Getting started with AT32WB415CCU7-7

Introduction

AT-START-WB415 is designed to help users explore the high performance of the 32-bit microcontroller, the ARM Cortex®-M4-based AT32WB415 with wireless Bluetooth feature, and expedite development cycles and shorten the time to the market.

AT-START-WB415 is an evaluation board based on AT32WB415CCU7-7 microcontroller. It features wireless Bluetooth transceiver, LEDs, buttons, and one USB micro-B connector. This board comes with a built-in AT-Link-EZ, a tool designed to perform debugging and programming operations, without the need of other extra development tools.

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1 Overview

1.1 Features

AT-START-WB415 has the following characteristics:

- AT32WB415CCU7-7 integrates Bluetooth 5.0 dual mode, programmable protocols and specifications, 2 Mbit/s data rate, and high-performance RF transmission/reception
- AT-START-WB415 has an on-board AT32WB415CCU7-7 microcontroller that embeds ARM Cortex®-M4 32-bit core, 256 KB Flash memory and 32 KB SRAM, in QFN48 7x7 mm packages.
- On-board AT-Link connector:
  - On-board AT-Link-EZ can be used for programming and debugging purposes (AT-Link-EZ is a simplified version of AT-Link, but without offline mode support)
- Power supply source:
  - USB bus of AT-Link-EZ
  - USB OTG bus (V_{BUS}) of AT-START-WB415
  - External 3.3 V power supply
- 4 x LED indicators:
  - LED1 (red) indicates that 3.3 V power of the board is supplied
  - 3 x USER LEDs, LED2 (red),LED3 (yellow) and LED4 (green), indicate operation status
- User button, and Reset buttons for MCU and Bluetooth module
- 16 MHz XTAL crystal
- 32.768 kHz LEXT crystal
- QFN48 I/O extension connectors

1.2 Definition of terms

- **Jumper JPx ON**

  Jumper fitted
- **Jumper JPx OFF**

  Jumped not fitted
- **Resistor Rx ON**

  Short by solder or 0Ω resistor.
- **Resistor Rx OFF**

  Connections left open.

2 Quick start guide

2.1 Get started

Configure the AT-START-WB415 board in the following sequence:

1. Check the Jumpers' position on board:

   JP1 is connected to GND or OFF (BOOT0 = 0, BOOT0 has a pull-down resistor in the AT32WB415CCU7-7);

2. Connect AT_Link_EZ to PC via USB cable (Type A to micro-B), and supply the evaluation board via USB connector CN1. LED1 (red) is always on, and three other LEDs (LED2 to LED4) start to blink in turn.
3. After pressing USER button (B3), the blinking frequency of three LEDs is changed.

2.2 AT-START-WB415 toolchains

- ARM® Keil®: MDK-ARM™
- IAR™: EWARM
- AT32 IDE

3 Hardware layout and configuration

AT-START-WB415 board is designed around an AT32WB415CCU7-7 microcontroller in QFN48 7x7 mm package.

Figure 1 shows the connections between AT-Link-EZ, AT32WB415CCU7-7 and their peripherals (RF antenna, buttons, LEDs, USB OTG and extension connectors)

Figure 2 and *Figure 3* shows their locations on the AT-Link-EZ and AT-START-WB415 board.

Figure 1. Hardware block diagram

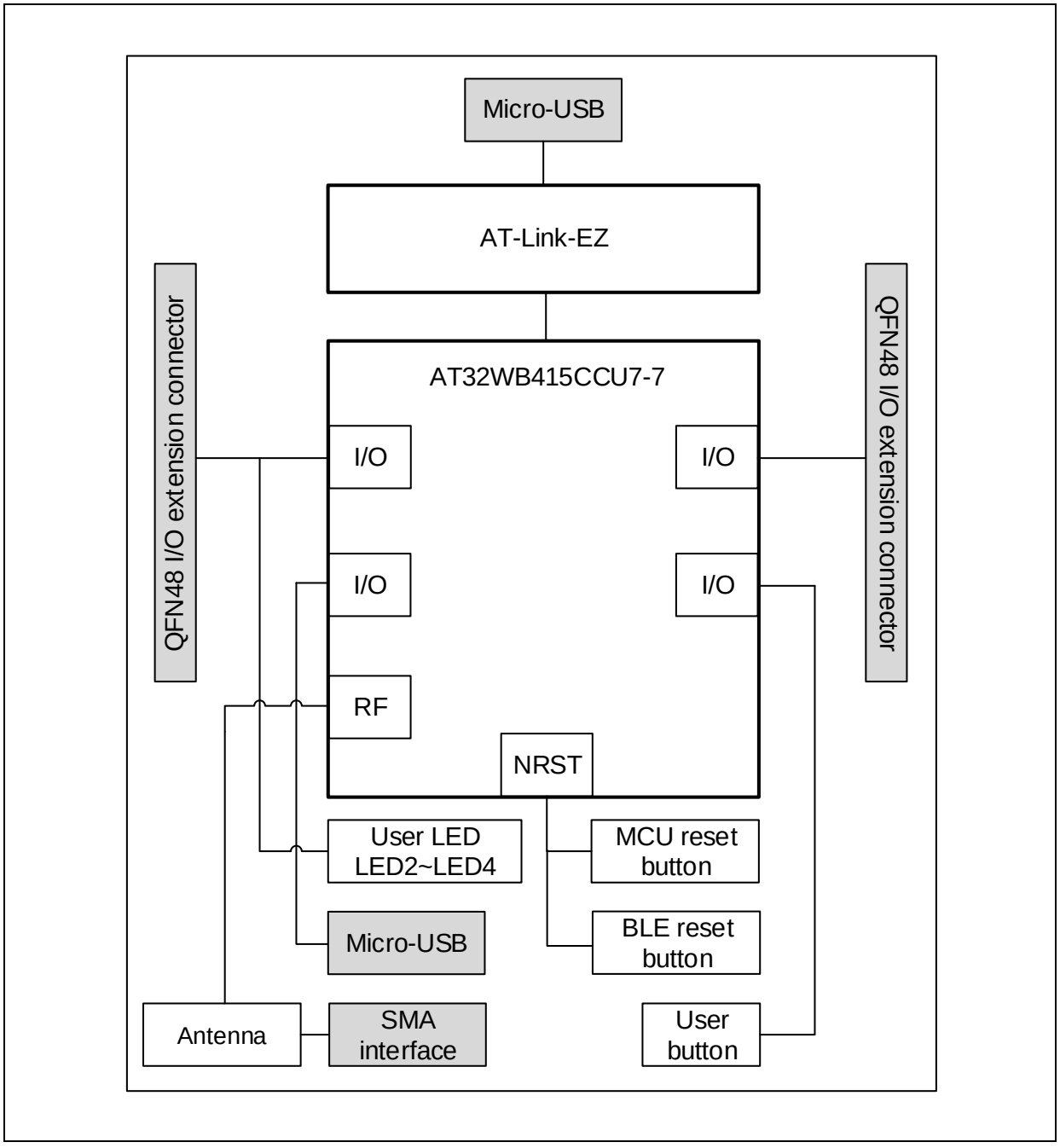


Figure 2. Top layer

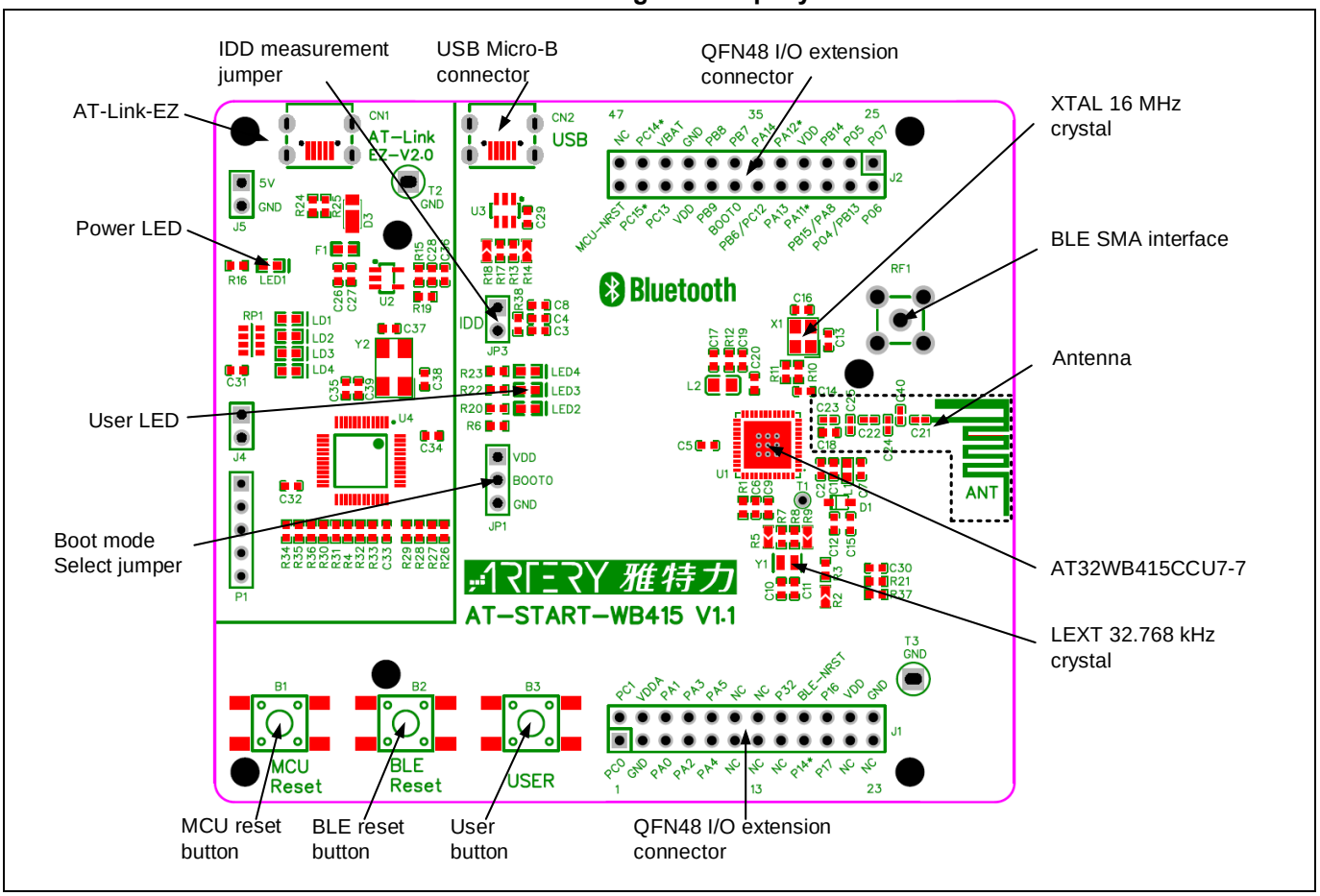
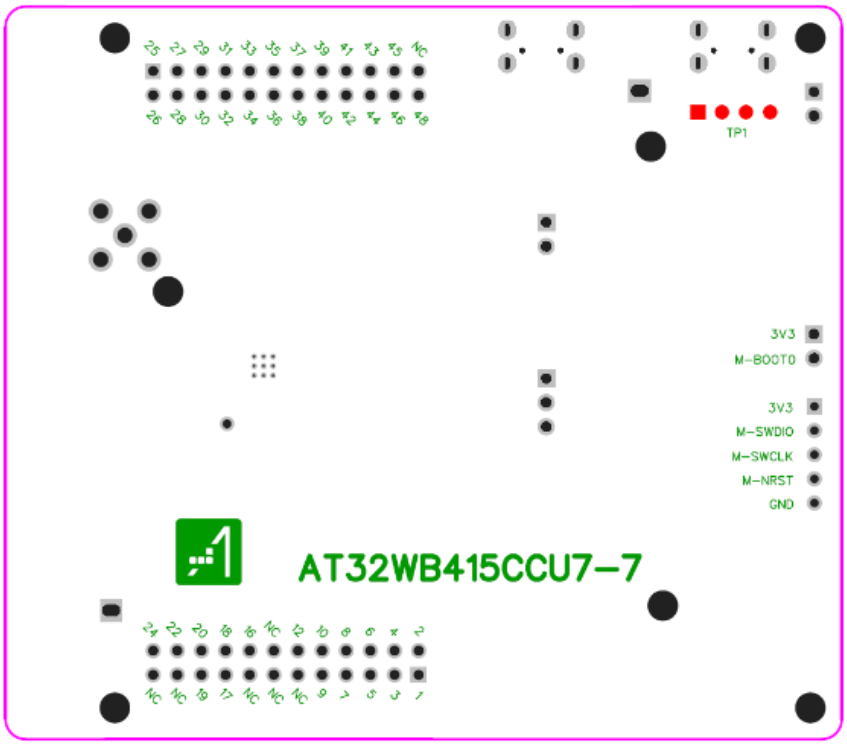


Figure 3. Bottom layer



3.1 Power supply sources

The 5 V power supply source required for AT-START-WB415 can be from USB cable (through USB connector CN1 on AT-Link-EZ or USB OTG connector CN2 on AT-START-WB415). Then the 5 V power supply provides the 3.3 V power to the microcontroller and peripherals via 3.3 V voltage regulator (U2) on-board.

The VDD pin of J1 and J2 can also be used as 3.3 V input directly, so the AT-START-WB415 board can be powered by a 3.3 V supply unit.

The 1.6 V power supply of the Bluetooth module is provided by its internal switching power supply. Note that the shortest circuit loop is required between the pin 23, pin 24 and external LC devices.

Note: Unless 5 V is provided through USB connector (CN1) on the AT-Link-EZ, the AT-Link-EZ will not be powered by other power supply methods.

When another board is connected to J1 and J2, the VDD pin can be used as 3.3 V output power supply.

3.2 IDD

When JP3 OFF (symbol IDD) and R38 OFF, an ammeter can be connected to measure the power consumption of AT32WB415CCU7-7.

- **JP3 OFF, R38 ON:**
  AT32WB415CCU7-7 is powered. (Default setting and JP3 plug is not mounted before shipping)
- **JP3 ON, R38 OFF:**
  AT32WB415CCU7-7 is powered.
- **JP3 OFF, R38 OFF:**
  An ammeter must be connected to measure the power consumption of AT32WB415CCU7-7 (If no ammeter, the AT32WB415CCU7-7 cannot be powered).

3.3 Programming and debugging: embedded AT-Link-EZ

The evaluation board integrates Artery AT-Link-EZ for users to program/debug the AT32WB415CCU7-7 on the AT-START-WB415 board via SWD interface. The AT-Link-EZ also supports a virtual COM port (VCP) to be connected to the USART2_TX/USART2_RX (MCU PA2/MCU PA3) of AT32WB415CCU7-7.

In addition, the AT-Link-EZ is connected to the P04, P05, P06 and P07 — the programming interfaces of the Bluetooth module, so as to program the Bluetooth module on the AT32WB415CCU7-7, in a way similar to SPI.

Please refer to AT-Link User Manual for complete details on AT-Link-EZ.

3.4 Boot mode selection

At startup, the board boots from the following memory locations.

Table 1. Boot mode selection

Jumper	BOOT0 pin configuration	Description
JP1 connected to GND or OFF	0	Boot from the internal Flash memory (Factory default setting)
JP1 connected to VDD	1	Boot from boot memory

3.5 RF antenna device

On-board PIFA PCB antenna and antenna-related devices support transmission and reception of 2.4 GHz wireless signals. The AT-START-WB415 board also offers a SMA connector (RF1) that can be externally connected to an instrument to test antenna-specific parameters such as power and matching performance. When in use, C21 must be desoldered, and C40 must be soldered with 0 Ω or an appropriate matchable capacitor.

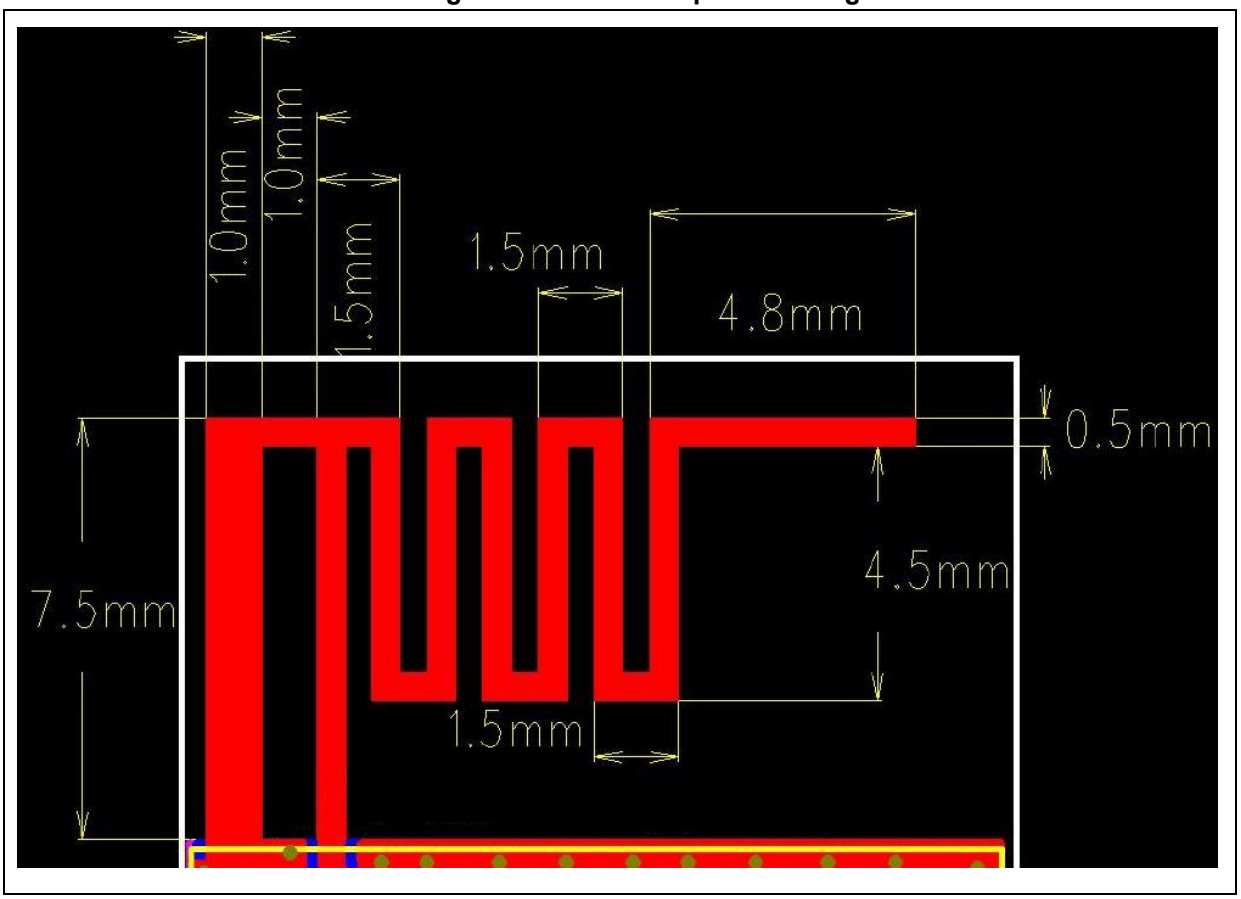
Murata GRM1555 0402 capacitor is recommended. The selection of PCB transmission line should take into account PCB materials, board thickness, number of layers and copper thickness. Its impedance should be limited to 50 Ω through the adjustments of matching devices. It is advised to use common 2-layer FR-4 material in 0.8~1.2 mm thickness and 1 oz copper sheet.

Note: It is recommended to follow the parameters of devices defined in Schematics and PCB layout when designing RF match circuit diagram, pattern and PCB antenna in order to achieve the best quality of signals.

RF antenna pattern design dimensions are shown in *Figure 4.* Attention should be paid to the following:

- Place RF antenna on the top layer. Top layer and the corresponding bottom layer should be of clearance area and copper-free
- No metal structure or components placed around antenna. Components or devices, if necessary, can only be placed one side at most and kept 5 mm away from antenna
- Antenna shorted pins (posts) are connected to the ground, with at least two Through holes down to (directly) the bottom layer
- 0.5 mm or greater is required between antenna and PCB copper ground. Punch a row of ground vias along the ground plane close to antenna
- No routing and devices placed at the bottom layer (especially the area close to RF match circuit) of AT32WB415 MCU. A complete ground plane allows for better RF performance

Figure 4. RF antenna pattern design dimensions



3.6 External clock source

3.6.1 BLE XTAL clock source

The XTAL serves as a clock source of Bluetooth module. The XTAL frequency should be 16 MHz with a total deviation (error) of 60 ppm. On-board 16 MHz crystal is used as the clock source of XTAL. The TZ0233A from Taiwan-based TST is recommended.

3.6.2 MCU HEXT clock source

The MCU high-speed external clock is provided by 8 MHz PWM output from P14 on BLE module. T1 point or J1 pin 17 (when R2 ON) can be used to measure frequencies.

3.6.3 MCU LEXT clock source

There are three hardware methods to configure the external low-speed clock sources:

- **On-board crystal (Factory default setting)**
  On-board 32.768 kHz crystal is used as LEXT clock source.
  Hardware settings: R7 and R8 must be ON, and R5, R9 OFF
- **Oscillator from external PC14**
  External oscillator is from the pin 21 of J2.
  Hardware settings: R5 and R9 must be ON, and R7, R8 OFF.
- **LEXT unused**
  MCU PC14 and PC15 are used as GPIOs.
  Hardware settings: R5 and R9 must be ON, and R7, R8 OFF.

3.7 LEDs

- **Power LED1**
  Red LED indicates that the AT-START-WB415 is powered by 3.3 V.
- **User LED2**
  Red LED is connected to the PB7 pin of AT32WB415CCU7-7.
- **User LED3**
  Yellow LED is connected to the PB8 pin of AT32WB415CCU7-7.
- **User LED4**
  Green LED is connected to the PB9 pin of AT32WB415CCU7-7.

3.8 Buttons

- **Reset B1: MCU reset button**
  It is connected to MCU_NRST to reset AT32WB415CCU7-7 microcontroller.
- **Reset B2: BLE reset button**
  It is connected to BLE_NRST to reset AT32WB415CCU7-7 Bluetooth module.
- **User B2: User button**
  It is connected to the MCU PA0 of AT32WB415CCU7-7. It is used as wake-up button as alternate function.

3.9 USB OTG

AT-START-WB415 board supports USB full-speed/low-speed host or full-speed device mode through USB micro-B connector (CN2). In device mode, the AT32WB415CCU7-7 can be directly connected to the host via USB micro-B, and V_{BUS} can be used as 5 V input power of AT- START-WB415 board; in host mode, an external USB OTG cable is needed to connect to the external device.

3.10 0 Ω resistors

Table 2. 0 Ω resistor settings

Resistors	State(1)	Description
R38 (MCU power consumption measurement)	**ON**	When JP3 OFF, the AT32WB415CCU7-7 is powered by 3.3V directly
	OFF	When JP3 OFF, an ammeter can be connected to 3.3 V to measure the power consumption of AT32WB415CCU7-7. (Without ammeter, AT32WB415CCU7-7 cannot be powered)
R7, R8, R5, R9 (LEXT)	**ON, ON, OFF, OFF**	On-board crystal Y1 is used as LEXT clock source.
	OFF, OFF, ON, ON	LEXT clock source is from external MCU PC14, or MCU PC14 and PC14 are used as GPIOs.
R14, R18 (MCU PA11, MCU PA12)	**OFF, OFF**	When used as USB, MCU PA11 and MCU PA12 are not connected to the pin 8 and pin 9 of J2.
	ON, ON	When not used as USB, MCU PA11 and MCU PA12 are connected to the pin 8 and pin 9 of J2.
R2 (P14)	OFF	Check P14 output on HEXT_IN using T1
	ON	It can be connected to the pin 17 of J1 to check P14 output

(1) Factory default Rx state is shown in **BOLD** font.

3.11 QFN48 I/O extension connectors

The extension connectors J1 and J2 are used to connect the IO ports of the AT32WB415CCU7-7 to external devices. All the I/O ports of AT32WB415CCU7-7 are accessible. Besides, J1 and J2 can be measured with oscilloscope, logic analyzer or voltmeter probe.

4 Revision history

Table 3. Document revision history

Date	Revision	Changes
2021.12.31	1.00	Initial release
2022.03.28	1.10	Added Antenna SMA measurement interface (RF1)
2023.7.17	1.11	Updated *3.3* to describe programming Bluetooth module through AT-Link-EZ

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