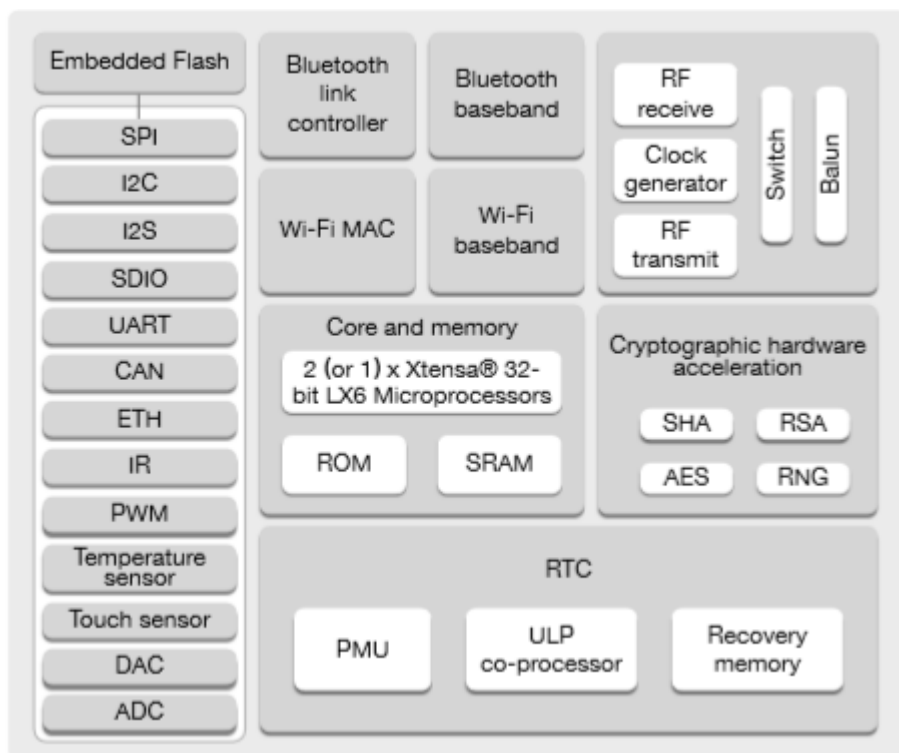


# KK-4000 User Manual

## 1. Overview

KK-4000 is a single chip integrated with 2.4 GHz Wi-Fi and Bluetooth dual mode. Using TSMC (TSMC) ultra low power consumption nanotechnology, it has the best power performance, RF performance, stability, versatility and reliability. It is suitable for various applications and different power consumption requirements.

Table 1: The block diagram of the KK-4000



### 1.1 KK-4000 Specifications

| Categories | Items           | Specifications                                                                                              |
|------------|-----------------|-------------------------------------------------------------------------------------------------------------|
| Wi-Fi      | Protocols       | IEEE 802.11b/g/n (802.11n up to 150 Mbps)<br>A-MPDU and A-MSDU aggregation and 0.4 s guard interval support |
|            | Frequency range | 2.4GWi-Fi:2412-2462MHz(802.11b/g/n-HT20)<br>2422-2452MHz(802.11n-HT40)                                      |

|           |           |                                             |
|-----------|-----------|---------------------------------------------|
| Bluetooth | Protocols | Bluetooth v4.2 BR/EDR and BLE specification |
|           | Radio     | NZIF receiver with -97 dBm sensitivity      |
|           |           | class-2 transmitter                         |
|           |           | AFH                                         |
|           | Audio     | CVSD and SBC                                |

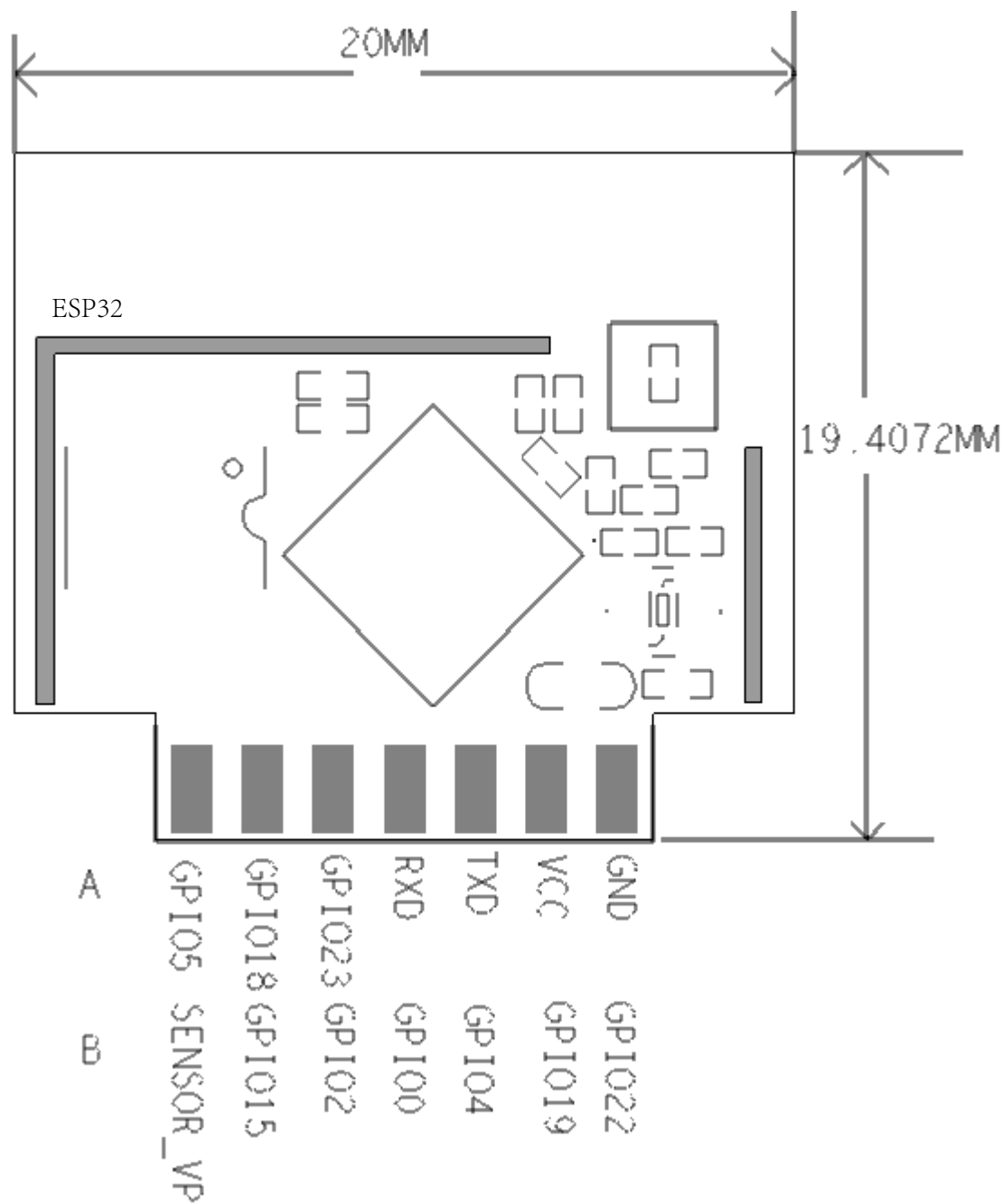
| Categories | Items                                     | Specifications                                             |
|------------|-------------------------------------------|------------------------------------------------------------|
| Hardware   | Module interface                          | SD card, UART, SPI, SDIO, I2C, LED PWM, Motor PWM, I2S, IR |
|            |                                           | GPIO, capacitive touch sensor, ADC, DAC                    |
|            | On-chip sensor                            | Hall sensor, temperature sensor                            |
|            | Operating voltage/Power supply            | 2.7 ~ 3.6V                                                 |
|            | Operating current                         | Average: 80 mA                                             |
|            | Minimum current delivered by power supply | 500 mA                                                     |
|            | Operating temperature range               | -40°C ~ +85°C                                              |
|            | Ambient temperature range                 | Normal temperature                                         |
|            | Package size                              | 20 mm x 19.4mm x 3mm                                       |

## 1.2 application

- ✧ universal low power IoT sensor Hub
- ✧ general low power IoT recorder
- ✧ Video streaming transmission of camera
- ✧ OTT TV box / set-top box equipment
- ✧ Music player - network music player - audio streaming media device
- ✧ Wi-Fi toys - counter - Toy anti - loss devices
- ✧ Wi-Fi speech recognition equipment
- ✧ Ear wheat
- ✧ Intelligent socket
- ✧ family automation
- ✧ Mesh network
- ✧ Industrial wireless control
- ✧ baby monitor
- ✧ Wearable electronic products

2. PIN DEFINITIONS

2.1 Dimensions



## 2.2 Pin Description

KK-4000 has 14 pins. See pin definitions in Table 2.

Table 2: Pin Definitions

| Name       | No. | Function                                                                  |
|------------|-----|---------------------------------------------------------------------------|
| GND_POWER  | A1  | Power pipe foot, grounding                                                |
| VDD_33     | A2  | Power pipe pin, 3.3V voltage input                                        |
| UTXD       | A3  | GPIO1、U0TXD、CLK_OUT3、EMAC_RXD2                                            |
| URXD       | A4  | GPIO3、U0RXD、CLK_OUT2                                                      |
| GPIO23     | A5  | GPIO23、VSPID、HS1_STROB                                                    |
| GPIO18     | A6  | GPIO18、VSPICLK、HS1_DATA7                                                  |
| GPIO5      | A7  | GPIO5、VSPICS0、HS1_DATA6、EMAC_RX_CL                                        |
| GPIO22     | B1  | GPIO22、VSPIWP、U0RTS、EMAC_TXD1                                             |
| GPIO19     | B2  | GPIO19、VSPIQ、U0CTS、EMAC_TXD                                               |
| GPIO4      | B3  | GPIO4、ADC2_CH0、TOUCH0、RTC_GPIO10、HSPIHD、<br>HS2_DATA1、SD_DATA1、EMAC_TX_ER |
| GPIO0      | B4  | GPIO0、ADC2_CH1、TOUCH1、RTC_GPIO11、CLK_OUT1、<br>EMAC_TX_CLK                 |
| GPIO2      | B5  | GPIO2、ADC2_CH2、TOUCH2、RTC_GPIO12、HSPIWP、<br>HS2_DATA0、SD_DATA0            |
| GPIO15     | B6  | General GPIO pin                                                          |
| SEBNSOR_VP | B7  | GPIO39、ADC1_CH3、ADC_PRE_AMP、RTC_GPIO3                                     |

### 3. Electrical Characteristics

Note:

The specifications in this chapter have been tested under the following general condition: VDD = 3.3V, T<sub>A</sub> = 27°C, unless otherwise specified.

#### 3.1 Absolute Maximum Ratings

Table 3: Absolute Maximum Ratings

| Parameter                                 | Symbol    | Min                    | Typ | Max                    | Unit |
|-------------------------------------------|-----------|------------------------|-----|------------------------|------|
| Power supply                              | VDD       | 2.7                    | 3.3 | 3.6                    | V    |
| Minimum current delivered by power supply | $I_{VDD}$ | 0.5                    | -   | -                      | A    |
| Input low voltage                         | $V_{IL}$  | -0.3                   | -   | $0.25 \times V_{IO}^1$ | V    |
| Input high voltage                        | $V_{IH}$  | $0.75 \times V_{IO}^1$ | -   | $V_{IO}^1 + 0.3$       | V    |
| Input leakage current                     | $I_{IL}$  | -                      | -   | 50                     | nA   |
| Input pin capacitance                     | $C_{pad}$ | -                      | -   | 2                      | pF   |
| Output low voltage                        | $V_{OL}$  | -                      | -   | $0.1 \times V_{IO}^1$  | V    |
| Output high voltage                       | $V_{OH}$  | $0.8 \times V_{IO}^1$  | -   | -                      | V    |
| Maximum output drive capability           | $I_{MAX}$ | -                      | -   | 40                     | mA   |
| Storage temperature range                 | $T_{SR}$  | -40                    | -   | 85                     | °C   |
| Operating temperature range               | $T_{OPR}$ | -40                    | -   | 85                     | °C   |

#### 3.2 Wi-Fi Radio

Table 4: Wi-Fi Radio Characteristics

| Description                     | Min   | Typical | Max   | Unit |
|---------------------------------|-------|---------|-------|------|
| Input frequency                 | 2412  | -       | 2462  | MHz  |
| Input reflection                | -     | -       | -10   | dB   |
| Tx power                        |       |         |       |      |
| Output power of PA for 11b mode | 18.32 | 18.98   | 19.03 | dBm  |
| Sensitivity                     |       |         |       |      |
| DSSS, 1 Mbps                    | -     | -98     | -     | dBm  |
| CCK, 11 Mbps                    | -     | -91     | -     | dBm  |
| OFDM, 6 Mbps                    | -     | -93     | -     | dBm  |
| OFDM, 54 Mbps                   | -     | -75     | -     | dBm  |
| HT20, MCS0                      | -     | -93     | -     | dBm  |
| HT20, MCS7                      | -     | -73     | -     | dBm  |

| Description                | Min | Typical | Max | Unit |
|----------------------------|-----|---------|-----|------|
| HT40, MCS0                 | -   | -90     | -   | dBm  |
| HT40, MCS7                 | -   | -70     | -   | dBm  |
| MCS32                      | -   | -89     | -   | dBm  |
| Adjacent channel rejection |     |         |     |      |
| OFDM, 6 Mbps               | -   | 37      | -   | dB   |
| OFDM, 54 Mbps              | -   | 21      | -   | dB   |
| HT20, MCS0                 | -   | 37      | -   | dB   |
| HT20, MCS7                 | -   | 20      | -   | dB   |

## 3.3 BLE Radio

### 3.3.1 Receiver

Table 6: Receiver Characteristics — BLE

| Parameter                          | Conditions          | Min | Typ | Max | Unit |
|------------------------------------|---------------------|-----|-----|-----|------|
| Sensitivity @30.8% PER             | -                   | -   | -97 | -   | dBm  |
| Maximum received signal @30.8% PER | -                   | 0   | -   | -   | dBm  |
| Co-channel C/I                     | -                   | -   | +10 | -   | dB   |
| Adjacent channel selectivity C/I   | F = F0 + 1 MHz      | -   | -5  | -   | dB   |
|                                    | F = F0 - 1 MHz      | -   | -5  | -   | dB   |
|                                    | F = F0 + 2 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 - 2 MHz      | -   | -35 | -   | dB   |
|                                    | F = F0 + 3 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 - 3 MHz      | -   | -45 | -   | dB   |
| Out-of-band blocking performance   | 30 MHz ~ 2000 MHz   | -10 | -   | -   | dBm  |
|                                    | 2000 MHz ~ 2400 MHz | -27 | -   | -   | dBm  |
|                                    | 2500 MHz ~ 3000 MHz | -27 | -   | -   | dBm  |
|                                    | 3000 MHz ~ 12.5 GHz | -10 | -   | -   | dBm  |
| Intermodulation                    | -                   | -36 | -   | -   | dBm  |

### 3.3.2 Transmitter

Table 7: Transmitter Characteristics — BLE

| Parameter              | Conditions | Min | Typ | Max | Unit |
|------------------------|------------|-----|-----|-----|------|
| RF transmit power      | -          | -   | 0   | -   | dBm  |
| RF power control range | -          | -1  | -   | +1  | dBm  |

| Parameter                                       | Conditions       | Min | Typ   | Max | Unit     |
|-------------------------------------------------|------------------|-----|-------|-----|----------|
| Adjacent channel transmit power                 | F = F0 + 1 MHz   | -   | -14.6 | -   | dBm      |
|                                                 | F = F0 - 1 MHz   | -   | -12.7 | -   | dBm      |
|                                                 | F = F0 + 2 MHz   | -   | -44.3 | -   | dBm      |
|                                                 | F = F0 - 2 MHz   | -   | -38.7 | -   | dBm      |
|                                                 | F = F0 + 3 MHz   | -   | -49.2 | -   | dBm      |
|                                                 | F = F0 - 3 MHz   | -   | -44.7 | -   | dBm      |
|                                                 | F = F0 + > 3 MHz | -   | -50   | -   | dBm      |
|                                                 | F = F0 - > 3 MHz | -   | -50   | -   | dBm      |
| $\Delta f_{1\text{avg}}$                        | -                | -   | -     | 265 | kHz      |
| $\Delta f_{2\text{max}}$                        | -                | 247 | -     | -   | kHz      |
| $\Delta f_{2\text{avg}}/\Delta f_{1\text{avg}}$ | -                | -   | -0.92 | -   | -        |
| ICFT                                            | -                | -   | -10   | -   | kHz      |
| Drift rate                                      | -                | -   | 0.7   | -   | kHz/50 s |
| Drift                                           | -                | -   | 2     | -   | kHz      |

## 3.4 Bluetooth Radio

### 3.4.1 Receiver (BDR)

Table 7: Receiver Characteristics — BDR

| Parameter                          | Conditions          | Min | Typ | Max  | Unit |
|------------------------------------|---------------------|-----|-----|------|------|
| Sensitivity @0.1% PER              | -                   | -   | -94 | -    | dBm  |
| Maximum received signal @30.8% PER | -                   | 0   | -   | -    | dBm  |
| Co-channel C/I                     | -                   | -   | +17 | -    | dB   |
| Adjacent channel selectivity C/I   | F = F0 + 1 MHz      | -   | -   | - 6  | dB   |
|                                    | F = F0 - 1 MHz      | -   | -   | -6   | dB   |
|                                    | F = F0 + 2 MHz      | -   | -   | -25  | dB   |
|                                    | F = F0 - 2 MHz      | -   | -   | - 33 | dB   |
|                                    | F = F0 + 3 MHz      | -   | -   | -25  | dB   |
|                                    | F = F0 - 3 MHz      | -   | -   | - 45 | dB   |
| Out-of-band blocking performance   | 30 MHz ~ 2000 MHz   | -10 | -   | -    | dBm  |
|                                    | 2000 MHz ~ 2400 MHz | -27 | -   | -    | dBm  |
|                                    | 2500 MHz ~ 3000 MHz | -27 | -   | -    | dBm  |
|                                    | 3000 MHz ~ 12.5 GHz | -10 | -   | -    | dBm  |
| Intermodulation                    | -                   | -36 | -   | -    | dBm  |

### 3.4.2 Receiver (EDR)

Table 7: Receiver Characteristics — EDR( $\pi/4$  DPSK)

| Parameter                          | Conditions          | Min | Typ | Max | Unit |
|------------------------------------|---------------------|-----|-----|-----|------|
| Sensitivity @0.1% PER              | -                   | -   | -90 | -   | dBm  |
| Maximum received signal @30.8% PER | -                   | 0   | 0   | -   | dBm  |
| Co-channel C/I                     | -                   | -   | +11 | -   | dB   |
| Adjacent channel selectivity C/I   | F = F0 + 1 MHz      | -   | -7  | -   | dB   |
|                                    | F = F0 - 1 MHz      | -   | -7  | -   | dB   |
|                                    | F = F0 + 2 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 - 2 MHz      | -   | -35 | -   | dB   |
|                                    | F = F0 + 3 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 - 3 MHz      | -   | -45 | -   | dB   |
| Out-of-band blocking performance   | 30 MHz ~ 2000 MHz   | -   | -   | -   | dBm  |
|                                    | 2000 MHz ~ 2400 MHz | -   | -   | -   | dBm  |
|                                    | 2500 MHz ~ 3000 MHz | -   | -   | -   | dBm  |
|                                    | 3000 MHz ~ 12.5 GHz | -   | -   | -   | dBm  |
| Intermodulation                    | -                   | -   | -   | -   | dBm  |

Table 8: Receiver Characteristics — EDR(8 DPSK)

| Parameter                          | Conditions          | Min | Typ | Max | Unit |
|------------------------------------|---------------------|-----|-----|-----|------|
| Sensitivity @0.1% PER              | -                   | -   | -84 | -   | dBm  |
| Maximum received signal @30.8% PER | -                   | 0   | 5   | -   | dBm  |
| Co-channel C/I                     | -                   | -   | +18 | -   | dB   |
| Adjacent channel selectivity C/I   | F = F0 + 1 MHz      | -   | 2   | -   | dB   |
|                                    | F = F0 - 1 MHz      | -   | 2   | -   | dB   |
|                                    | F = F0 + 2 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 - 2 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 + 3 MHz      | -   | -25 | -   | dB   |
|                                    | F = F0 - 3 MHz      | -   | -38 | -   | dB   |
| Out-of-band blocking performance   | 30 MHz ~ 2000 MHz   | -   | -   | -   | dBm  |
|                                    | 2000 MHz ~ 2400 MHz | -   | -   | -   | dBm  |
|                                    | 2500 MHz ~ 3000 MHz | -   | -   | -   | dBm  |
|                                    | 3000 MHz ~ 12.5 GHz | -   | -   | -   | dBm  |
| Intermodulation                    | -                   | -   | -   | -   | dBm  |

### 3.4.3 Transmitter

Table 9: Transmitter Characteristics — BDR

| Parameter              | Conditions | Min   | Typ   | Max   | Unit |
|------------------------|------------|-------|-------|-------|------|
| RF transmit power      | -          | -     | -1.61 | -     | dBm  |
|                        |            |       |       |       |      |
| RF power control range | -          | -1.81 | -     | -1.39 | dBm  |

| Parameter                         | Conditions       | Min   | Typ   | Max | Unit     |
|-----------------------------------|------------------|-------|-------|-----|----------|
| Adjacent channel transmit power   | F = F0 + 1 MHz   | -     | -24   | -   | dBm      |
|                                   | F = F0 - 1 MHz   | -     | -16.1 | -   | dBm      |
|                                   | F = F0 + 2 MHz   | -     | -40.8 | -   | dBm      |
|                                   | F = F0 - 2 MHz   | -     | -35.6 | -   | dBm      |
|                                   | F = F0 + 3 MHz   | -     | -45.7 | -   | dBm      |
|                                   | F = F0 - 3 MHz   | -     | -40.2 | -   | dBm      |
|                                   | F = F0 + > 3 MHz | -     | 45.6  | -   | dBm      |
|                                   | F = F0 - > 3 MHz | -     | 45.6  | -   | dBm      |
| $\Delta f_{1avg}$                 | -                | -     | -     | 155 | kHz      |
| $\Delta f_{2max}$                 | -                | 133.7 | -     | -   | kHz      |
| $\Delta f_{2avg}/\Delta f_{1avg}$ | -                | -     | 0.92  | -   | -        |
| ICFT                              | -                | -     | -7    | -   | kHz      |
| Drift rate                        | -                | -     | 0.7   | -   | kHz/50 s |
| Drift                             | -                | -     | 6     | -   | kHz      |

Table 10: Transmitter Characteristics — EDR

| Parameter              | Conditions | Min   | Typ   | Max  | Unit |
|------------------------|------------|-------|-------|------|------|
| RF transmit power      | -          | -     | -0.02 | -    | dBm  |
| Gain controll step     | -          | -     | -     | -    | dBm  |
| RF power control range | -          | -0.48 | -     | 0.49 | dBm  |

| Parameter                         |                            | Min | Typ   | Max   | Unit |
|-----------------------------------|----------------------------|-----|-------|-------|------|
| $\pi/4$ DQPSK max $w_0$           |                            | -   | -0.72 | -     | kHz  |
| $\pi/4$ DQPSK max $w_i$           |                            | -   | -6    | -     | kHz  |
| $\pi/4$ DQPSK max ( $w_i + w_0$ ) |                            | -   | -7.42 | -     | kHz  |
| 8DPSK max $w_0$                   |                            | -   | 0.7   | -     | kHz  |
| 8DPSK max $w_i$                   |                            | -   | -9.6  | -     | kHz  |
| 8DPSK max ( $w_i + w_0$ )         |                            | -   | -10   | -     | kHz  |
| $\pi/4$ DQPSK modulation accuracy | RMS DEVM                   | -   | 4.28  | -     | %    |
|                                   | 99% DEVM                   | -   | -     | 30    | %    |
|                                   | Peak DEVM                  | -   | 13.3  | -     | %    |
| 8DPSK modulation accuracy         | RMS DEVM                   | -   | 5.8   | -     | %    |
|                                   | 99% DEVM                   | -   | -     | 20    | %    |
|                                   | Peak DEVM                  | -   | 14    | -     | %    |
| In-band spurious emissions        | $F = F_0 + 1\text{MHz}$    | -   | -34   | -     | dBm  |
|                                   | $F = F_0 - 1\text{MHz}$    | -   | -40.2 | -     | dBm  |
|                                   | $F = F_0 + 2\text{MHz}$    | -   | -34   | 155   | dBm  |
|                                   | $F = F_0 - 2\text{MHz}$    | -   | -36   | -     | dBm  |
|                                   | $F = F_0 + 3\text{MHz}$    | -   | -38   | -     | dBm  |
|                                   | $F = F_0 - 3\text{MHz}$    | -   | -40.3 | -     | dBm  |
|                                   | $F = F_0 \pm >3\text{MHz}$ | -   | -     | -41.5 | dBm  |
| EDR differential phase coding     |                            | -   | 100   | -     | %    |

## 4. Functional Description

This chapter describes the modules and functions integrated in KK-4000

### 4.1 CPU and Internal Memory

KK-4000 contains two low-power Xtensa<sup>®</sup> 32-bit LX6 microprocessors. The internal memory includes:

- 448 kB of ROM for booting and core functions.
- 520 kB (8 kB RTC FAST Memory included) of on-chip SRAM for data and instruction.
  - 8 kB of SRAM in RTC, which is called RTC FAST Memory and can be used for data storage; it is accessed by the main CPU during RTC Boot from the Deep-sleep mode.
- 8 kB of SRAM in RTC, which is called RTC SLOW Memory and can be accessed by the co-processor during the Deep-sleep mode.
- 1 kbit of eFuse, of which 320 bits are used for the system (MAC address and chip configuration) and the remaining 704 bits are reserved for customer applications, including Flash-Encryption and Chip-ID.

### 4.2 External Flash and SRAM

KK-4000 supports up to four 16-MB of external QSPI flash and SRAM with hardware encryption based on AES to protect developers' programs and data.

KK-4000 can access the external QSPI flash and SRAM through high-speed caches.

- Up to 16 MB of external flash are memory-mapped onto the CPU code space, supporting 8, 16 and 32-bit access. Code execution is supported.
- Up to 8 MB of external flash/SRAM are memory-mapped onto the CPU data space, supporting 8, 16 and 32-bit access. Data-read is supported on the flash and SRAM. Data-write is supported on the SRAM.

integrates 4 MB of external SPI flash. The 4-MB SPI flash can be memory-mapped onto the CPU code space, supporting 8, 16 and 32-bit access. Code execution is supported.

### 4.3 Crystal Oscillators

The KK-4000 Wi-Fi/BT firmware can only support 40 MHz crystal oscillator for now.

#### FCC Statement

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

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 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.

#### ISED RSS Warning/ISED RF Exposure Statement

##### ISED RSS Warning:

This device complies with Innovation, Science and Economic Development Canada licence-exempt RSS standard(s).

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

##### ISED RF exposure statement:

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

Le rayonnement de la classe b respecte ISED fixaient un environnement non contrôlés. Installation et mise en œuvre de ce matériel devrait avec échangeur distance minimale entre 20 cm ton corps. Lanceurs ou ne peuvent pas coexister cette antenne ou capteurs avec d'autres.

#### FCC & ISED Label Instructions

The outside of final products that contains this module device must display a label referring to the enclosed module. This exterior label can use wording such as: "Contains Transmitter Module FCC ID: 2AMI2-KK4000, IC:22853-KK4000" or "Contains FCC ID: 2AMI2-KK4000, IC:22853-KK4000" Any similar wording that expresses the same meaning may be used.