



ALXC2X

Wireless IoT Controller Datasheet

Version 1.2

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List of Contents

| | |
|---|-----------|
| 1. INTRODUCTION..... | 8 |
| 1.1 ALXC2X MODULE OVERVIEW..... | 8 |
| 1.2 FEATURES..... | 8 |
| 2. PIN ASSIGNMENT | 10 |
| 2.1 PIN CONFIGURATION..... | 10 |
| 2.2 PIN DEFINITIONS | 11 |
| 3. MICROCONTROLLER SUBSYSTEM | 12 |
| 3.1 ARM CORTEX-M4 WITH FPU CORE WITH EMBEDDED FLASH AND SRAM..... | 12 |
| 3.2 EMBEDDED FLASH MEMORY..... | 12 |
| 3.3 EMBEDDED SRAM..... | 12 |
| 3.4 NRST..... | 12 |
| 3.5 UART INTERFACE | 12 |
| 3.6 SERIAL PERIPHERAL INTERFACE (SPI) | 12 |
| 3.7 UNIVERSAL SERIES BUS (USB) | 13 |
| 3.8 INTER-INTEGRATED SOUND (I2S)..... | 13 |
| 3.9 INTER-INTEGRATED CIRCUIT INTERFACE (I2C)..... | 14 |
| 3.10 ANALOG-TO-DIGITAL CONVERTER (ADC)..... | 14 |
| 3.11 GENERAL-PURPOSE INPUT/OUTPUTS (GPIOs) | 14 |
| 3.12 JTAG DEBUG PORT (SWJ-DP) | 14 |
| 4. SPECIFICATION | 15 |
| 4.1 GENERAL SPECIFICATION | 15 |
| 4.2 VOLTAGES..... | 15 |
| 4.3 TEMPERATURE AND HUMIDITY..... | 15 |
| 5. WI-FI RF SPECIFICATION | 16 |
| 5.1 RF SPECIFICATION | 16 |
| 5.2 WI-FI POWER CONSUMPTION..... | 16 |
| 5.3 WI-FI SENSITIVITY SPECIFICATION | 17 |
| 5.4 WI-FI RF TX SPECIFICATION | 17 |
| 6. BT SPECIFICATION..... | 18 |
| 6.1 RF SPECIFICATION | 18 |
| 6.2 BT POWER CONSUMPTION | 18 |
| 7. DIMENSIONS..... | 19 |
| 7.1 PHYSICAL DIMENSIONS..... | 19 |
| 7.2 TOP VIEW | 19 |
| 7.3 PCB FOOTPRINT (TOP VIEW)..... | 19 |
| 8. RECOMMENDED REFLOW PROFILE | 20 |

| | |
|-------------------------------------|----|
| 9. ROHS DECLARATION..... | 20 |
| 10. ORDER INFORMATION..... | 21 |
| 11. TECHNICAL SUPPORT CONTACT | 21 |
| ACRONYMS AND ABBREVIATIONS..... | 21 |

List of Figures

| | |
|---|----|
| Figure 1 ALXC2X PIN Configuration..... | 10 |
| Figure 2 ALXC2X (Ceramic Antenna) Top View..... | 19 |
| Figure 3 ALXC2X Pad Dimensions (Top View)..... | 19 |
| Figure 4 Reflow Profile..... | 20 |

List of Tables

| | |
|---|----|
| Table 1 PIN Description..... | 11 |
| Table 2 Comparison of I2C analog and digital filters..... | 14 |
| Table 3 Range of Operation – General Specification..... | 15 |
| Table 4 Range of Operation-temperature..... | 15 |
| Table 5 Range of Operation - Voltages..... | 15 |
| Table 6 Temperature and Humidity | 15 |
| Table 7 2.4GHz Wireless Specification | 16 |
| Table 8 5GHz Wireless Specification | 16 |
| Table 9 Wi-Fi Power Consumption..... | 16 |
| Table 10 Wi-Fi 2.4GHz Receiver Sensitivity Specification..... | 17 |
| Table 11 Wi-Fi 5GHz Receiver Sensitivity Specification | 17 |
| Table 12 Wi-Fi 2.4GHz RF TX Power Specification..... | 17 |
| Table 13 Wi-Fi 5GHz RF TX Power Specification..... | 17 |
| Table 14 Bluetooth Transmitter RF Specifications..... | 18 |
| Table 15 Bluetooth Receiver RF Specifications | 18 |
| Table 16 BT Power Consumption | 18 |
| Table 17 Physical Dimensions | 19 |
| Table 18 Order Information | 21 |

1. Introduction

1. 1 ALXC2X Module Overview

ALXC2X module is a low-cost and ultra-low power consumption wireless IoT controller, with integrated IEEE 802.11a/b/g/n functionalities, dual band 5 GHz/2.4 GHz, and Bluetooth 4.0.

The ALXC2X Module series is a family of low-power, self-contained, embedded wireless module solution that addresses the connectivity demands of machine to machine applications. An RF front end and two clocks embeds into a small factor modules.

The ALXC2X module includes various different interfaces to communicate with the Host such as UART, SPI etc. The modules can be purchased with ceramic antennas on-board.

1. 2 Features

- Dynamic Efficiency Line
 - Core: ARM® 32-bit Cortex®-M4 CPU with FPU, Adaptive real-time accelerator (ART Accelerator™) allowing 0-wait state execution from Flash memory, frequency 100MHz, memory protection unit, 125 DMIPS/1.25 DMIPS/MHz (Dhrystone 2.1), and DSP instructions.
- Memories
 - 128 KB of SRAM
 - 512 KB of Built-in Serial Flash
 - 1 MB of additional Serial Flash
- Clock, reset and supply management
 - 3v to 3.6v application supply and I/Os
 - Internal 33kHz± 30% LPO clock
 - Internal 26 MHz crystal oscillator
 - Internal 37.4 MHz crystal oscillator
 - Internal 32.768 kHz LPO clock for the PMU sequencer
- Concurrent Bluetooth, and WLAN operation

- Dual-band 2.4G/5GHz IEEE802.11a/b/g/n
- Bluetooth v4.0 with integrated Class 1 PA
- Bluetooth Low Energy (BLE) support
- Four WLAN power states: Active mode, Doze mode, Deep-sleep mode, Power-down mode
- Integrated WLAN CMOS power amplifier with internal power detector and closed-loop power control
- HCI high-speed UART transport support
- Transmitter power:
 - 2.4 GHz: +19.5dBm (11b), +18dBm (11g), +16.5dBm (11n)
 - 5GHz: +16.5dBm (11a), +15dBm (11n)
- Receiver sensitivity:
 - 2.4GHz Wi-Fi: -89dBm (11b), -83dBm (11g), -80dBm (11n)
 - 5GHz Wi-Fi: -82dBm (11a), -81.8dBm (11n)
- Host interface Options with different module: UART, USBH, USHD, SPI
- Peripheral interface Options: ADC, I2C, I2S, GPIO
- Operation temperature range: -30 °C to +85 °C
- RoHS compliant
- Easy for integration into mobile and handheld device with flexible system configuration
- Security:
 - Hardware WAPI acceleration engine
 - Open, WEP, WPA_TKIP_PSK, WPA_AES_PSK, WPA2_AES_PSK, WPA2_Mixed_PSK
 - WPA/WPA2_Enterprise
- Dimensions: 28mm(L)*14.3mm(W)*2.2mm(H), 36Pins Small size suitable for low volume system integration
- Antenna configurations: On-board antenna
- Over-the-air (OTA) upgrade support

2. PIN Assignment

2.1 PIN Configuration

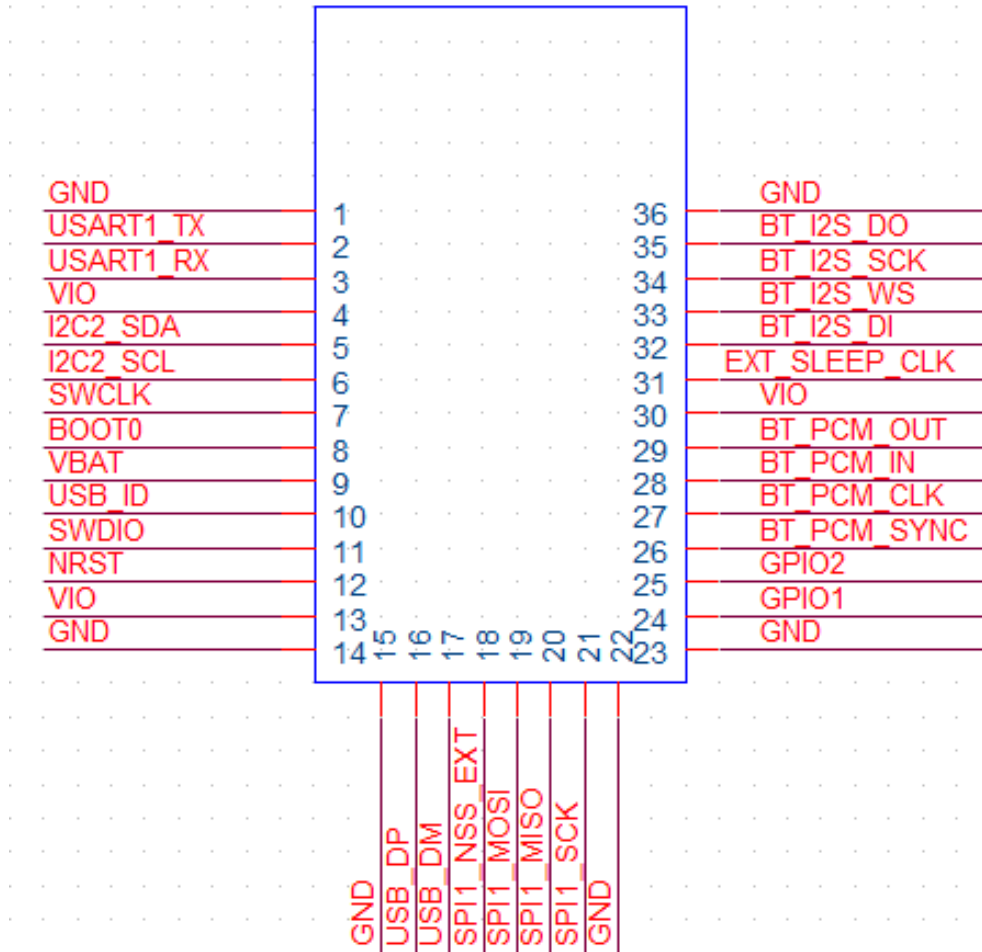


Figure 1 ALXC2X PIN Configuration

2. 2 PIN Definitions

Table 1 PIN Description

| Pin# | Type | Name (Main function) | Alternate functions | PIN connection(when not using) |
|------|------|----------------------|-----------------------------|--------------------------------|
| 1 | S | GND | | |
| 2 | I/O | USART1_TX | PB6 | floating |
| 3 | I/O | USART1_RX | PA10, USB_ID | floating |
| 4 | S | VIO | | |
| 5 | I/O | I2C2_SDA | PB3, SPI1_SCK, USART1_RX | floating |
| 6 | I/O | I2C2_SCL | PB10 | floating |
| 7 | I/O | SWCLK | PA14 | floating |
| 8 | I | BOOT0 | | floating |
| 9 | S | VBAT | | floating |
| 10 | I/O | USB_ID | PB13 | floating |
| 11 | I/O | SWDIO | PA13 | floating |
| 12 | I | NRST | | floating |
| 13 | S | VIO | | |
| 14 | S | GND | | |
| 15 | S | GND | | |
| 16 | I/O | USB_DP | PA12, USART1_RTS, USART6_RX | floating |
| 17 | I/O | USB_DM | PA11, USART1_CTS, USART6_TX | floating |
| 18 | I/O | SPI1_NSS_EXT | PB12, I2C2_SMBA | floating |
| 19 | I/O | SPI1_MOSI | PA7, ADC1_7 | floating |
| 20 | I/O | SPI1_MISO | PB4 | floating |
| 21 | I/O | SPI1_SCK | PA5, ADC1_5 | floating |
| 22 | S | GND | | |
| 23 | S | GND | | |
| 24 | I/O | GPIO1(PB1) | ADC1_9 | floating |
| 25 | I/O | GPIO2(PB0) | ADC1_8 | floating |
| 26 | NC | NC | BT_PCM_SYNC | floating |
| 27 | NC | NC | BT_PCM_CLK | floating |
| 28 | NC | NC | BT_PCM_IN | floating |
| 29 | NC | NC | BT_PCM_OUT | floating |
| 30 | S | VIO | | |
| 31 | I/O | EXT_SLEEP_CLK | External 32.768K Clock | floating |
| 32 | NC | NC | BT_I2S_DI | floating |
| 33 | NC | NC | BT_I2S_WS | floating |
| 34 | NC | NC | BT_I2S_SCK | floating |
| 35 | NC | NC | BT_I2S_DO | floating |
| 36 | S | GND | | |

3. Microcontroller Subsystem

3.1 ARM Cortex-M4 with FPU core with embedded Flash and SRAM

The ARM[®] Cortex[®]-M4 with FPU processor is the latest generation of ARM processors for embedded systems. It provides a low-cost platform to meet the needs of MCU implementation with a reduced pin count and low-power consumption, while delivering outstanding computational performances and advanced responses to interrupts. The ARM[®] Cortex[®]-M4 with FPU 32-bit RISC processor features exceptional code efficiency, delivering the high performance expected from an ARM core in the memory footprint usually associated with 8- and 16-bit devices. The processor supports a set of DSP instructions which allow efficient signal processing and complex algorithm execution. Its single precision FPU (floating point unit) speeds up software development by using meta-language development tools, while avoiding saturation.

3.2 Embedded Flash Memory

The ALXC2X Controller embeds 512 Kbytes of Flash memory, available for storing programs and data.

3.3 Embedded SRAM

The ALXC2X embeds 128 Kbytes of system SRAM which can be accessed (read/write) at CPU clock speed with 0 wait states.

3.4 NRST

NRST is hardware PIN to support built-in reset simultaneously to the MCU and the Wi-Fi chip.

3.5 UART interface

The ALXC2X embeds 2 universal synchronous/asynchronous receiver transmitters (USART1 and USART6). The UART interfaces are able to communicate at speed of up to 6.25Mbit/s. USART1 provides hardware management of the CTS and RTS signals, Smart Card mode (ISO 7816 compliant) and SPI-like communication capability. All interfaces can be served by the DMA controller

3.6 Serial peripheral interface (SPI)

The ALXC2X features up to four SPIs in slave or master modes in full-duplex or simplex

communication modes. The SPI can communicate at up to 50Mbit/s. The 3-bit pre-scaler gives 8 master mode frequencies and the frame is configurable to 8 bits or 16 bits. The hardware CRC generation/verification supports basic SD Card/MMC modes. All SPIs can be served by DMA controller.

The SPI interface can be configured to operate in TI mode for communications either in master mode or slave mode.

3. 7 Universal series bus (USB)

The ALXC2X embed an USB OTG full-speed device/host/OTG peripheral with integrated transceivers. The USB OTG FS peripheral is compliant with the USB 2.0 specification and with the OTG 1.0 specification. It has software-configurable endpoint setting and supports suspend/resume. The USB OTG full-speed controller requires a dedicated 48 MHz clock that is generated by a PLL connected to the HSE oscillator. The major features are:

- Combined RX and TX FIFO size of 320 × 35 bits with dynamic FIFO sizing
- Supports the session request protocol (SRP) and host negotiation protocol (HNP)
- 4 bidirectional endpoints
- 8 host channels with periodic OUT support
- HNP/SNP/IP inside (no need for any external resistor)
- For OTG/Host modes, a power switch is needed in case bus-powered devices are connected

3. 8 Inter-integrated Sound (I2S)

Five standard I2S interfaces (multiplexed with SPI1 to SPI5) are available. They can be operated in master or slave mode, in simplex communication modes or full duplex for I2S2 and I2S3, and can be configured to operate with a 16-/32-bit resolution as an input or output channel. All the I2Sx audio sampling frequencies from 8 kHz up to 192 kHz are supported. When either or both of the I2S interfaces are configured in master mode, the master clock can be output to the external DAC/CODEC at 256 times the sampling frequency.

All I2Sx can be served by the DMA controller.

The ALXC2X features an additional dedicated PLL for audio I2S applications. It allows error-free I2S sampling clock accuracy without compromising on the CPU performance.

The PLL I2S configuration can be modified to manage an I2S sample rate change without disabling the main PLL used for the CPU.

The audio PLL can be programmed with very low error to obtain sampling rates ranging from 8 kHz to 192 kHz.

In addition to the audio PLL, a master clock input pin can be used to synchronize the I2S flow with an external PLL (or Codec output).

3. 9 Inter-integrated circuit interface (I2C)

Up to three I2C bus interfaces can operate in master or slave modes. They can support standard (up to 100 kHz) and fast (up to 400 kHz) modes. The I2C bus frequency can be increased up to 1 MHz. They also support the 7/10-bit addressing mode and the 7-bit dual addressing mode (as slave). A hardware CRC generation/verification is embedded.

They can be served by DMA and they support SMBus 2.0/PMBus.

The ALXC2X also include programmable analog and digital noise filters

Table 2 Comparison of I2C analog and digital filters

| | Analog filter | Digital filter |
|----------------------------------|--------------------|---|
| Pulse width of suppressed spikes | $\geq 50\text{ns}$ | Programmable length from 1 to 15 I2C peripheral clock |

3. 10 Analog-to-digital converter (ADC)

One 12-bit analog-to-digital converter is embedded and shares up to 16 external channels, performing conversions in the single-shot or scan mode. In scan mode, automatic conversion is performed on a selected group of analog inputs.

The ADC can be served by the DMA controller. An analog watchdog feature allows very precise monitoring of the converted voltage of one, some or all selected channels. An interrupt is generated when the converted voltage is outside the programmed thresholds.

To synchronize A/D conversion and timers, the ADCs could be triggered by any of TIM1, TIM2, TIM3, or TIM4 timer.

3. 11 General-purpose input/outputs (GPIOs)

Each of the GPIO pins can be configured by software as output (push-pull or open-drain, with or without pull-up or pull-down), as input (floating, with or without pull-up or pull-down) or as peripheral alternate function. Most of the GPIO pins are shared with digital or analog alternate functions. All GPIOs are high-current-capable and have speed selection to better manage internal noise, power consumption and electromagnetic emission.

The I/O configuration can be locked if needed by following a specific sequence in order to avoid spurious writing to the I/Os registers.

Fast I/O handling allowing maximum I/O toggling up to 100 MHz

3. 12 JTAG debug port (SWJ-DP)

The ARM SWJ-DP interface is embedded, and is a combined JTAG and serial wire debug port that enables either a serial wire debug or a JTAG probe to be connected to the target. Debug is performed using 2 pins only instead of 5 required by the JTAG (JTAG pins could be re-use as GPIO with alternate function): the JTAG TMS and TCK pins are shared with SWDIO and SWCLK, respectively, and a specific sequence on the TMS pin is used to switch between JTAG-DP and SW-DP.

4. Specification

4. 1 General Specification

The absolute maximum rating are shown in the following table:

Table 3 Range of Operation – General Specification

| Symbol | Description | Min | Max | Unit |
|--------|-------------------------------------|-----------|-----|------|
| Tg | General Operating temperature | -30 | 85 | °C |
| To | Operating temperature | -40 | 85 | °C |
| Ts | Storage temperature | -40 | 85 | °C |
| VDDIO | IO Power supply | 0 | 3.6 | V |
| VDDBAT | Power supply | 0 | 3.6 | V |
| RFi | RF input power | | 0 | dBm |
| MSL | Moisture Sensitivity Level | 3 | | |
| RoHS | Restriction of Hazardous Substances | Compliant | | |

4. 2 Voltages

Table 4 Range of Operation-temperature

| | | |
|----------------------------------|----------------------|---|
| Supply Power | Max +3.6 Volt | |
| Non-Operating Temperature | - 30° to 85° Celsius | |
| Voltage ripple | +/- 2% | Max. Values not exceeding operating voltage |

Power supply for the ALXC2X Controller will be provided by the host via the power pins.

Table 5 Range of Operation - Voltages

| Symbol | Min. | Typ. | Max. | Unit |
|--------|------|------|------|------|
| VDD | 3.0 | 3.3 | 3.6 | V |

4. 3 Temperature and humidity

Table 6 Temperature and Humidity

| | |
|------------------------------|---|
| Operating Temperature | -20° to 70° Celsius |
| Humidity range | Max 95%, No condensing, relative humidity |

The maximum operating ambient temperature can be up to 85° Celsius, but exposure to absolute-maximum-rated conditions may cause performance degradation and affect device reliability.

5. Wi-Fi RF Specification

5.1 RF Specification

The ALXC2X Controller complies with the following features and standards:

Table 7 2.4GHz Wireless Specification

| Features | Specification |
|--------------------|--|
| WLAN Standards | IEEE802.11 b/g/n |
| Antenna | Ceramic Antenna |
| Frequency Band | 2.412GHz – 2.484 GHz ETSI: 2412MHz – 2472MHz FCC: 2412Mhz-2462Mhz |
| Modulation | DSSS, CCK, OFDM, BPSK, QPSK, QAM |
| Support data rates | 802.11b: 1, 2, 5.5, 11 (Mbps) 802.11g: 6, 9, 12, 18, 24, 36, 48, 54 (Mbps) 802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 (Mbps) |

Table 8 5GHz Wireless Specification

| Features | Specification |
|---------------------|--|
| WLAN Standards | IEEE802.11 a/n |
| Antenna | Ceramic Antenna |
| Frequency Band | 5.17GHz – 5.31GHz, 4.915GHz – 5.825GHz ETSI: 5180Mhz-5240Mhz FCC: 5180Mhz-5240Mhz, 5745Mhz-5825Mhz |
| Modulation | OFDM, BPSK, QPSK, QAM |
| Supports data rates | 802.11a: 6, 9,12, 18,24,36,48,54 (Mbps) 802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 (Mbps) |

5.2 Wi-Fi Power Consumption

WLAN system power consumption shows estimated typical values. Power consumption targets referenced to VBAT @3.3V, 20°C.

Table 9 Wi-Fi Power Consumption

| Mode | Conditions | Module Current (mA) |
|----------------------------|---|---------------------|
| Data Transfer Transmit TCP | 10kbps data rate @ baud rate = 921600 2.4G | 66.49 |
| Data Transfer Transmit TCP | 10kbps data rate @ baud rate = 921600 5G | 88.00 |
| Data Transfer Transmit TCP | 100kbps data rate @ baud rate = 921600 2.4G | 69.34 |
| Data Transfer Transmit TCP | 100kbps data rate @ baud rate = 921600 5G | 89.37 |
| Data Transfer Transmit TCP | 700kbps data rate @ baud rate = 921600 2.4G | 78.31 |
| Data Transfer Transmit TCP | 700kbps data rate @ baud rate = 921600 5G | 97.56 |
| Idle | Remaining connected to AP, Power-Save mode | 16.80 |
| Sleep | Not connected to an AP | 9.45 |

5. 3 Wi-Fi Sensitivity Specification

Table 10 Wi-Fi 2.4GHz Receiver Sensitivity Specification

| Receiver Characteristics | TYP. | Unit |
|---|-------|------|
| PER <8%, Rx Sensitivity @ 1 Mbps DSSS | -88.1 | dBm |
| PER < 8%, Rx Sensitivity @ 11 Mbps DSSS | -81.6 | dBm |
| PER < 10%, Rx Sensitivity @ 6 Mbps OFDM | -83.4 | dBm |
| PER < 10%, Rx Sensitivity @ 54 Mbps OFDM | -70.0 | dBm |
| PER < 10%, Rx Sensitivity @ MCS0 800ns GI | -82.8 | dBm |
| PER < 10%, Rx Sensitivity @ MCS7 800ns GI | -68.0 | dBm |

Table 11 Wi-Fi 5GHz Receiver Sensitivity Specification

| Receiver Characteristics | TYP. | Unit |
|--|-------|------|
| PER <10%, Rx Sensitivity @ 6 Mbps OFDM | -81.5 | dBm |
| PER < 10%, Rx Sensitivity @ 18 Mbps OFDM | -77.0 | dBm |
| PER < 10%, Rx Sensitivity @ 36 Mbps OFDM | -72.5 | dBm |
| PER < 10%, Rx Sensitivity @ 54 Mbps OFDM | -66.1 | dBm |
| PER < 10%, Rx Sensitivity @ MCS0 20Mbps 800ns GI | -81.5 | dBm |
| PER < 10%, Rx Sensitivity @ MCS7 20Mbps 800ns GI | -67.5 | dBm |

5. 4 Wi-Fi RF TX Specification

Table 12 Wi-Fi 2.4GHz RF TX Power Specification

| RF Characteristics | TYP. | Unit |
|-------------------------|------|------|
| RF TX Power@11b,11 Mbps | 18.2 | dBm |
| RF TX Power@11g,54 Mbps | 16.9 | dBm |
| RF TX Power@11n,65 Mbps | 16.8 | dBm |

Table 13 Wi-Fi 5GHz RF TX Power Specification

| RF Characteristics | TYP. | Unit |
|-------------------------|------|------|
| RF TX Power@11a,54 Mbps | 14.5 | dBm |
| RF TX Power@11n,65 Mbps | 14.4 | dBm |

6. BT Specification

6. 1 RF Specification

Table 14 Bluetooth Transmitter RF Specifications

| Parameter | Conditions | Minimum | Typical | Maximum | Unit |
|----------------------------|------------|---------|---------|---------|------|
| Frequency range | – | 2402 | – | 2480 | MHz |
| Basic rate (GFSK) | – | 10 | 12 | – | dBm |
| QPSK Tx Power at Bluetooth | – | 7 | 9 | – | dBm |
| 8PSK Tx Power at Bluetooth | – | 7 | 2 | – | dBm |
| Power control step | – | 2 | 4 | 6 | dB |

Table 15 Bluetooth Receiver RF Specifications

| Parameter | Conditions | Minimum | Typical | Maximum | Unit |
|-----------------|-----------------------|---------|---------|---------|------|
| Frequency range | – | 2402 | – | 2480 | MHz |
| RX sensitivity | GFSK,0.1%BER,1Mbps | – | -93.5 | – | dBm |
| RX sensitivity | 8-DPSK,0.01%BER,3Mbps | – | -89.5 | – | dBm |

6. 2 BT Power Consumption

Table 16 BT Power Consumption

| Mode | Module Current(mA) |
|----------------------|-----------------------------------|
| Power ON | 5-8mA |
| Advertisement | 4.33-10mA |
| Connected | 3.37-3.44mA |
| Download | 11mA |
| Sleep Mode | 270-370uA |
| Deep Sleep | 175-200uA,hardware HIDEOFF 29.6uA |
| BR/EDR Data Transfer | 16-48mA |

7. Dimensions

7.1 Physical Dimensions

Table 17 Physical Dimensions

| Parameter | Typical | Units |
|-----------------------------------|-------------------|-------|
| Dimensions (L x W x H) | 28.0 x 14.3 x 2.2 | mm |
| Dimensions tolerances (L x W x H) | ±0.2 | mm |

7.2 Top View



Figure 2 ALXC2X (Ceramic Antenna) Top View

7.3 PCB Footprint (Top View)

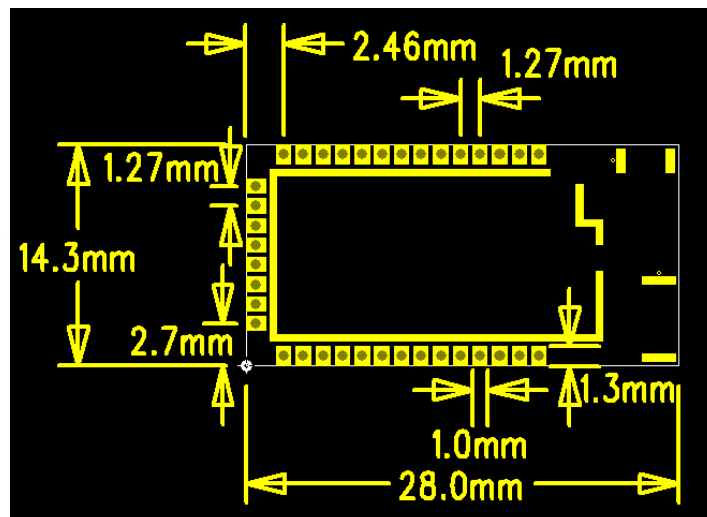


Figure 3 ALXC2X Pad Dimensions (Top View)

8. Recommended Reflow Profile

Referred to IPC/JEDEC Standard

Peak Temperature < 250 °C

Number of Times <= 2Times

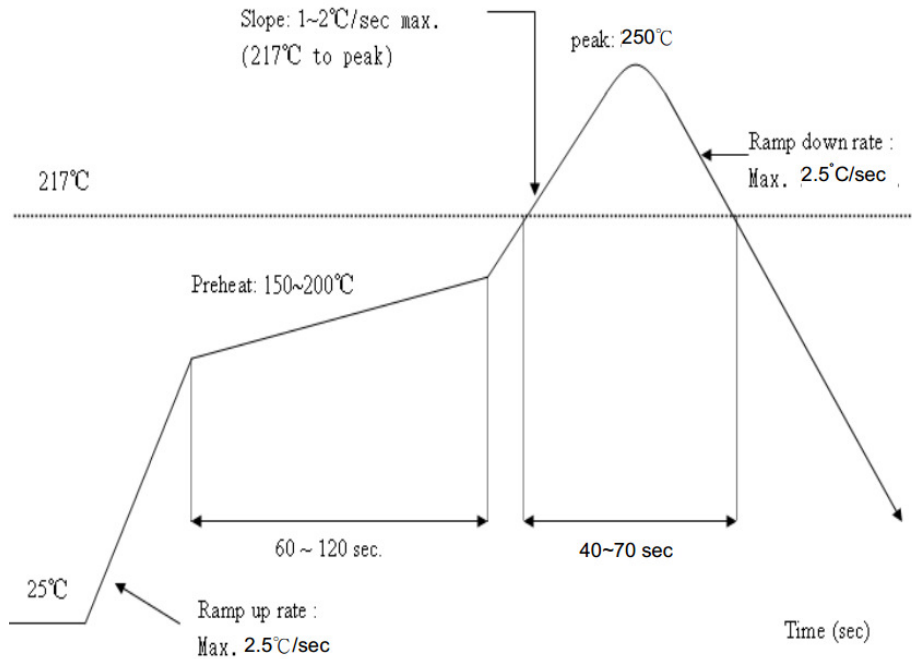


Figure 4 Reflow Profile

9. RoHS Declaration

To the best of our present knowledge, given our supplier declarations, this product does not contain any substance that is banned by EU RoHS Directive 2011/65/EU and its amendment directives – XRF. RoHS restricted substances are list below.

- Cadmium (Cd)
- Lead (Pb)
- Mercury (Hg)
- Hexavalent Chromium (Cr(VI))
- Polybrominated biphenyls (PBBs)
- Polybrominated diphenylether (PBDEs)

10. Order Information

Table 18 Order Information

| | |
|---------|--|
| ALXC20A | 2.4G/5G WiFi + BT/BLE 4.0 Combo Controller, On-Board Antenna |
|---------|--|

11. Technical Support Contact

For technical support, please mail support@alinket.com, or call 021-61048128.

Alinket Electronic Technology (Shanghai) Co., Ltd.

Floor 4, No.10, Lane 198, Zhangheng Road, Shanghai, 201204 P. R. China

Acronyms and Abbreviations

The following list of acronyms and abbreviations may appear in this document.

- ADC Analog-to-Digital Converter
- AES Audio Engineering Society
- ARM Advanced RISC Machines
- CCK Complementary Code Keying
- CMOS Complementary Metal Oxide Semiconductor
- CPU Central Processing Unit
- CRC Cyclic Redundancy Code
- DMA Direct Memory Access
- DSS Direct Sequence Spread Spectrum
- EAP Extension Authentication Protocol
- EVK Evaluation Kit
- GPIO General-Purpose Input-Output
- HNP Host Negotiation Protocol
- I2C Inter-Integrated Circuit
- IoT Internet of Things
- I2S Inter-IC Sound
- IC Integrated Circuit
- IEEE Institute of Electrical and Electronics Engineers
- ISM Industrial
- IP Internet Protocol
- JTAG Joint Test Action Group
- LQFP Low-profile Quad Flat Package
- MAC Medium Access Control
- MSL Moisture Sensitivity Level
- OFDM Orthogonal Frequency Division Multiplexing

| | | |
|---|------|--|
| - | OTG | On-The-Go |
| - | PER | Packet Error Rate |
| - | PLL | Phase Locked Logic |
| - | PMU | Phasor Measurement Unit |
| - | PWM | Pulse Width Modulation |
| - | RC | Real Clock |
| - | RTC | Real Time Clock |
| - | RF | Radio Frequency |
| - | ROHS | Restriction of Hazardous Substances |
| - | SKU | Stock Keeping Unit |
| - | SPI | Serial Peripheral Interface |
| - | SRAM | Static Random Access Memory |
| - | SRP | Session Request Protocol |
| - | TLS | Transport Layer Security |
| - | TCP | Transmission Control Protocol |
| - | TKIP | Temporal Key Integrity Protocol |
| - | USBH | Universal Serial Bus Host Mode |
| - | USBD | Universal Serial Bus Device Mode |
| - | UDP | User Datagram Protocol |
| - | UART | universal asynchronous receiver/transmitter |
| - | WAPI | WLAN Authentication and Privacy Infrastructure |
| - | WiFi | Wireless Fidelity |
| - | WLAN | Wireless Local Area Network |
| - | WPA | Wi-Fi Protected Access |

Notice:

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.

To satisfy FCC RF Exposure requirements for this transmission devices, a separation distance of 20cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The modular transmitter must be equipped with either a permanently affixed label or must be capable of electronically displaying its FCC identification number :

(A) If using a permanently affixed label, the modular transmitter must be labeled with its own FCC identification number, and, if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID:2AELJ-ALXCOMBA." Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement. In the latter case, a copy of these instructions must be included in the application for equipment authorization.