DZ-i5005

Product Specification

Ultra-Low Power 2.4GHZ Wi-Fi +BT5.0 Module

(OPL1000)

Version Ver1.2

History

Document Release	Date	Modification	Initials	Approved
Version V1.0	2021/01/04			

Overview

The OPL1000 SoC features a fully integrated 2.4GHz radio transceiver and baseband processor for Wi-Fi 802.11b and Bluetooth® Smart applications.The SoC can be used as a standalone application-specific communication processor or as a wireless data link in hosted MCU systems where ultra-low power is critical. The OPL1000 supports flexible memory architecture for storing profiles, stacks and custom application codes, and can be updated using Over-The-Air (OTA) technology. Qualified Bluetooth Smart protocol stack and Wi-Fi TCP/IP stack are stored in a dedicated ROM. The OPL1000 is equipped with dual processors, ARM® Cortex®-M0 and M3, for handling different processes. All software runs on the ARM® Cortex®-M0 processor while more intensive application-specific activities run on the ARM® Cortex®-M3 processor. The OPL1000 can be connected to any external MCU through SPI, I2C or UART interfaces and sensors or other devices through GPIOs. The transceiver interfaces directly to the antenna and is fully compliant with the Wi-Fi 802.11b and Bluetooth 5.0 BLE standards. With integrated antenna switch, RF balun, power amplifier (PA) and low noise amplifier (LNA), the OPL1000 allows both Wi-Fi and Bluetooth Smart to minimize PCB design area and external component requirement.

Features

The OPL1000 complies with ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan).

Processors

- ARM® Cortex®-M3 Application Processor
- ARM® Cortex®-M0 Link Controller

Wi-Fi

- 802.11b up to 11Mbps
- Supports STA mode
- WPA/WPA2 security supported
- Automatic beacon scanning and discovery
- Built-in TCP/IP stack
- Integrated dual power amplifiers: low (-2 dBm), high (+10 dBm) †
  Optional internal T/R switch by-pass mode available to increase to +12dBm

Bluetooth Smart

- Compliant with Bluetooth 5.0 BLE specifications with 1Mbps rate capability
- Slave mode support
- Adaptive Frequency Hopping (AFH)
- All GATT-based profiles supported
- Built-in BLE stack
- Max. 8 concurrent BLE connections supported
- 2 to 12 dBm transmit output power
- -80 dBm receive sensitivity

Memories

- 4kb One-Time-Programmable (OTP) memory
- 384 kB System SRAM
- 768 kB ROM

HW Crypto Engine

- AES-128/256 bits Encryption
- P-192/256 ECDH (Elliptic Curve Diffie-Hellman) Key Generation
- SHA2
- TRNG

Power Management

- Integrated Buck DC-DC converter
- Supports coin cell and alkaline battery

Clock

- Built-in low power 32KHz RC oscillator and support optional 32KHz crystal.
- Optional external 32 kHz crystal (±150 ppm max) and built-in low power oscillator

General purpose, capture and sleep timers

FW OTA (Over-The-Air) update support

Digital Interfaces

- General purpose I/Os: 24
- Two UARTs with hardware flow control up to 3Mbps
- Three SPI+™ interfaces
- One I2C bus at 100 kHz, 400 kHz

Analog Interfaces

- 10-bit Auxiliary ADC inputs up to 16 channels
- Six GPIO pins with 16mA driving capability
- Six PWMs

Radio Transceiver

- Fully integrated dual-mode 2.4 GHz CMOS transceiver
- Single wire antenna: no external matching and no external T/R switch required

Current Consumption

- Real Time Clock (RTC) mode with always-on domain alive < 5uA
- Deep sleep current ~ 3 uA1
- Timed sleep current ~4 uA2
- Supply current at battery terminal (with DC-DC) †
  - o Wi-Fi 802.11b:
    Tx ~ 18mA @ -2 dBm; 115mA @ +10 dBm
    Rx ~ 17.5 mA
  - o Bluetooth Smart:
    Tx ~ 12 mA @ 2 dBm;   63 mA @ +12 dBm
    Rx ~ 12 mA

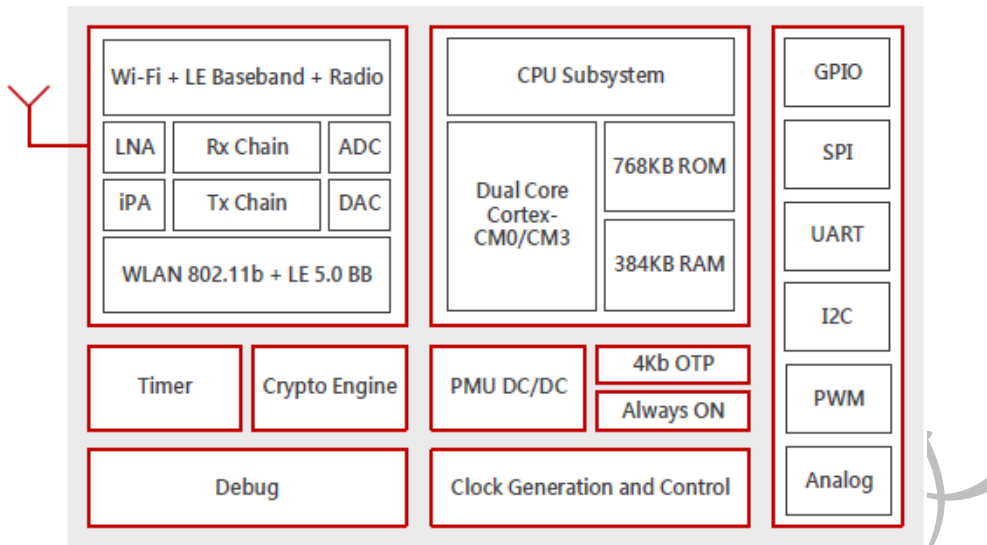Optional internal T/R switch by-pass mode available to increase to +12dBm
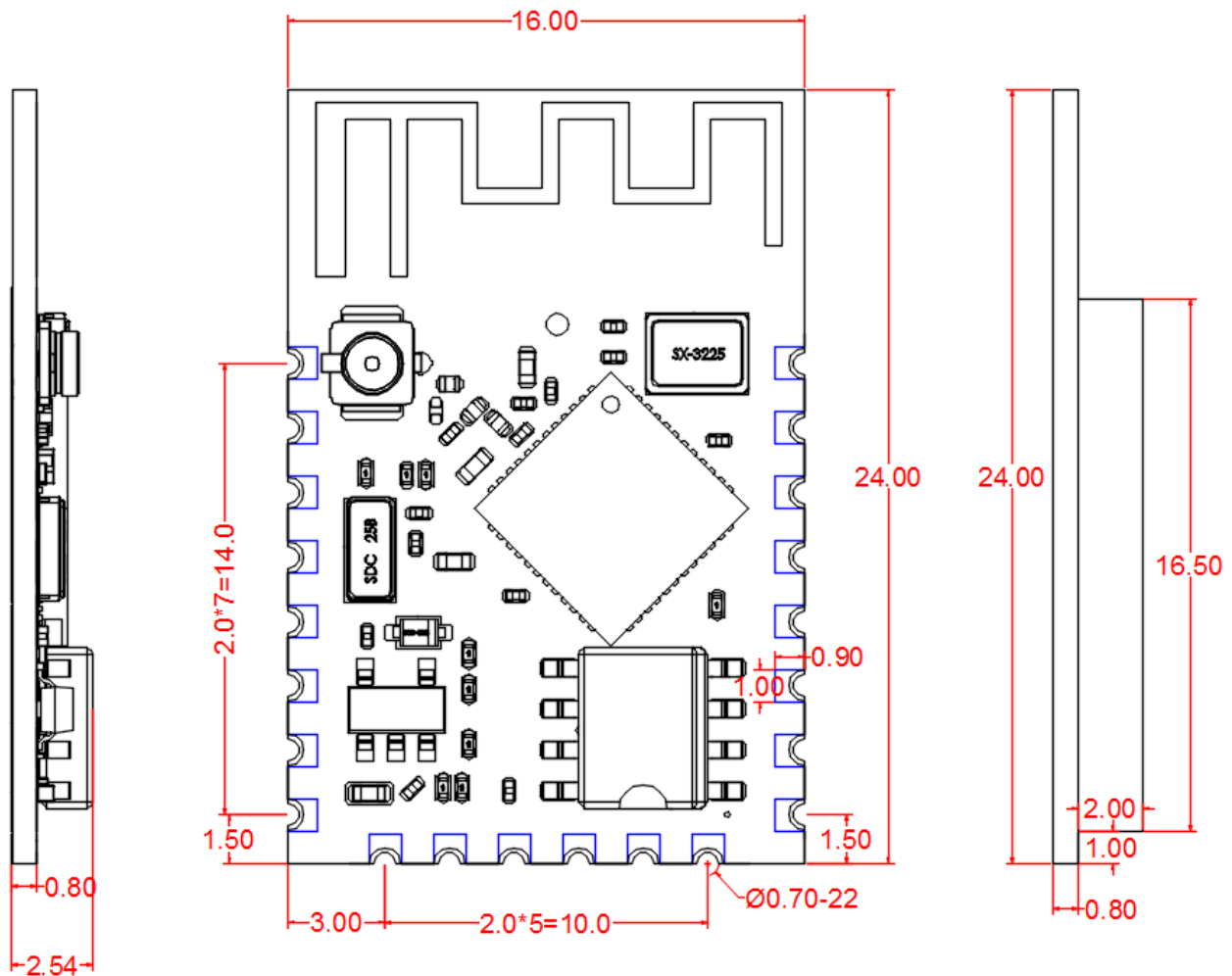
Package

- 48-pin QFN, 6 mm x 6 mm

Flash

- Module internal expansion 8Mbit SPI Flash

Block Diagram

Wi-Fi + LE Baseband + Radio			CPU Subsystem		GPIO
LNA	Rx Chain	ADC			SPI
iPA	Tx Chain	DAC	Dual Core Cortex-CM0/CM3	768KB ROM	UART
WLAN 802.11b + LE 5.0 BB				384KB RAM	I2C
Timer	Crypto Engine		PMU DC/DC	4Kb OTP / Always ON	PWM
Debug			Clock Generation and Control		Analog

Module Size

Unit：mm

无屏蔽罩侧面图　　　　　　　　正面俯视图　　　　　　　　带屏蔽罩侧面图
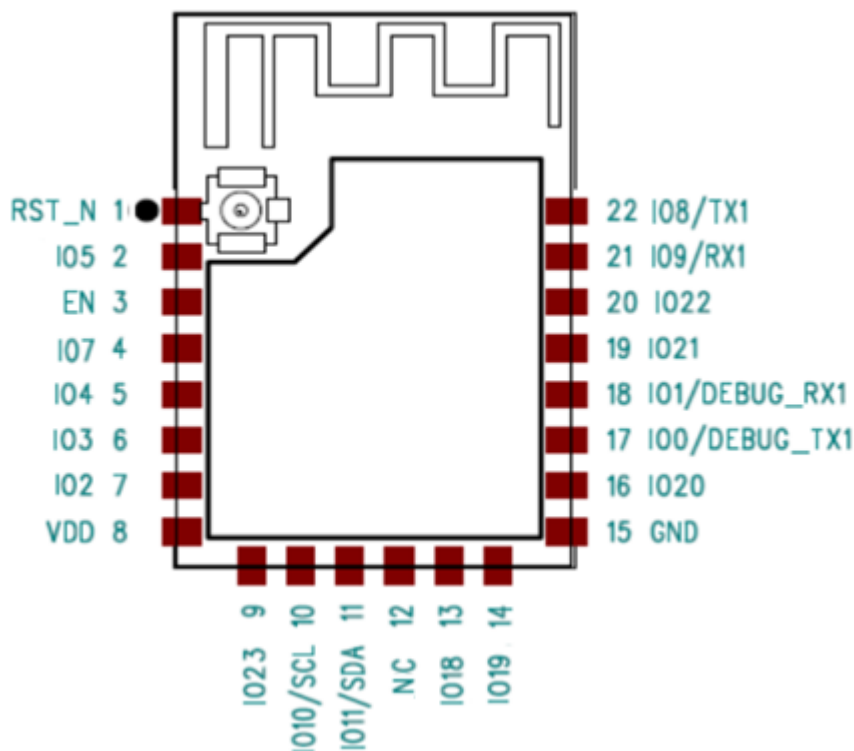
Pin Description

PIN	FUNCTION	Description
PIN1	RST_N	复位
PIN2	IO5	GPIO_5
PIN3	EN	使能复位管脚（高电平有效），模组内部与RST_N相连
PIN4	IO7	GPIO_7
PIN5	IO4	GPIO_4
PIN6	IO3	GPIO_3
PIN7	IO2	GPIO_2
PIN8	VDD	电源
PIN9	IO23	GPIO_23
PIN10	IO10/SCL	GPIO_10
PIN11	IO11/SDA	GPIO_11
PIN12	NC	NC
PIN13	IO18	GPIO_18
PIN14	IO19	GPIO_19
PIN15	GND	GND
PIN16	IO20	GPIO_20
PIN17	IO0/TX	GPIO_0/通信发射串口，默认烧录、Debug口
PIN18	IO1/RX	GPIO_1/通信接收串口，默认烧录、Debug口
PIN19	IO21	GPIO_21
PIN20	IO22	GPIO_22
PIN21	IO9/RX	GPIO_9/通信接收串口，默认AT口
PIN22	IO8/TX	GPIO_8/通信发射串口，默认AT口

ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit
Battery Supply	VDD_BAT			3.8	V
RF LDO Supply	DCDC_IN			1.59	V
PA Supply	VDD_PA			3.8	V
OTP Programming Supply	VDDQ			2.75	V
Digital Core Supply	VDD			1.35	V
IO Supply	VDDO			3.8	V
Operating Ambient Temperature	TO	-30		70	ºC
Storage Temperature	TS	-40		125	ºC
Junction temperature	TJ			125	ºC

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Battery Supply[†1]	VDD_BAT	2.0		3.6	V
RF LDO Supply	DCDC_IN	1.2	1.32	1.5	V
PA Supply[†1]	VDD_PA	2.0		3.6	V
OTP Programming Supply[†2]	VDDQ	2.25	2.5	2.75	V
Digital Core Supply	VDD	1.08	1.2	1.32	V
IO Supply	VDDO	2.0		3.6	V

1 Application voltage under 2.7v will degrade RF performance
2 VDDQ should be kept low or floating except during programming. Maximum accumulative time for the entire macro exposed under 2.5 +/- 10% should be less than 1 second.

Wi-Fi RF specification

Parameter	Mode & Condition	Min	Typ	Max	Unit
Frequency Range		2400		2500	MHz
Input Impedance			50		Ω
Input Reflection				-10	dB
Rx Max Input Level	DSSS 2Mb/s, FER<8%, MPDU = 1024 octets	-6			dBm
	HR/DSSS 11Mb/s, FER<8%, MPDU = 1024 octets	-9.5			dBm
Rx Sensitivity	DSSS 1Mb/s, FER<8%, MPDU = 1024 octets			-91	dBm

	HR/DSSS 11Mb/s, FER<8%, MPDU = 1024 octets		-80	dBm
Adjacent Channel Rejection	≥30MHz separation, Pwanted = Psens+6dB, DSSS 2Mb/s, FER<8%, MPDU = 1024 octets	35		dB
	≥25MHz separation, Pwanted = Psens+6dB, HR/DSSS 11Mb/s, FER<8%, MPDU = 1024 octets	35		dB
Tx Output Power	@ Low Power (LP)	0	−2	dBm
	@ High Power (HP)	8	10	dBm
Tx EVM	DQPSK, peak		-21	dB

Bluetooth RF specification

LE Receiver

Parameter	Condition	Min	Typ	Max	Unit
Sensitivity	BLE, 1Mbps, 0.1% BER			$-80^{\dagger}$	dBm
Max Input Power	BLE, 1Mbps, 0.1% BER			-20	dBm
C/I Co-Channel	P_{wanted}=-67dBm, BLE, 0.1% BER		6		dB
C/I ±1MHz Adjacent Channel	P_{wanted}=-67dBm, BLE, 0.1% BER		-4		dB
C/I ±2MHz Adjacent Channel	P_{wanted}=-67dBm, BLE, 0.1% BER		-31		dB
C/I ≥3MHz Adjacent Channel	P_{wanted}=-67dBm, BLE, 0.1% BER		-40		dB
Out-Of-Band Blocking	30 MHz ~ 2000 MHz, P_{wanted}=-67dBm, f_{wanted}=2426MHz, 0.1% BER	-5			dBm
	2000 MHz ~ 2400 MHz, P_{wanted}=-67dBm, f_{wanted}=2426MHz, 0.1% BER	-15			dBm
	2500 MHz ~ 3000 MHz, P_{wanted}=-67dBm, f_{wanted}=2426MHz, 0.1% BER	-35			dBm
	3000 MHz ~ 12.5 GHz, P_{wanted}=-67dBm, f_{wanted}=2426MHz, 0.1% BER	-30			dBm
Intermodulation	P_{wanted}=-64dBm, 0.1% BER, n=3,4,5	-34	-29		dBm

LE Transmitter

| Parameter	Condition	Min	Typ	Max	Unit
Tx Output Power	Low Power		2	5	dBm
	Gain control range		20		dB
	High Power		12	14	dBm
	Gain Step		2		dB
Tx In-Band Spurious Emissions	@ 0dBm, foffset=2MHz		-53		dBm
	@ 0dBm, foffset=3MHz		-57		dBm
	@10dBm, foffset=2MHz		-41		dBm
	@10dBm, foffset=3MHz		-45		dBm
Tx Out-Of-Band Spurious Emissions	Narrowband spurious,30MHz-1GHz			36	dBm
	Narrowband spurious, GHz-12.75GHz			30	dBm
	Narrowband spurious, 1.8GHz-1.9GHz, 5.15GHz-5.3GHz			-47	dBm
	Wideband spurious, 30MHz-1GHz			-86	dBm
	Wideband spurious,1GHz-12.75GHz			-80	dBm
	Wideband spurious, 1.8GHz-1.9GHz, 5.15GHz-5.3GHz			-97	dBm
LO Performance	Initial carrier frequency tolerance ,	-150		150	KHz
Frequency Drift	Frequency drift	50		50	KHz
	Drift rate			20	kHz/50μs
Frequency Deviation	Average deviation in payload (sequence used is 00001111)	225		275	KHz
	Maximum deviation in payload (sequence used is 10101010)	185			KHz
	Channel spacing		2		MHz

Recommended Reflow Profile

Referred to IPC/JEDEC standard.
Peak Temperature ： <250°C
Number of Times ： ≤2 times
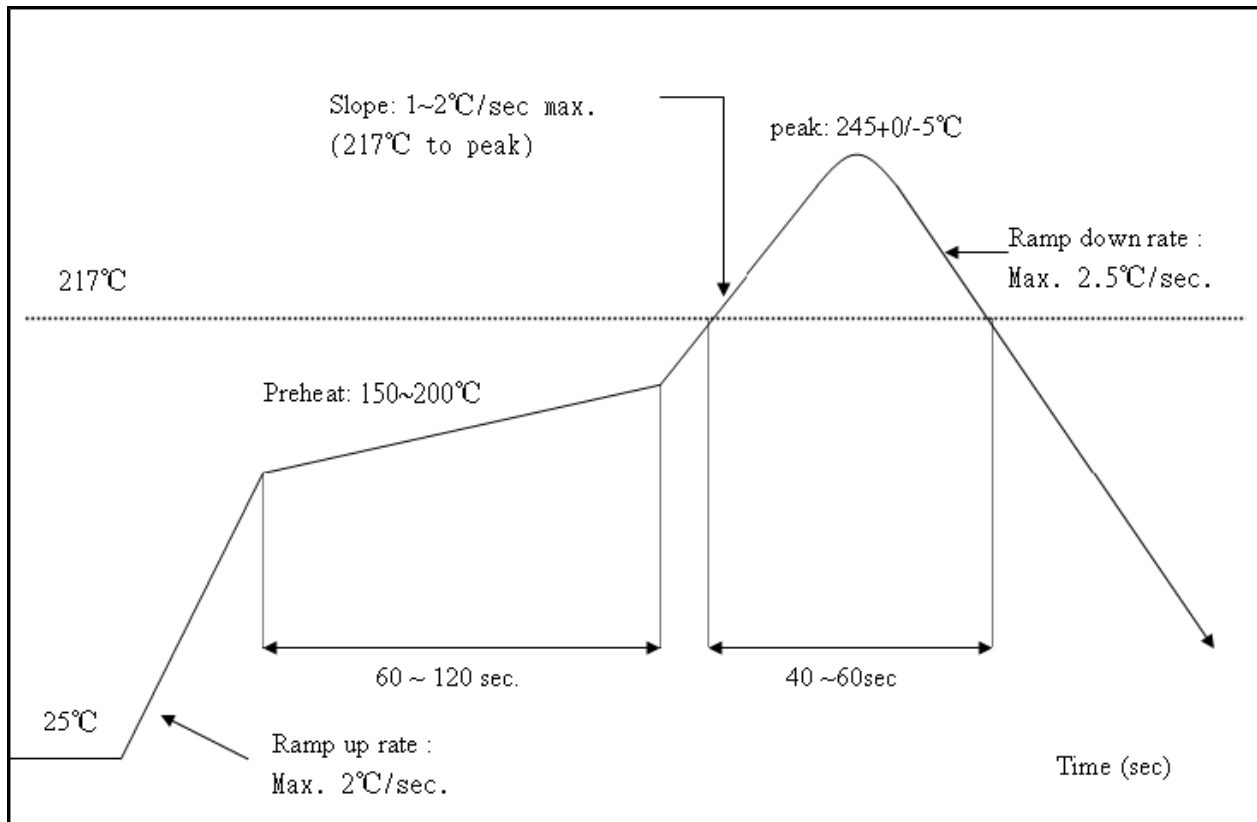
Federal Communication Commission Statement (FCC, U.S.)

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 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.

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.

FCC Caution:

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

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment

should be installed and operated with minimum distance 20cm between the radiator & your body.

IMPORTANT NOTES

Co-location warning:

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM integration instructions:

This device is intended only for OEM integrators under the following conditions:

The transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

Validity of using the module certification:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module 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.

End product labeling:

The final end product must be labeled in a visible area with the following: "Contains Transmitter Module FCC ID: 2ATZK-DZ-I5005".

Information that must be placed in the end user manual:

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 manufactures according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules

FCC Part 15 Subpart C 15.247 & 15.207 & 15.209

2.3 Specific operational use conditions

The module is a Bluetooth module with WiFi & BLE 2.4G function.

WiFi Specification：

Operation Frequency: 2412~2462MHz Number of Channel: 11

Modulation: DSSS

Type: PCB Antenna

Gain: 1 dBi

BLE Specification：

Operation Frequency: 2402~2480MHz Number of Channel: 40

Modulation: GFSK Type: PCB Antenna Gain: 1 dBi

The module can be used for mobile or applications with a maximum 1dBi antenna. The host manufacturer installing this module into their product must ensure that the final composit product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operaition. The host manufacturer 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.

2.4 Limited module procedures

Not applicable.

2.5 Trace antenna designs

Not applicable. The module has its own antenna, and doesn't need a host's printed board microstrip trace antenna etc.

2.6 RF exposure considerations

The module must be installed in the host equipment such that at least 20cm is maintained between the antenna and users' body; and if RF exposure statement or module layout is changed, then the host product manufacturer required to take responsibility of the module through a change in FCC ID or new application. The FCC ID of the module cannot be used on the final product. In these circumstances, the host manufacturer will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization

2.7 Antennas

Antenna Specification are as follows: Type: PCB Antenna

Gain: 1 dBi

This device is intended only for host manufacturers under the following conditions: The transmitter module may not be co-located with any other transmitter or antenna; The module shall be only used with the internal antenna(s) that has been originally tested and certified with this module. The antenna must be either permanently attached or employ a 'unique' antenna coupler.

As long as the conditions above are met, further transmitter test will not be required. However, the host manufacturer is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.)

2.8 Label and compliance information

Host product manufacturers need to provide a physical or e-label stating "Contains Transmitter Module FCC ID: 2ATZK-DZ-I5005" with their finished product.

2.9 Information on test modes and additional testingrequirements BLE

Operation Frequency: 2402~2480MHz Number of Channel: 40

Modulation: GFSK

WIFI

Operation Frequency: 2412~2462MHz Number of Channel: 11

Modulation: DSSS

Host manufacturer must perfom 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

The modular transmitter is only FCC authorized for FCC Part 15 Subpart C 15.247 & 15.207 & 15.209 and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed