Getting started with AT32F421C8T7

Introduction

AT-START-F421 evaluation board is designed to help you experience the high-performance of the 32-bit microcontroller, the ARM Cortex®-M4-based AT32F421, and expedite development cycles and shorten the time to the market.

AT-START-F421 is an evaluation board based on AT32F421C8T7 microcontroller. It features LEDs, buttons and Arduino™ Uno R3 extension connectors. This board comes with a built-in AT-Link-EZ, a tool designed to perform debugging/programming operations, without the need of other extra development tools.

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1 Overview

1.1 Features

AT-START-F421 has the following features:

- AT-START-F421 has an on-board AT32F421C8T7 microcontroller that embeds ARM Cortex®-M4, 32-bit processor, 64 KB Flash memory and 16 KB SRAM, LQFP48 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, without offline mode support)
  - If AT-Link-EZ is separated from this board by bending it along the joint, AT-START-F421 can be connected to an independent AT-Link for programming and debugging
- On-board 20-pin ARM standard JTAG connector (connected to SWD connector for programming/debugging)
- Power supply source
  - USB bus of AT-Link-EZ
  - External 7~12 V power supply (VIN)
  - External 5 V power supply (E5V)
  - External 3.3 V power supply
- 4 x LED indicators:
  - LED1(red) indicates that 3.3V power of the board is supplied
  - 3 x user LEDs, LED2 (red), LED3 (yellow) and LED4 (green), indicate operation status
- User button and Reset button
- 8 MHz HEXT crystal
- 32.768 kHz LEXT crystal
- Rich extension connectors
  - Arduino™ Uno R3 extension connectors
  - LQFP48 I/O extension connectors

1.2 Definition of terms

- **Jumper JPx ON**

  Jumper fitted

- **Jumper JPx OFF**

  Jumped not fitted

- **Resistor Rx ON**

  Short circuit by solder or 0Ω resistor.

- **Resistor Rx OFF**

  Connections left Open

2 Quick start guide

2.1 Get started

Configure the AT-START-F421 board in the following sequence:

1. Check the Jumper position on the board:
   JP1 is connected to GND or OFF (BOOT0= 0, BOOT0 has an pull-down resistor in the AT32F421C8T7);
2. Connect the AT-START-F421 board to PC via USB cable (Type A to micro-B) so that the board is powered via USB connector CN6. LED1 (red) is always on, and the three other LEDs (LED2 to LED4) start to blink in turn.
3. After pressing USER button (B2), the blinking frequency of three LEDs is changed.

2.2 Toolchains supporting AT-START-F421

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

3 Hardware layout and configuration

AT-START-F421 board is designed around an AT32F421C8T7 microcontroller in LQFP48 package.

Figure 1 shows the connections between AT-Link-EZ, AT32F421C8T7 and their peripherals (buttons, LEDs and extension connectors)

Figure 2 and *Figure 3* show their respective positions on the AT-Link-EZ and AT-START-F421.

Figure 1. Hardware block diagram

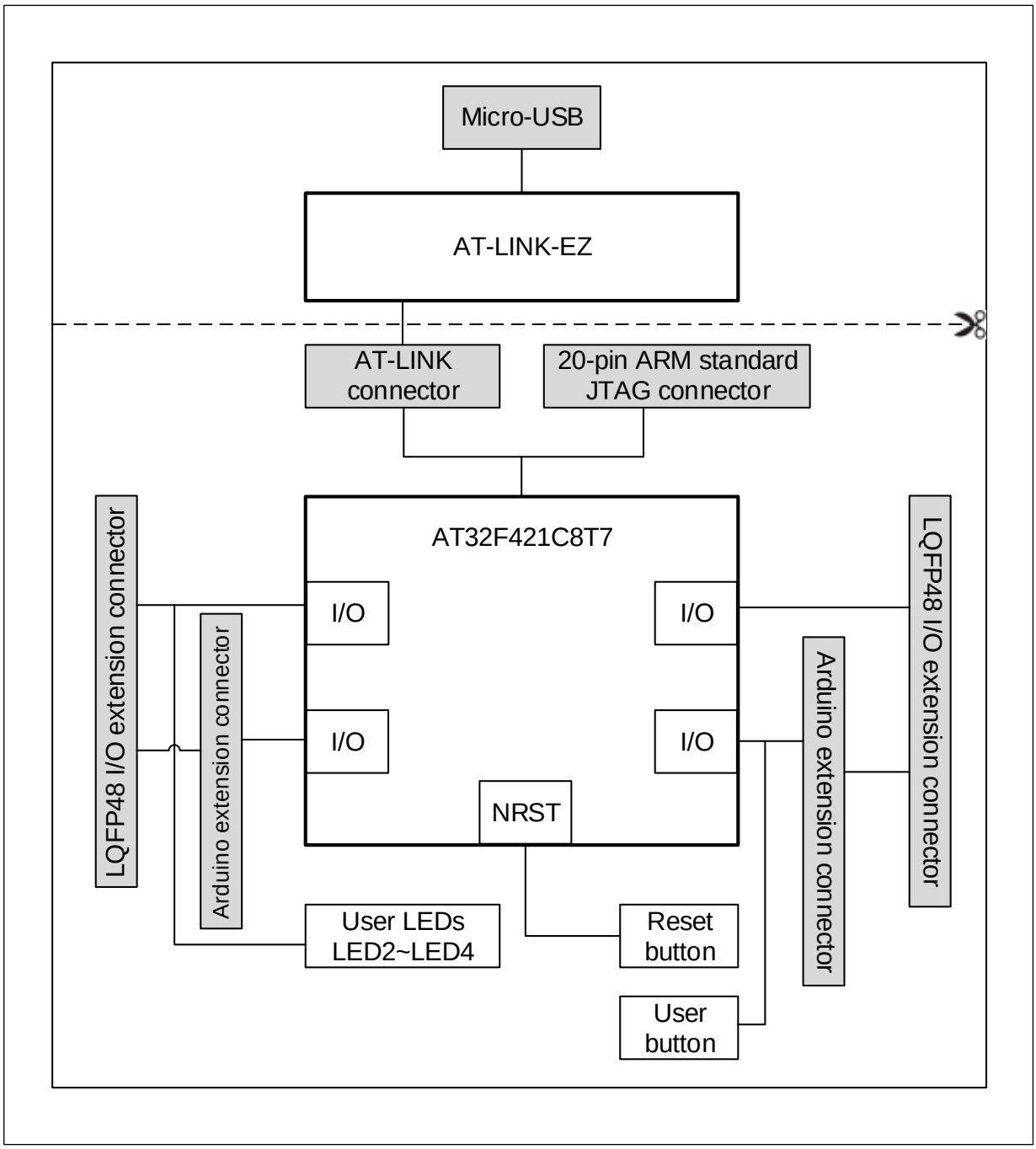


Figure 2. Top layer

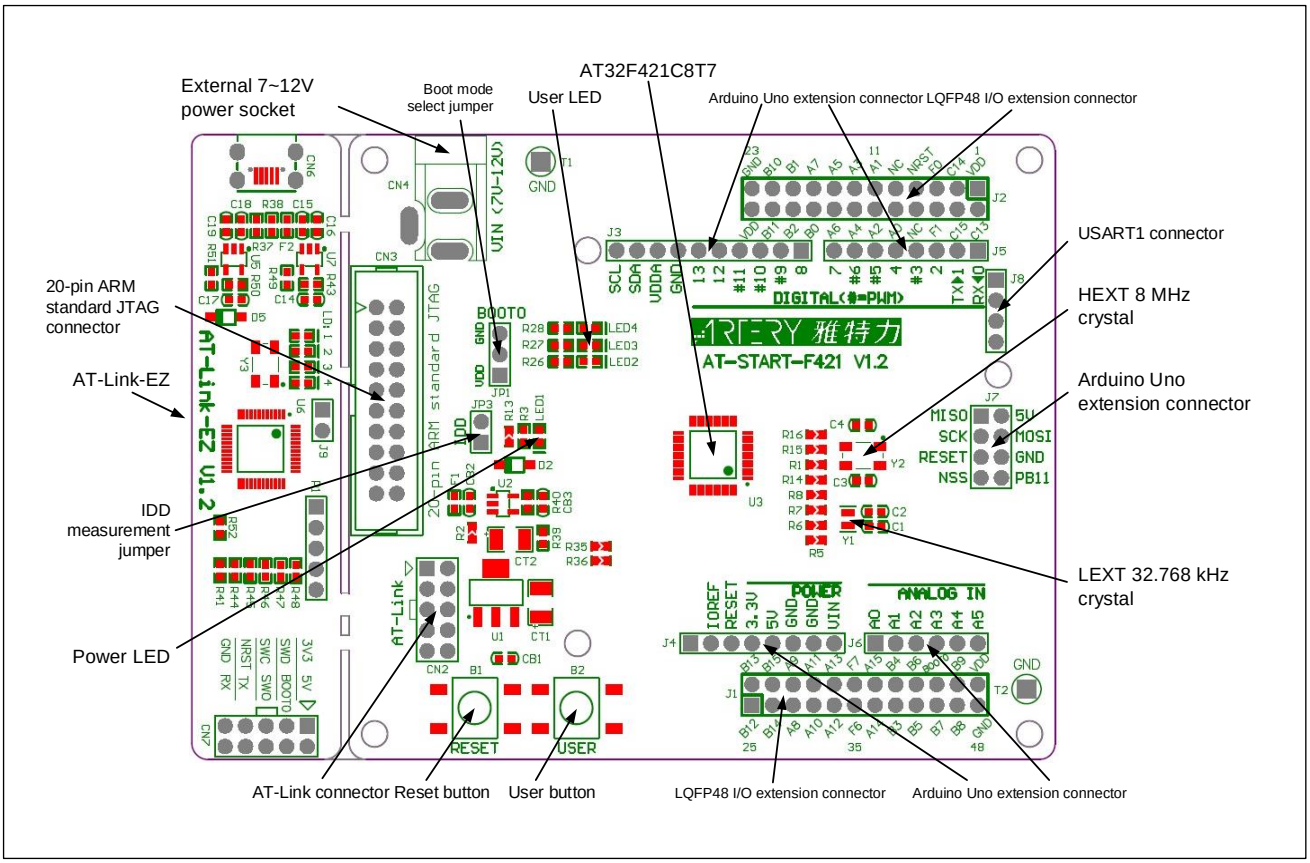
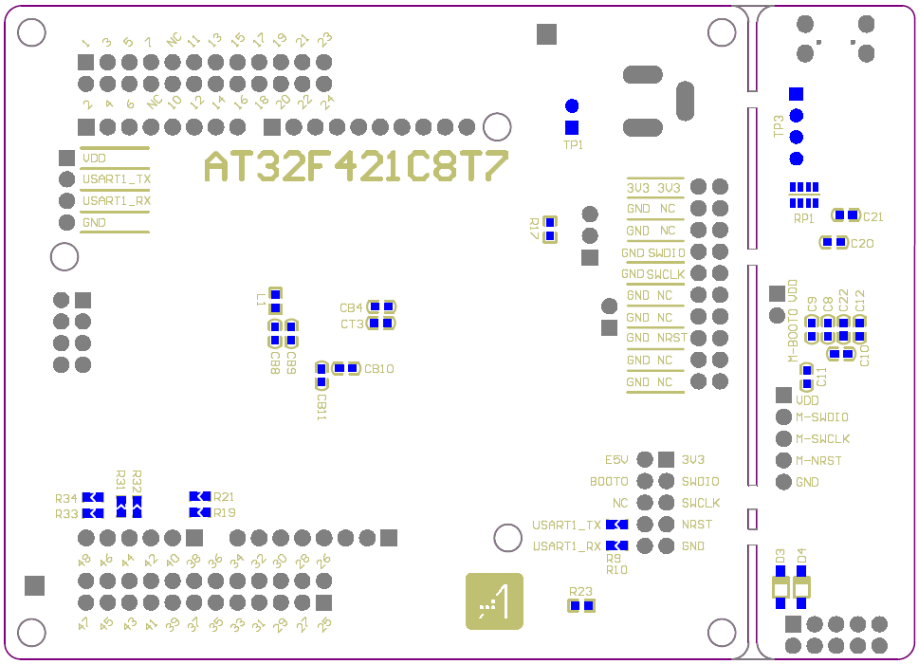


Figure 3. Bottom layer



3.1 Power supply sources

The 5 V power supply source required for AT-START-F421 can be from USB connector (CN6) on the AT-Link-EZ via USB cable, or from an external 5 V (E5V), or from an external 7~12 V (VIN) which can provide the desired 5 V via voltage regulator (U1) on the board. 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 the board.

The 5 V pin of J4 or J7 can also be used as an input power source. Then the AT-START-F421 board must be powered by a 5 V power supply unit.

The 3.3 V pin of J4 or the VDD pin of J1 and J2 can also be directly used as 3.3 V input power supply. Then the AT-START-F421 board must be powered by a 3.3 V power supply unit.

Note: Unless 5 V is provided through the USB connector (CN6) on the AT-Link-EZ, the AT-Link-EZ will not be powered by other power supply methods.

When another application board is connected to J4, the VIN pin, 5 V and 3.3 V can be used as output power, the 5V pin of J7 as 5 V output power supply; the VDD pin of J1 and J2 as 3.3 V output power supply.

3.2 IDD

When JP3 OFF (symbol IDD) and R13 OFF, an ammeter can be connected to measure the power consumption of AT32F421C8T7.

- **JP3 OFF, R13 ON:**

  AT32F421C8T7 is powered. (Default setting, and JP3 plug is not mounted before shipping)
- **JP3 ON, R13 OFF:**

  AT32F421C8T7 is powered.
- **JP3 OFF, R13 OFF:**
  An ammeter must be connected to measure the power consumption of AT32F421C8T7 (if no ammeter, the AT32F421C8T7 cannot be powered).

3.3 Programming and debugging

3.3.1 Embedded AT-Link-EZ

The evaluation board integrates Artery AT-Link-EZ for users to program/debug the AT32F421C8T7 on the AT-START-F421 board. AT-Link-EZ supports SWD interface mode. It offers a virtual COM port (VCP) to connect to the USART1_TX/USART1_RX (PA9/PA10) of AT32F421C8T7.

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

The AT-Link-EZ PCB on board can be separated from AT-START-F421 by bending it along the joint. In this case, AT-START-F421 can still be connected to the connector CN7 of AT-Link-EZ through CN2 (not mounted before shipping), or can be connected with another AT-Link to continue programming and debugging the AT32F421C8T7.

3.3.2 20-pin ARM® standard JTAG connector

AT-START-F421 also reserves SWD general-purpose connectors as programming/debugging tools. If the user wants to use this connector to program and debug the AT32F421C8T7, please separate the AT-Link-EZ from this board or configure R41, R44 and R46 OFF, and then connect the CN3 (not mounted before shipping) to the programming and debugging tool.

3.4 Boot mode selection

At startup, the board boots from the following memory locations, depending on BOOT0.

Table 1. Boot mode selection jumper setting

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

(1) It depends on the internal user option byte nBOOT1.

3.5 External clock source

3.5.1 HEXT clock source

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

- **On-board crystal (default setting):**

  The 8 MHz crystal on board is used as HEXT clock source.

  Hardware settings: R1 and R15 must be ON, and R14, R16 OFF
- **Oscillator from PF0:**

  External oscillator is from the pin_5 of J2.

  Hardware settings: R14 and R16 must be ON, and R1, R15 OFF.
- **HEXT not used:**

  PF0 and PF1 are used as GPIOs.

  Hardware settings: R14 and R16 must be ON, and R1, R15 OFF.

3.5.2 LEXT clock source

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

- **On-board crystal (default setting):**

  The 32.768 kHz crystal on board is used as LEXT clock source.

  Hardware settings: R6 and R7 must be ON, and R5, R8 OFF
- **Oscillator from PC14:**

  External oscillator is from the pin_3 of J2.

  Hardware settings: R5 and R8 must be ON, and R6, R7 OFF.
- **LEXT not used:**

  PC14 and PC15 are used as GPIOs.

  Hardware settings: R5 and R8 must be ON, and R6, R7 OFF.

3.6 LEDs

- **Power LED1**

  Red color, indicating that the board is powered by 3.3 V.

- **User LED2**

  Red color, connected to the PF6 pin of AT32F421C8T7.

- **User LED3**

  Yellow color, connected to the PF7 pin of AT32F421C8T7.

- **User LED4**

  Green color, connected to the PB11 pin of AT32F421C8T7.

3.7 Buttons

- **Reset button B1**

  Connected to NRST to reset AT32F421C8T7.

- **User button B2**

  By default, it is connected to the PA0 of AT32F421C8T7 and used as a wake-up button (R19 ON, R21 OFF) as alternate function; it can also be connected to PC13 and used as TAMPER-RTC button (R19 OFF, R21 ON) as alternate function.

3.8 0 Ω resistors

Table 2. 0 Ω resistor settings

Resistors	State(1)	Description
R13 (Microcontroller power consumption measurement)	**ON**	When JP3 OFF, the AT32F421C8T73.3V is powered by 3.3 V
	OFF	When JP3 OFF, an ammeter can be connected to 3.3 V to measure the power consumption of AT32F421C8T7 (if no ammeter, AT32F421C8T7 cannot be powered)
R1, R14, R15, R16 (HEXT)	**ON, OFF, ON, OFF**	The crystal Y2 on board is used as HEXT clock source
	OFF, ON, OFF, ON	HEXT clock source is from external PF0 or PF0 and PF1 are used as GPIOs.
R5, R6, R7, R8 (LEXT)	**OFF, ON, ON, OFF**	The crystal Y1 on board is used as LEXT clock source
	ON, OFF, OFF, ON	LEXT clock source is from PC14 oscillator or PC14 and PC15 are used as GPIOs.
R19, R21 (User button B2)	**ON, OFF**	User button B2 is connected to PA0
	OFF, ON	User button B2 is connected to PC13
R31, R32, R33, R34 (Arduino™ A4, A5)	**OFF, ON, OFF, ON**	Arduino™ A4 and A5 are connected to ADC_IN6 and ADC_IN9
	ON, OFF, ON, OFF	Arduino™ A4 and A5 are connected to I2C1_SDA and I2C1_SCL
R35, R36 (Arduino™ D10)	**OFF, ON**	Arduino™ D10 is connected to SPI1_SS
	ON, OFF	Arduino™ D10 is connected to PWM (TMR16_CH1N)

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

3.9 Extension connectors

3.9.1 Arduino™ Uno R3 extension connectors

Female plug J3~J6 and male J7 support standard Arduino™ Uno R3 connectors. Most of the daughter boards designed around Arduino™ Uno R3 are fit to AT-START-F421.

Note 1: The I/O ports of AT32F421C8T7 are 3.3 V compatible with Arduino™ Uno R3, but 5V incompatible.

Note 2: The pin_8 of J3 is VDDA, the same level as VDD, and has no AFEF function of Arduino™ Uno R3.

Table 3. Arduino™ Uno R3 extension connectors

Connectors	Pin No.	Arduino pin name	AT32F421 pin name	Function
J4 (Power)	1	NC	-	-
	2	IOREF	-	3.3 V reference voltage
	3	RESET	NRST	External reset
	4	3.3V	-	3.3 V input/output
	5	5V	-	5 V input/output
	6	GND	-	Ground
	7	GND	-	Ground
	8	VIN	-	7~12 V input/output
J6 (Analog input)	1	A0	PA0	ADC1_IN0
	2	A1	PA1	ADC1_IN1
	3	A2	PA4	ADC1_IN4
	4	A3	PB0	ADC1_IN8
	5	A4	PA6 or PB9(1)	ADC1_IN6 or I2C1_SDA
	6	A5	PB1 or PB8(1)	ADC1_IN9 or I2C1_SCL
J5 (Logic input/output low byte)	1	D0	PA3	USART2_RX
	2	D1	PA2	USART2_TX
	3	D2	PA10	-
	4	D3	PB5	TMR3_CH2
	5	D4	PB3	-
	6	D5	PB4	TMR3_CH1
	7	D6	PB8	TMR1_CH1
	8	D7	PB10	-
J3 (Logic input/output high byte)	1	D8	PA9	-
	2	D9	PB7	TMR17_CH1C
	3	D10	PA15 or PB6(1)	SPI1_CS or TMR16_CH1C
	4	D11	PA7	TMR3_CH2 or SPI1_MOSI
	5	D12	PA6	SPI1_MISO
	6	D13	PA5	SPI1_SCK
	7	GND	-	Ground
	8	VDDA	-	VDDA output
	9	SDA	PB9	I2C1_SDA
	10	SCL	PB8	I2C1_SCL

Connectors	Pin No.	Arduino pin name	AT32F421 pin name	Function
J7 (Others)	1	MISO	PB14	SPI2_MISO
	2	5V	-	5 V input/output
	3	SCK	PB13	SPI2_SCK
	4	MOSI	PB15	SPI2_MOSI
	5	RESET	NRST	External reset
	6	GND	-	Ground
	7	CS	PB12	SPI2_CS
	8	PB11	PB11	-

(1) 0Ω resistor settings are shown in *Table 3*.

3.9.2 LQFP48 I/O extension connectors

The extension connectors J1 and J2 are used to connect the IO ports of the AT-START-F421 to external devices. All the I/O ports of AT32F421C8T7 are accessible. J1 and J2 can also be measured with oscilloscope, logic analyzer or voltmeter probe.

4 Revision history

Table 4. Document revision history

Date	Revision	Changes
2020.8.17	1.0	Initial release
2020.9.29	1.10	1. Changed the revision of this document to 3 digits, with the first two for the AT-START hardware version, and the last for the document version. 2. Updated AT-Link-EZ hardware to V1.1 to support SWO debug, but AT32F421C8T7 does not support this function. 3. Revised the GPIO corresponding to Arduino interface D3, D4, D6 and D7.
2021.1.8	1.20	1. Updated AT-Link-EZ hardware to V1.2, and reversed two rows of CN7 signals and modified the silkscreen to match Artery development tools. 2. Modified the CN2 silkscreen to match Artery development tools. 3. Added GND test ring for measurement.
2023.9.7	1.21	Updated related terms and descriptions

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