

BP1032A2 Datasheet

High Performance 32-bit Bluetooth and 2.4GHz Wireless Audio Processor

Versions:

Date	Version	Description
2019/9	V0.4	Preliminary English version
2021/10	V0.5	Update the Table.1, modify IO parameters in the Table.5
2022/3	V0.6	Add the appendix of Bluetooth characteristic index, and supplement the power consumption data
2023/5	V2.0	Bluetooth upgraded to 5.3 certification, adding 2.4GHz wireless audio and 24-bit DSP processing to the introduction

Content

1. Overview	1
2. Functional Block Diagram	3
3. DSP processing block diagram	4
4. Pin Definition	5
5. GPIO Pin Description	5
6. Electrical Characteristics	8
6.1. Working condition for BP1032A2	8
6.2. Digital IO Electrical Characteristics	8
6.3. Audio Performance	9
7. Operational Frequency and Power Consumption	11
7.1. Power Consumption under Typical Mode	11
8. Package	12
9. Storage and Soldering	13
10. Declaration	14
11. Technical Support	15

Figures

Figure 1 . Functional Block Diagram of BP1032A2	3
Figure 2 . Audio DSP signal processing block diagram	4
Figure 3 . Pin Definition	5
Figure 4 . Package and Size	12

Tables

Table 1 . Pin definition	5
Table 2 . GPIO State and Electric level (POR)	6
Table 3 . Working Condition of BP1032A2	8
Table 4 . Digital IO DC Characteristics	8
Table 5 . Digital IO Driving and Pull-Up/Down Capability	8
Table 6 . Audio DAC performance@44.1KHz	9
Table 7 . Audio ADC performance @LINEIN3 channel, 44.1KHz	9
Table 8 . Audio ADC performance @LINEIN4 channel, 44.1KHz	10
Table 9 . Audio ADC performance @microphone channel, 44.1KHz	10
Table 10 . Power consumption	11

1. Overview

Core and Memory

- High performance 32-bit RISC core, @ max. 288MHz, supports DSP instruction, with floating-point unit(FPU) integrated
- FFT/IFFT accelerator supports operations of up to 1024 complex numbers or 2048 real numbers
- 320KB on-chip SRAM, 32KB I-Cache and 32KB D-Cache
- Internal 16M bits FLASH code and data storage
- EFUSE configuration register
- 2-wire SDP(Serial Debug Port), break-point and code tracking debug
- 40 interrupt vectors
- 4-level interrupt priority

Audio

- Three audio ADC, $SNR \geq 94dB$, 9 sampling rate: 8KHz / 11.025KHz / 12KHz / 16KHz / 22.05KHz / 24KHz / 32KHz / 44.1KHz / 48KHz
- Support up to 1 digital microphones or 1 analog microphone with AGC
- ADC line-in supports single-end or differential input
- Three audio DAC, $SNR \geq 105dB$, 9 sampling rate: 8KHz / 11.025KHz / 12KHz / 16KHz / 22.05KHz / 24KHz / 32KHz / 44.1KHz / 48KHz
- Directly drive earphone of 16Ω or 32Ω with power of 40mW
- One half-duplex S/PDIF supporting HDMI audio and ARC

Bluetooth

- Dual mode Bluetooth V5.3, compatible with Bluetooth V5.0 and V2.1+EDR
- Support Piconet and Scatternet networking protocols
- Maximum transmit power is 10dBm, support class1, class2 and class3
- Receiving sensitivity
 - DH1: -88dBm
 - 2DH5: -88dBm
 - 3DH5: -82dBm
 - BLE: -92dBm
- Support A2DP/AVRCP/HFP/HSP/OPP/HID/SPP/PBAP/GATT/SM profiles
- Support PLC(Package Loss Concealment)

2.4GHz Wireless Audio

- Share Bluetooth RF and Modem
- Use GFSK bi-directional link communication
- Support 1 / 2M rate
- Support high quality and low latency wireless audio bi-directional transmission with latency as low as 25ms or less

Power, Clock and Reset

- DC 3.3~5V power supply @ LDOIN
- Internal LDOs: 5V to 3.3V and 3.3V to 1.2V
- RC 12MHz and two PLL clocks
- Support 24MHz crystal
- Internal POR(Power on Reset), LVD(Low-Voltage-Detection) and Watchdog
- Multiple low-power options: CPU clock frequency reduction, system clock frequency reduction, sleep, deep sleep

Timer, PWM and PWC

- 2 basic timers (TIM1, TIM2)
- 4 general timers (TIM3, TIM4, TIM5, TIM6), with PWM and PWC function

Peripherals

- Max. 13 GPIOs
- All GPIOs support external interrupt and wakeup
- GPIOs configurable: pull-up, pull-down, Hi-impedance, pull-down current source, etc
- USB 2.0 Full-speed OTG controller and PHY, 6 endpoints
- One SDIO @ max.30M
- Two duplex UART @ max.3Mbps
- One I2C master/slave controller @ max.400K
- 12-bit SAR-ADC @ max. 450K sampling rate, sampling from 5 external IOs or 2 internal voltages
- One IR interface, supports NEC or SONY mode
- True random number generator

DMA

- 8-channel DMA, all memory direct addressing, addresses can be assigned to any peripherals except OTG, IR and I2C
- Unique automatic transmit-and-capture mechanism for memory and IO matching, or DMA-GPIO, can simulate various communication and controlling timing

SDK Firmware Stack and IDE

- Audio algorithm list:
Decode: MP2, MP3, WMA, APE, FLAC, AAC, MP4, M4A, WAV(IMA-ADPCM & PCM), AIF, AIFC

Encode: MP2/MP3, IMA-ADPCM

- Sound effects:
Echo, Reverb, 3D, Virtual bass, Auto-tune/pitch shifter/Voice changer, EQ, DRC, AEC, Noise suppression, Frequency-shifting, Screaming detection and suppression
- Support 24-bit high-precision DSP sound processing
- SDK includes abound of examples and middleware
- Free Eclipse-based IDE and GCC compiler
- Support FreeRTOS
- All C programming, easy for porting

Firmware Programming and Protection

- Multiple flash programming supported: debugger, specific burner/programmer, or Flash Burner Lite
- Firmware upgradable with Dual-bank
- 32-bit customized key for firmware encryption
- On-chip 64-bit unique ID

ESD

- HBM 2KV ESD capability

Package and Operational Temperature

- QFN32-5x5mm
- Working temperature: -40℃ ~ 85℃

Application Fields

- Bluetooth audio speaker
- Bluetooth Karaoke equipment
- Bluetooth Headphone
- Bluetooth Car audio
- Multiple microphone system for intelligent voice application with Bluetooth

2. Functional Block Diagram

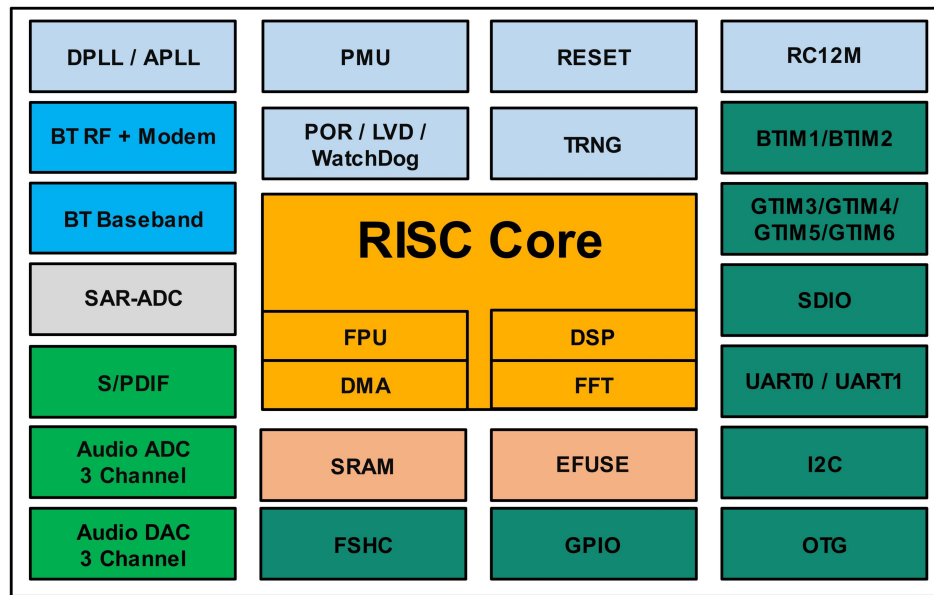


Figure 1. Functional Block Diagram of BP1032A2

3. DSP processing block diagram

BP10系列 Audio DSP signal flow diagram

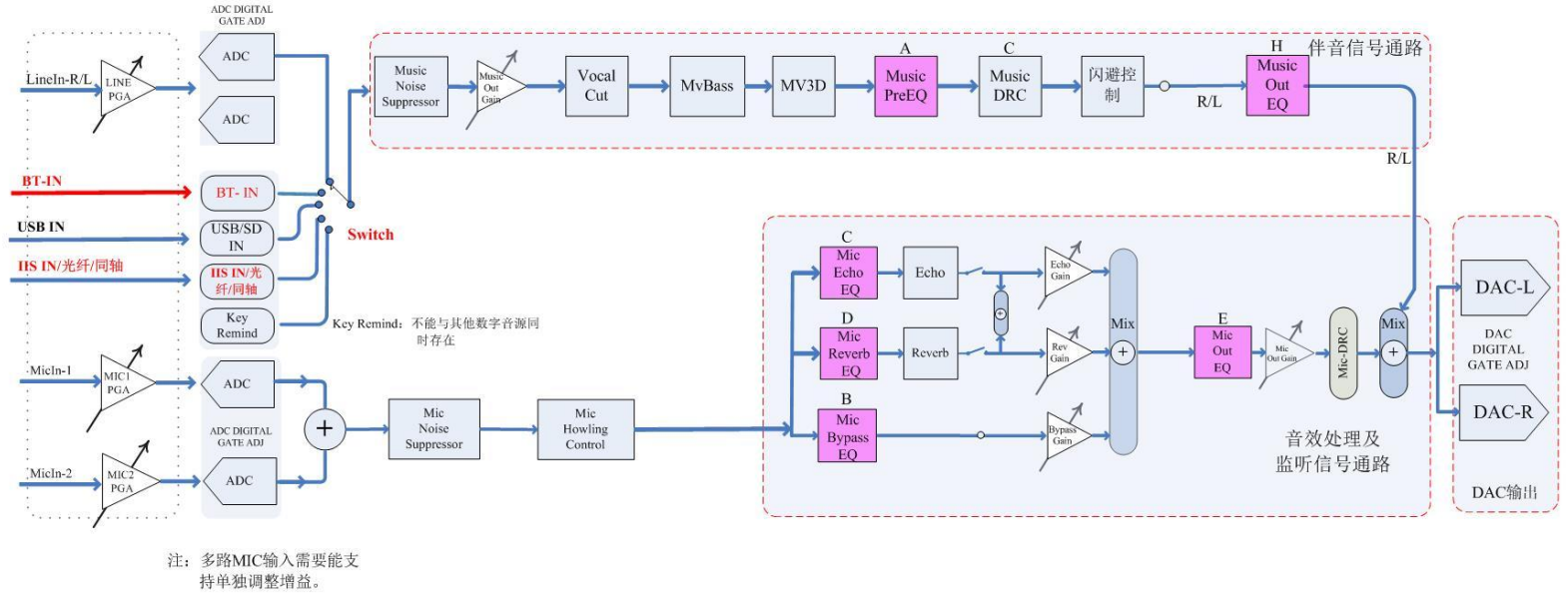


Figure 2. Audio DSP signal processing block diagram

4. Pin Definition

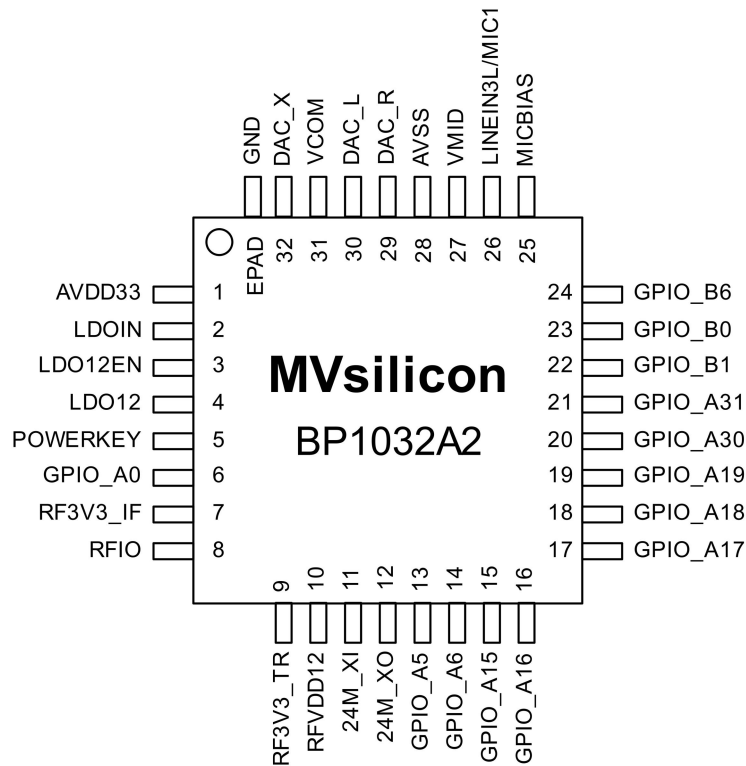


Figure 3. Pin Definition

5. GPIO Pin Description

Table 1. Pin definition

Pin#	Pin Name	Type	Other multiplexing function(s)
1	AVDD33	PWR	Analog power output, external filter capacitor is required
2	LDOIN	PWR	Power input for whole chip
3	LDO12EN	I	1.2V power source selector pin. If LDO12EN is connected to RF3V3_IF, internal 1.2V LDO is used. If LDO12EN is connected to GND, outside 1.2V DC-DC can be used to reduce the power consumption.
4	LDO12	PWR	If internal 1.2V LDO is used, external filter capacitor is required. If outside 1.2V power (ex.1.2V DC-DC) is used, it's a power input pin.
5	POWERKEY	I	Configurable power key, also be used as an ADC channel (AD11)
6	GPIO_A0	I/O	UART0_RXD / UART0_TXD / MCLK0_OUT / MCLK0_IN / TIM3_PWM
7	RF3V3_IF	PWR	RF power 3.3V input
8	RFIO	AI	RF antenna port
9	RF3V3_TR	PWR	RF power 3.3V input

Pin#	Pin Name	Type	Other multiplexing function(s)
10	RFVDD12	PWR	RF power 1.2V output, external filter capacitor is required
11	24M_XI	I	24M crystal XI
12	24M_XO	O	24M crystal XO
13	GPIO_A5	I/O	UART0_RXD / I2C_SDA
14	GPIO_A6	I/O	UART0_TXD / I2C_SCL
15	GPIO_A15	I/O	SD_DAT
16	GPIO_A16	I/O	SD_CLK
17	GPIO_A17	I/O	SD_CMD
18	GPIO_A18	I/O	USB_DM / UART1_RXD
19	GPIO_A19	I/O	USB_DP / UART1_TXD
20	GPIO_A30	I/O	AD7 / SPDIF_AI_2 / I2C_SDA / SPDIF_DI / SPDIF_DO / DMIC1_DAT
21	GPIO_A31	I/O	AD8 / SPDIF_AI_3 / I2C_SCL / SPDIF_DI / SPDIF_DO / DMIC1_CLK
22	GPIO_B1	I/O	LINEIN4_L / AD10 / TIM6_PWM / SW_D
23	GPIO_B0	I/O	LINEIN4_R / AD9 / TIM5_PWM / SW_CLK
24	GPIO_B6	I/O	EFUSE_VDD / CLK_OUT / IR
25	MICBIAS	O	Bias voltage for MIC
26	LINEIN3L / MIC1	AI	Analog audio LINEIN-3 left-channel input or MIC1 input
27	VMID	AO	Bias voltage for audio module internal use
28	AVSS	GND	Analog ground
29	DAC_R	AO	Audio right-channel output
30	DAC_L	AO	Audio left-channel output
31	VCOM	AO	Common mode sink used to drive the headset in a capa-less mode
32	DAC_X	AO	Audio x-channel output
EPAD	GND	GND	Ground for Digital and RF

Note:

1) Pad types:

I: digital input; O: digital output; AI: analog input; AO: analog output; I/O: bi-directional input/output; PWR: Power; GND: Ground

2) All GPIOs are grouped into A, B. Group A has 10 signals and Group B has 3.

3) BP1032A2 is a CMOS device and all unconnected GPIO pins are supposed to be set to pull-up or pull-down in order to avoid the unnecessary power consumption cause by the electric charge accumulation.

4) GPIOs response differently with the different type of resets:

- If Power-on-Reset (POR) is active, GPIOs will be reset as input and be set to high-impedance as indicated in table 2.
- If Watchdog reset or software SYSTEM RESET is active, GPIOs, based on the register configuration, can either keep the previous status(multiplexing, input/output or pull-up/down setting) before the reset or be set as the same as described in a) or table 2.

Table 2. GPIO State and Electric level (POR)

Pin(s)	Type	Electric level
GPIO_A[0]	Floating	High Impedance
GPIO_A[6:5]	Floating	High Impedance
GPIO_A[19:15]	Floating	High Impedance
GPIO_A[31:30]	Floating	High Impedance
GPIO_B[1:0]	Floating	High Impedance

GPIO_B[6]	Floating	High Impedance
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- 5) When the POWERKEY is not used, please keep the POWERKEY pin unconnected. Do not short to the ground or LDOIN.
- 6) MCLK0 is used for connected to other audio peripherals as audio clock, which can be configured as input (IN) or output (OUT).

6. Electrical Characteristics

6.1. Working condition for BP1032A2

Table 3. Working Condition of BP1032A2

Parameter	Pin	Min	Typ	Max	Unit
Ambient temperature		-40		85	°C
Power supply for chip	LDOIN	3.3		5.25	V
Power supply for analog modules	AVDD33		3.3		V
RF and digital power supply	RF3V3_IF & RV3V3_TR		3.3		V
Core working voltage	LDO12		1.2		V

6.2. Digital IO Electrical Characteristics

Table 4. Digital IO DC Characteristics

Symbol	Meaning	Min.	Typ.	Max.	Unit	Testing Condition
VIH	Input High	2.2		3.6	V	VDD33=3.3V
VIL	Input Low	-0.3		1.0	V	VDD33=3.3V
IL	Input leakage current	-10		10	uA	
VOH	Output High	3.0			V	@IOH=8mA
VOL	Output Low			0.3	V	@IOL=8mA

Table 5. Digital IO Driving and Pull-Up/Down Capability

Name	IOs	Normal	Enhanced	Unit	Testing Condition
Driving Capability	GPIO_A[6:5] / GPIO_A[17:15] / GPIO_A[31:30]	8	24	mA	VDD33=3.3V, typical
	GPIO_A[0] / GPIO_A[19:18] / GPIO_B[1:0] / GPIO_B[6]	4	8	mA	VDD33=3.3V, typical
Pull-up	GPIO_A[6:5] / GPIO_A[15] / GPIO_A[17] / GPIO_A[31:30]	10	-	KΩ	VDD33=3.3V, typical
	GPIO_A[0] / GPIO_A[16] / GPIO_A[19:18] / GPIO_B[1:0] / GPIO_B[6]	35	-	uA	VDD33=3.3V, typical
Pull-down	All GPIOs	35	-	uA	VDD33=3.3V, typical
Pull-down	GPIO_A[6:5] /	1.3	2.6 /	mA	VDD33=3.3V, typical

current source	GPIO_A[17:15] / GPIO_A[31:30]		1.3+2.6		
	GPIO_A[0] / GPIO_A[19:18] / GPIO_B[1:0] / GPIO_B[6]	-	2.6	mA	VDD33=3.3V, typical

6.3.Audio Performance

Table 6. Audio DAC performance@44.1KHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolution				24	Bits
Full Scale Output Signal Level	AVDD=3.3V		1.067		Vrms
Sampling frequency		8		48	KHz
Dynamic Range	A-Weighted, 1KHz -60dBFS input signal		105		dB
Signal to Noise Ratio	A-Weighted, 1KHz 0dBFS, input signal		105		dB
Total Harmonic Distortion + Noise	A-Weighted, 1KHz -6dBFS, input signal		-86		dB
Gain Error			0.008		dB
Group Delay	20 samples		2.65		ms
Phase deviation			0.18		degree
Channel Separation			-106		dB

Table 7. Audio ADC performance @LINEIN3 channel, 44.1KHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolution				16	bits
Full Scale input Signal Level	AVDD=3.3V		0.85		Vrms
Sampling frequency		8		48	KHz
PGA Gain Range		-18		12	dB
Input Resistance	PGA gain=0dB		36		KΩ
Dynamic Range	No Filter 1KHz input signal		94		dB
	A-Weighted 1KHz input signal		96		dB
Signal to Noise Ratio	No Filter, 850mVrms 1KHz input signal		94		dB
	A-Weighted, 850mVrms 1KHz input signal		96		dB
Total Harmonic Distortion + Noise	700mVrms 1KHz input signal		-86		dB
Gain Error			0.033		dB
Group Delay	20 samples		850		us
Channel Separation			-100		dB

Table 8. Audio ADC performance @LINEIN4 channel, 44.1KHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolution				16	bits
Full Scale input Signal Level	AVDD=3.3V		0.85		Vrms
Sampling frequency		8		48	KHz
PGA Gain Range		-19		42	dB
Input Resistance			50		KΩ
Dynamic Range	No Filter @ Fin=1KHz		93		dB
	A-Weighted @ Fin=1KHz		95		dB
Signal to Noise Ratio	No Filter @ 850mVrms, Fin=1KHz		93		dB
	A-Weighted @ 850mVrms, Fin=1KHz		95		dB
Total Harmonic Distortion + Noise	@ 700mVrms, Fin=1KHz		-82		dB
Gain Error			0.033		dB
Group Delay	20 samples		850		us
Channel Separation			-100		dB

Table 9. Audio ADC performance @microphone channel, 44.1KHz

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolution				16	bits
Full Scale input Signal Level	AVDD=3.3V		0.85		Vrms
Sampling frequency		8		48	KHz
PGA Gain Range	Without GainBoost	-20		20	dB
	With GainBoost	-20		47	dB
Input Resistance	PGA gain=20dB with Gainboost		1.5		KΩ
Dynamic Range	No Filter		94		dB
	A-Weighted		96		dB
Signal to Noise Ratio	No Filter		94		dB
	A-Weighted		96		dB
Total Harmonic Distortion + Noise	PGA Gain=0, -2dBFS Without GainBoost		-80		dB
	PGA Gain=0, -2dBFS With GainBoost		-86		dB
Gain Error			0.03		dB
Group Delay			850		us
Channel Separation			-97		dB

7. Operational Frequency and Power Consumption

7.1. Power Consumption under Typical Mode

Table 10. Power consumption

Typical Mode	Typical Current	Condition
Bluetooth A2DP	50mA	Without load (e.g. headset or speaker), disable all audio effect
Bluetooth HFP	52mA	Without load (e.g. headset or speaker), disable all audio effect
Bluetooth sniff	2mA	Bluetooth sniff interval is 500ms
Powerdown	20uA	Models with powerkey function

Note:

1. Power consumption parameters are only based on samples and measured at normal temperature and atmospheric pressure.
2. The internal 1.2V LDO is used in the test. If the external 1.2V DCDC is used, the power consumption can be lower.

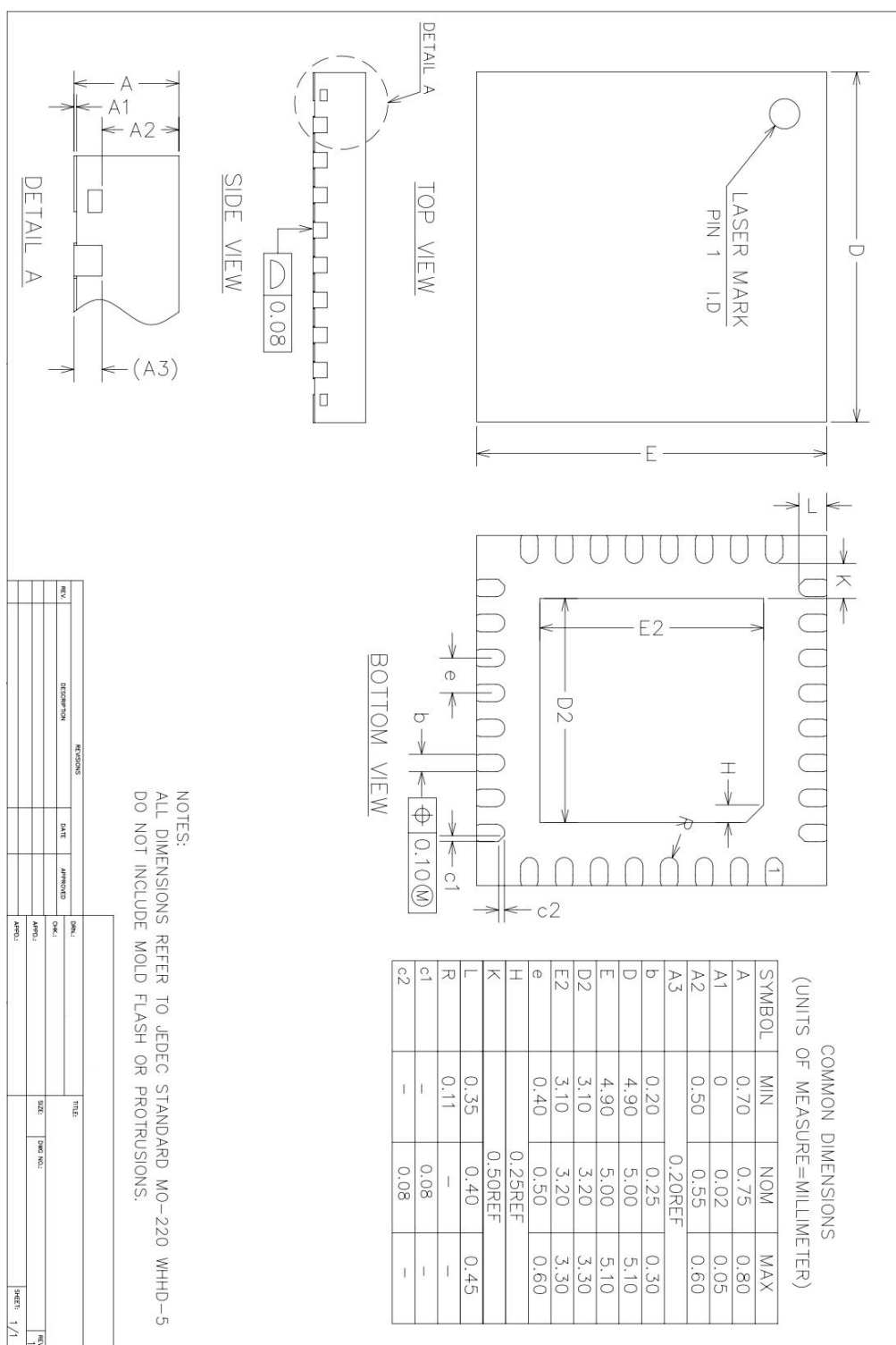


Figure 4. Package and Size

9. Storage and Soldering

Storage temperature: -65°C ~ 150°C.

BP1032A2 is a moisture sensitive component. The moisture sensitivity classification is **Class 3**.

It's important that the parts are handled under precaution and a proper manner.

The handling, baking and out-of-pack storage conditions of the moisture sensitive components are described in IPC/JEDC S-STD-033A.

The Technologies recommends utilizing the standard precautions listed below.

1. Calculated shelf life in Sealed Bag: 12 months at <40°C and <90% relative humidity(RH)
2. Peak Package Body Temperature: 250°C
3. After bag is opened, devices that will be subjected to reflow solder of other high temperature process must be:
 - a. Mounted within 168 hours of factory condition $\leq 30^{\circ}\text{C}$ / 60% RH
 - b. Stored at <10% RH if not used
4. Devices require baking, before mounting if:
 - a. Humidity indicator card is >10% when read at $23\pm 5^{\circ}\text{C}$ immediately after moisture barrier bag is opened
 - b. Items 3a or 3b is not met
5. If baking is required, please refer to J-STD-033 standard for low temperature (40°C) baking requirement in Tape/Reel form.

10. Declaration

All information and data contained in this document are without any commitment, are not to be considered as an offer for conclusion of a contract, nor shall they be construed as to create any liability. Any new issue of this document invalidates previous issues. Product availability and delivery are exclusively subject to our respective order confirmation form; the same applies to orders based on delivered development samples delivered. By this publication, Shanghai Mountain View Silicon Co., Ltd. ("MVSILICON") does not assume responsibility for patent infringements or other rights of third parties that may result from its use.

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FCC Statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help important announcement

Important Note:

Radiation Exposure Statement

This device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. The device is installed and operated without restriction.

The transmitter module may not be co-located with any other transmitter or antenna

End Product Labeling

The final end product must be labeled in a visible area with the following

"Contains FCC ID:2BWIABP1032A2"

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01r01

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C 15.247 & 15.207 & 15.209 has been investigated. It is applicable to the modular transmitter

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

Not applicable

2.6 RF exposure considerations

This device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. The device is installed and operated without restriction.

The transmitter module may not be co-located with any other transmitter or antenna

2.7 Antennas

This radio transmitter **FCC ID:2BWIABP1032A2** has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)	Frequency range:
Bluetooth	/	PCB Antenna	2.81dBi	2402-2480MHz

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following "Contains FCC ID:2BWIABP1032A2".

2.9 Information on test modes and additional testing requirements

Operation Frequency: 2402-2480MHz

Number of Channel: 79

Modulation: GFSK, $\pi/4$ DQPSK, 8DPSK

Host manufacturer must perform test of radiated & conducted emission and spurious emission, etc. according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.

2.11 Note EMI Considerations

Host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

2.12 How to make changes

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. According to the KDB 996369 D02 Q&A Q12, For EMC/radio-parameter compliance purposes, when an evaluation is done by the grantee or host provider and there are no additional emissions generated due to simultaneous-transmission operations compared to single transmitter operations testing (i.e., not transmitting simultaneously), it is not necessary to file the additional simultaneous transmission test data. The host manufacturer is responsible for ensuring compliance with the applicable FCC rules for the transmitters operating individually and simultaneously. This includes compliance for the summation of all emissions from all outputs occupying the same or overlapping frequency ranges, as defined by the applicable rules.

Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.