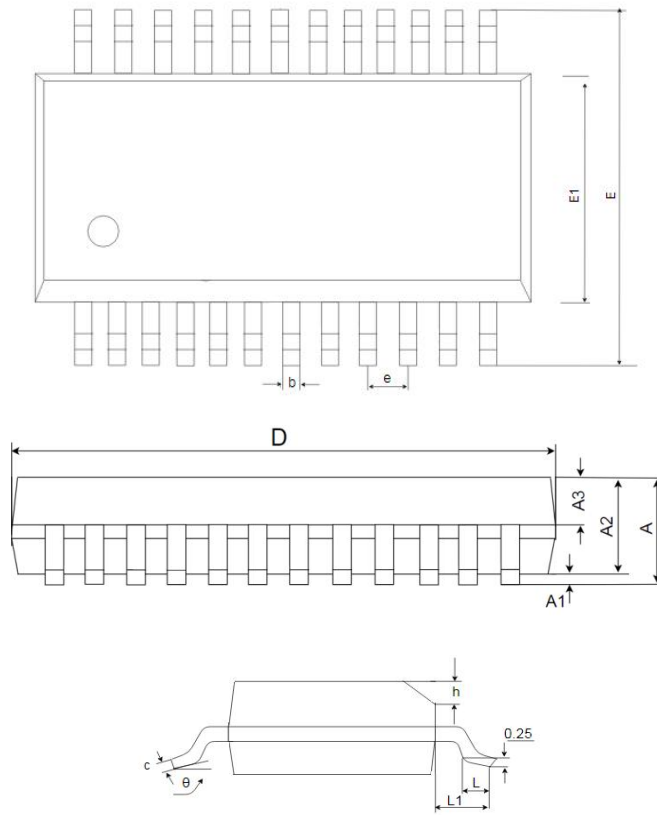
COMMON DIMENSIONS

SYMBOL	UNIT：MILLIMETER		
	MIN	NOM	MAX
A	–	–	1.2
A1	0.05	-	0.15
A2	0.8	1.00	1.05
b	0.19	–	0.30
c	0.09	–	0.20
D	7.70	7.80	7.90
E	4.30	4.40	4.50
E1	6.20	6.40	6.60
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00REF		
θ	0	–	8°

6 Order Information

Table 5-1 Order Information Table

Orderable Device	Flash	Status	Package Type	Pins	Package Qty	Eco Plan	MSL Peak Temp	Op Temp (°C)
CI2312	2MByte	MP	TSSOP24/Tube	24	50	RoHS & Green	Level-3 260C-UNLIM	-40 to 85

- Chipintelli reserves the right to change the instruction without further notice. Customers should obtain the latest version before placing an order, and verify that the relevant information is complete and up-to-date.
- Under specific conditions, any semiconductor product has a certain possibility of failure or failure. The buyer has the responsibility to comply with safety standards and take safety measures when using the product for system design and manufacturing, to avoid potential failure risk which may cause personal injury or property loss.
- Product improvement is endless. Chipintelli will provide customers with better products wholeheartedly!