

**Getting started with AT32F421C8T7**

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## Introduction

AT-START-F421 is designed to help you explore the high-performance features of the 32-bit microcontroller, AT32F421 embedded with ARM Cortex<sup>®</sup>-M4 core, and help develop your applications.

AT-START-F421 is an evaluation board based on AT32F421C8T7 chip with LED indicators, buttons and Arduino<sup>™</sup> Uno R3 extension connector. This evaluation board embeds debugging/programming tool AT-Link-EZ without the need of other development tools.

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# 1 Overview

## 1.1 Features

AT-START-F421 has the following characteristics:

- AT-START-F421 has an on-board AT32F421C8T7 microcontroller that embeds ARM Cortex<sup>®</sup>-M4, 32-bit processor, 64 KB Flash memory and 16 KB SRAM, LQFP48 packages.
- On-board AT-Link connector:
  - The on-board AT-Link-EZ can be used for programming and debugging. (AT-Link-EZ is a simplified version of AT-Link, and does not support offline mode)
  - If AT-Link-EZ is separated from this board by bending over 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 (can be connected to SWD connector for programming/debugging)
- Various power supply methods:
  - Through the 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) used for 3.3 V power-on
  - 3 x user LEDs, LED2 (red), LED3 (yellow) and LED4 (green)
- 2 x buttons (user button and reset button)
- 8 MHz HSE crystal
- 32.768 kHz LSE crystal
- Various extension connectors can be quickly connected into a prototype board and easy to explore:
  - Arduino<sup>™</sup> Uno R3 extension connector
  - LQFP48 I/O extension connector

## 1.2 Definition of terms

*Table 1* shows the definitions of some conventions used in this document.

- **Jumper JPx ON**  
Jumper installed.
- **Jumper JPx OFF**  
Jumped not installed.
- **Resistor Rx ON**  
Short by solder or 0Ω resistor.
- **Resistor Rx OFF**  
Open.

## 2 Quick start

AT-START-F421 is a low-cost and easy-to-use development kit that is designed for quickly evaluating and using the high-performance AT32F421 microcontrollers to develop applications.

### 2.1 Get started

Configure the AT-START-F421 board in the following order to start the application:

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

### 2.2 Toolchains supporting AT-START-F421

- ARM® Keil®: MDK-ARM™
- IAR™: EWARM

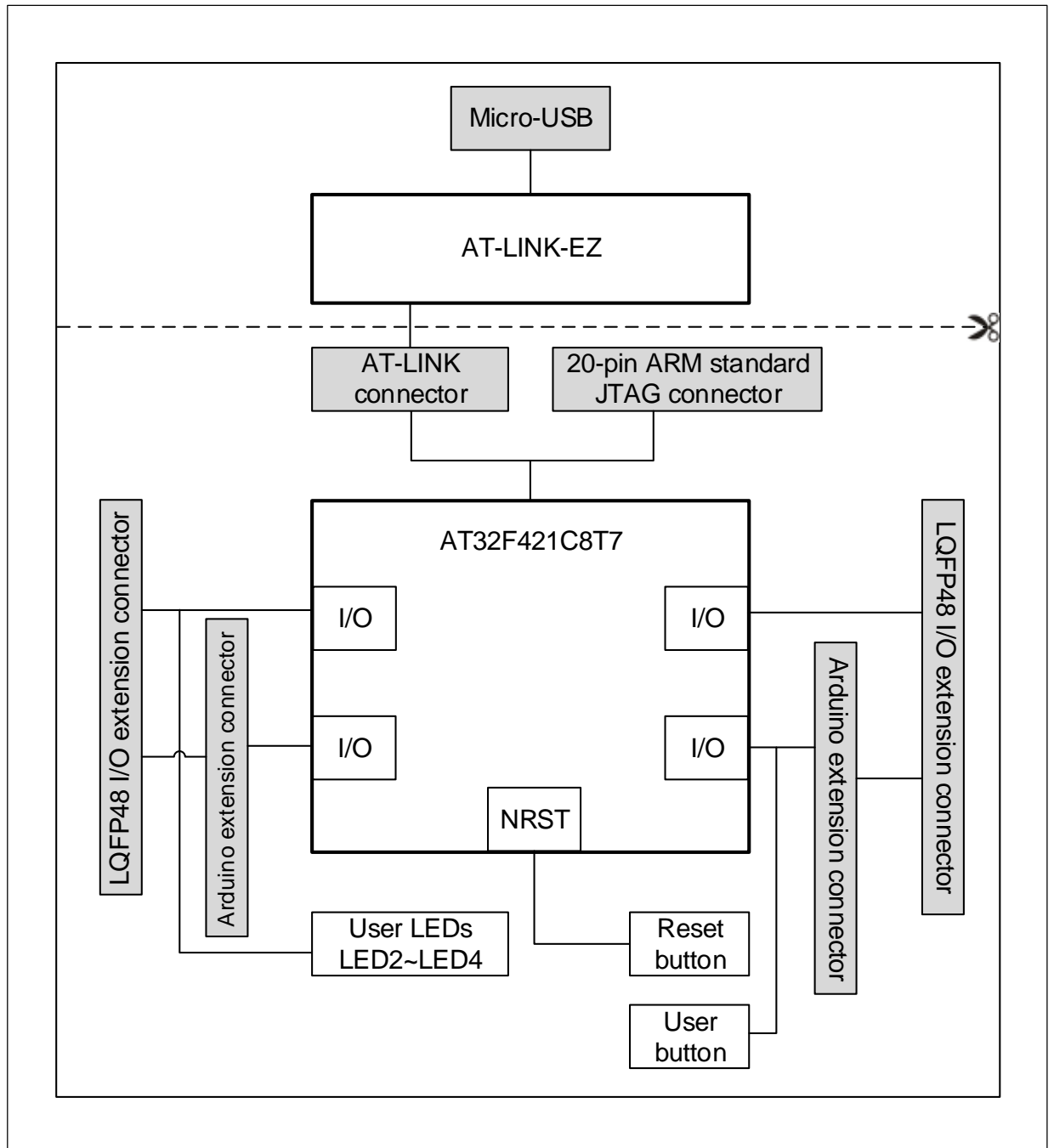
## 3 Hardware and layout

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 these features on the AT-Link-EZ and AT-START-F421 board.

**Figure 1. Hardware block diagram**







## 3.1 Power supply selection

The 5 V power supply of AT-START-F421 can be provided by connecting USB cable to the USB connector (CN6) on the AT-Link-EZ, or through an external 5 V power supply (E5V), or by an external 7~12 V power supply (VIN) via 5V voltage regulator (U1) on the board. In this case, the 5 V power supply provides the 3.3 V power required by the microcontrollers and peripherals by means of the 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. 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. 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; J7 5V pin used as 5 V output power; the VDD pin of J1 and J2 used as 3.3 V output power.

## 3.2 IDD

In the event of JP3 OFF (symbol IDD) and R13 OFF, it is allowed to connect an ammeter 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 there is no ammeter, the AT32F421C8T7 cannot be powered).

## 3.3 Programming and debugging

### 3.3.1 Embedded AT-Link-EZ

The evaluation board embeds Artery AT-Link-EZ programming and debugging tool for users to program/debug the AT32F421C8T7 on the AT-START-F421 board. AT-Link-EZ supports SWD interface mode and supports a set of virtual COM ports (VCP) to connect to the USART1\_TX/USART1\_RX (PA9/PA10) of AT32F421C8T7. In this case, PA9 and PA10 of AT32F421C8T7 will be affected by AT-Link-EZ as follows:

- PA9 is weakly pulled up to high level by the VCP RX pin of AT-Link-EZ;
- PA10 is strongly pulled up to high level by the VCP TX pin of AT-Link-EZ

The user can set R9 or R10 OFF, then the use of PA9 and PA10 of AT32F421C8T7 is not subject to the above restrictions.

Please refer to [AT-Link User Manual](#) for complete details on the operations, firmware upgrade and precautions of AT-Link-EZ

The AT-Link-EZ PCB on the evaluation board can be separated from AT-START-F421 by bending

over along the joint. In this case, AT-START-F421 can still be connected to the CN7 of AT-Link-EZ through CN2 (not mounted before shipping), or can be connected with another AT-Link to continue the programming and debugging on 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 set R41, R44 and R46 OFF, and connect the CN3 (not mounted before shipping) to the programming and debugging tool.

## 3.4 Boot mode selection

At startup, three different boot modes can be selected by means of the pin configuration.

**Table 1. Boot mode selection jumper setting**

Jumper	BOOT0 pin configuration	Setting
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 <sup>(1)</sup>

(1) It is determined by the internal user option byte nBOOT1.

## 3.5 External clock source

### 3.5.1 HSE clock source

There are three hardware modes to set the external high-speed clock sources:

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

The 8 MHz crystal on the board is used as HSE clock source. The hardware setting must be: R1 and R15 ON, R14 and R16 OFF

- **Oscillator from external PF0:**

External oscillator is injected from the pin\_5 of J2. The hardware setting must be: R14 and R16 ON, R1 and R15 OFF.

- **HSE not used:**

PF0 and PF1 are used as GPIO. The hardware setting must be: R14 and R16 ON, R1 and R15 OFF.

### 3.5.2 LSE clock source

There are three hardware modes to set the external low-speed clock sources:

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

The 32.768 kHz crystal on the board is used as LSE clock source. The hardware setting must be: R6 and R7 ON, R5 and R8 OFF

- **Oscillator from external PC14:**

External oscillator is injected from the pin\_3 of J2. The hardware setting must be: R5 and R8 ON, R6 and R7 OFF.

- **LSE not used:** PC14 and PC15 are used as GPIO. The hardware setting must be: R5 and R8 ON, R6 and R7 OFF.

## 3.6 LEDs

- **Power LED1**  
Red, indicating that the board is powered by 3.3 V.
- **User LED2**  
Red, connected to the PF6 pin of AT32F421C8T7.
- **User LED3**  
Yellow, connected to the PF7 pin of AT32F421C8T7.
- **User LED4**  
Green, connected to the PB11 pin of AT32F421C8T7.

## 3.7 Buttons

- **Reset button B1**  
Connected to NRST to reset AT32F421C8T7.
- **User button B2**  
It is, by default, connected to the PA0 of AT32F421C8T7, and alternatively used as a wake-up button (R19 ON, R21 OFF); or connected to PC13 and alternatively used as TAMPER-RTC button (R19 OFF, R21 ON)

### 3.8 0 Ω resistors

**Table 2. 0 Ω resistor setting**

Resistors	State <sup>(1)</sup>	Description
R13 (Microcontroller power consumption measurement)	<b>ON</b>	When JP3 is OFF, 3.3V is connected to the microcontroller to provide power supply for AT32F421C8T7
	OFF	When JP3 is OFF, 3.3V allows an ammeter to be connected to measure the power consumption of AT32F421C8T7 (if no ammeter, AT32F421C8T7 cannot be powered)
R1, R14, R15, R16 (HSE)	<b>ON, OFF, ON, OFF</b>	HSE clock source uses crystal Y2 on the board
	OFF, ON, OFF, ON	HSE clock source is from external PF0 or PF0 and PF1 are used as GPIO.
R5, R6, R7, R8 (LSE)	<b>OFF, ON, ON, OFF</b>	LSE clock source uses crystal Y1 on the board
	ON, OFF, OFF, ON	LSE clock source is from external PC14 or PC14 and PC15 are used as GPIO.
R19, R21 (User button B2)	<b>ON, OFF</b>	User button B2 is connected to PA0
	OFF, ON	User button B2 is connected to PC13
R31, R32, R33, R34 (Arduino™ A4, A5)	<b>OFF, ON, OFF, ON</b>	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)	<b>OFF, ON</b>	Arduino™ D10 is connected to SPI1_SS
	ON, OFF	Arduino™ D10 is connected to PWM (TMR16_CH1N)
R9 (USART1_RX)	<b>ON</b>	USART1_RX of AT32F421C8T7 is connected to VCP TX of AT-Link-EZ
	OFF	USART1_RX of AT32F421C8T7 is disconnected from VCP TX of AT-Link-EZ
R10 (USART1_TX)	<b>ON</b>	USART1_TX of AT32F421C8T7 is connected to the VCP RX of AT-Link-EZ
	OFF	USART1_TX of AT32F421C8T7 is disconnected from VCP RX of AT-Link-EZ

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

### 3.9 Extension connectors

#### 3.9.1 Arduino™ Uno R3 extension connector

Female plug J3~J6 and male J7 support standard Arduino™ Uno R3 connectors. Most of the daughter boards designed around Arduino™ Uno R3 are suitable for 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, which has the same level as VDD, without AFEF function defined by Arduino™ Uno R3.

**Table 3. Arduino™ Uno R3 extension connector pin definition**

Connector	Pin number	Arduino pin name	AT32F421 pin name	Functions
J4 (Power supply)	1	NC	-	-
	2	IOREF	-	3.3 V reference
	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	ADC_IN0
	2	A1	PA1	ADC_IN1
	3	A2	PA4	ADC_IN4
	4	A3	PB0	ADC_IN8
	5	A4	PA6 or PB9 <sup>(1)</sup>	ADC_IN6 or I2C1_SDA
	6	A5	PB1 or PB8 <sup>(1)</sup>	ADC_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_CH21N
	3	D10	PA15 or PB6 <sup>(1)</sup>	SPI1_NSS or TMR16_CH1N
	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

Connector	Pin number	Arduino pin name	AT32F421 pin name	Functions
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	NSS	PB12	SPI2_NSS
	8	PB11	PB11	-

(1) 0Ω resistor setting is shown in [Table 3](#).

## 3.9.2 LQFP48 I/O extension connector

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



Figure 5. Schematic (microcontroller)

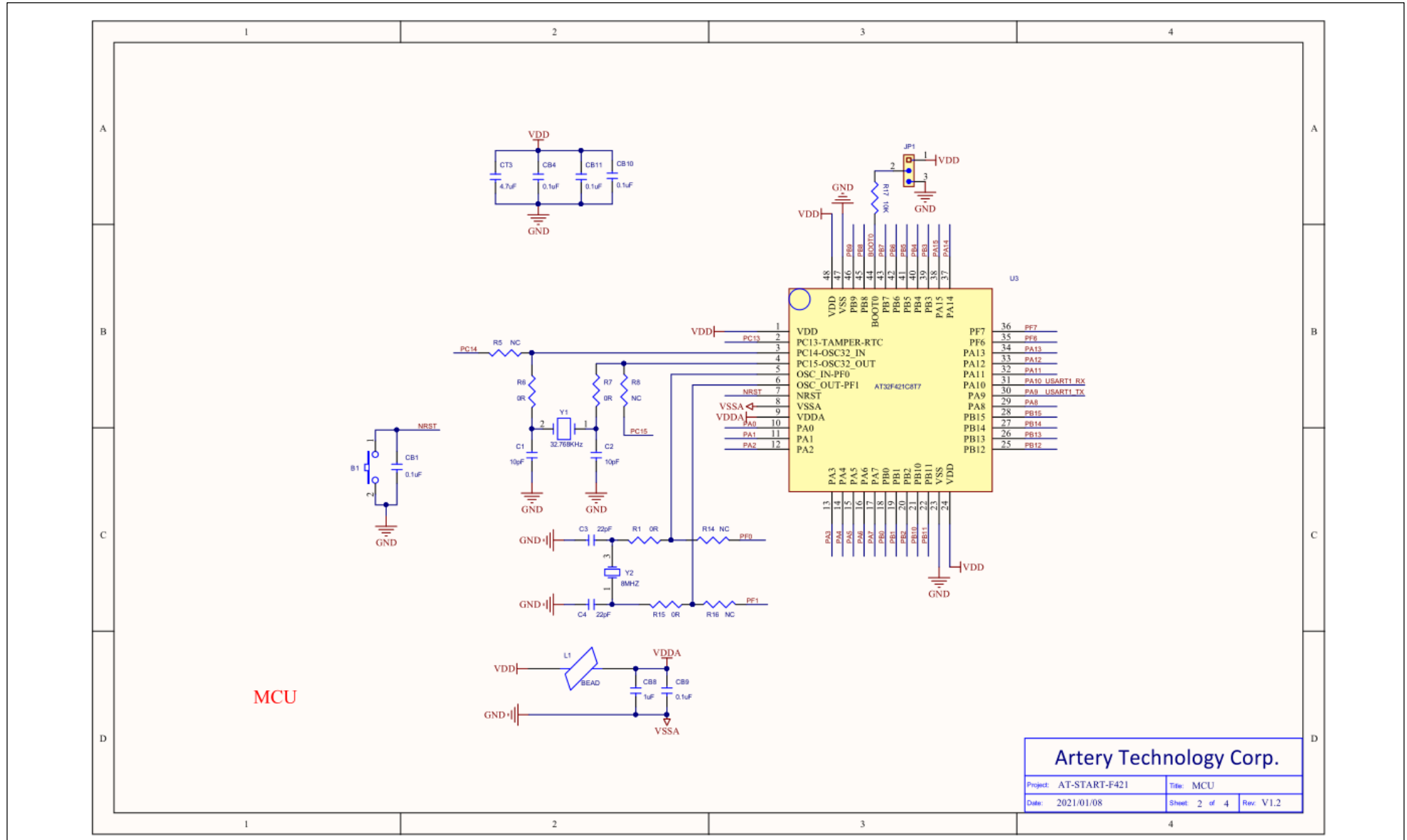




Figure 6. Schematic (power supply and peripherals)

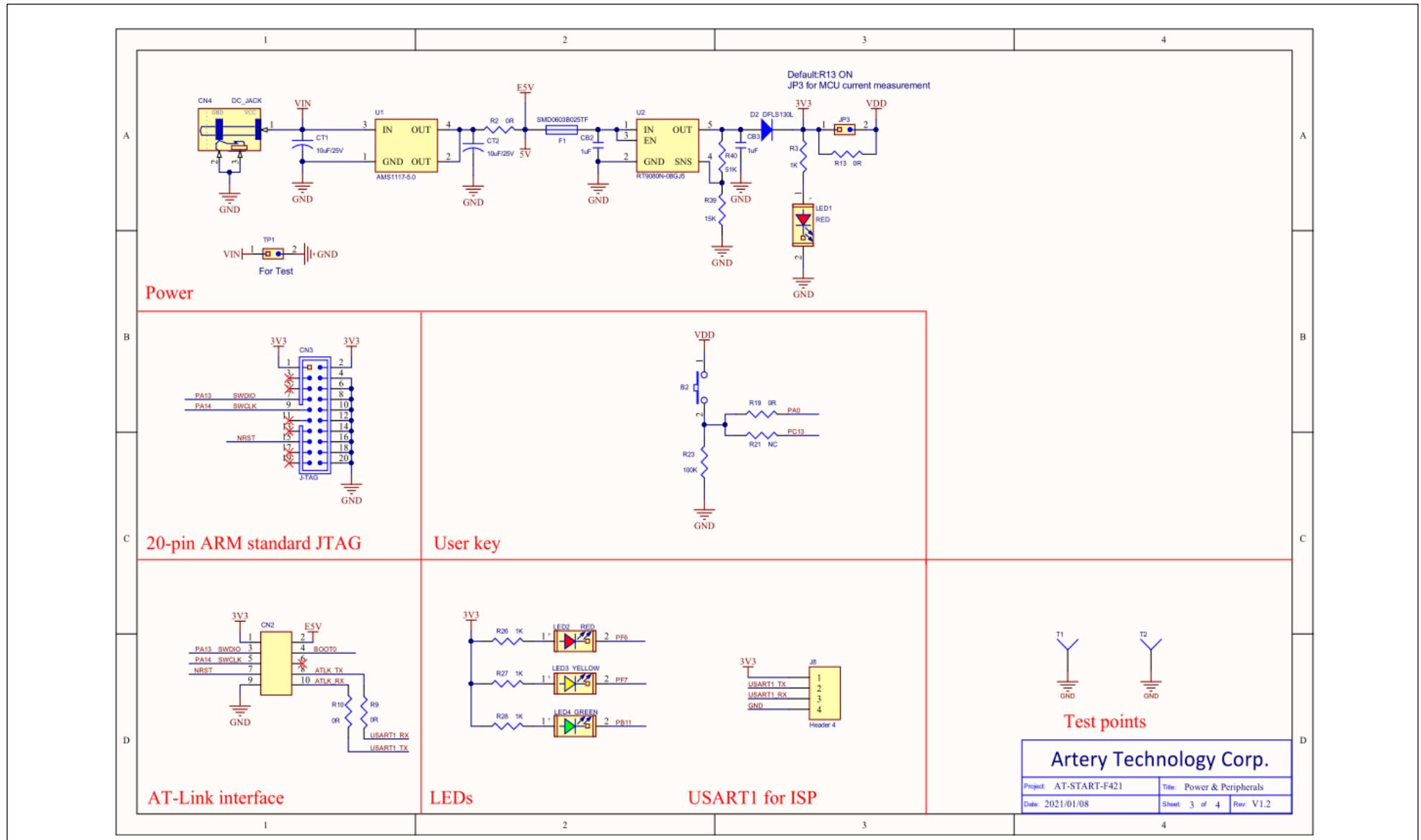
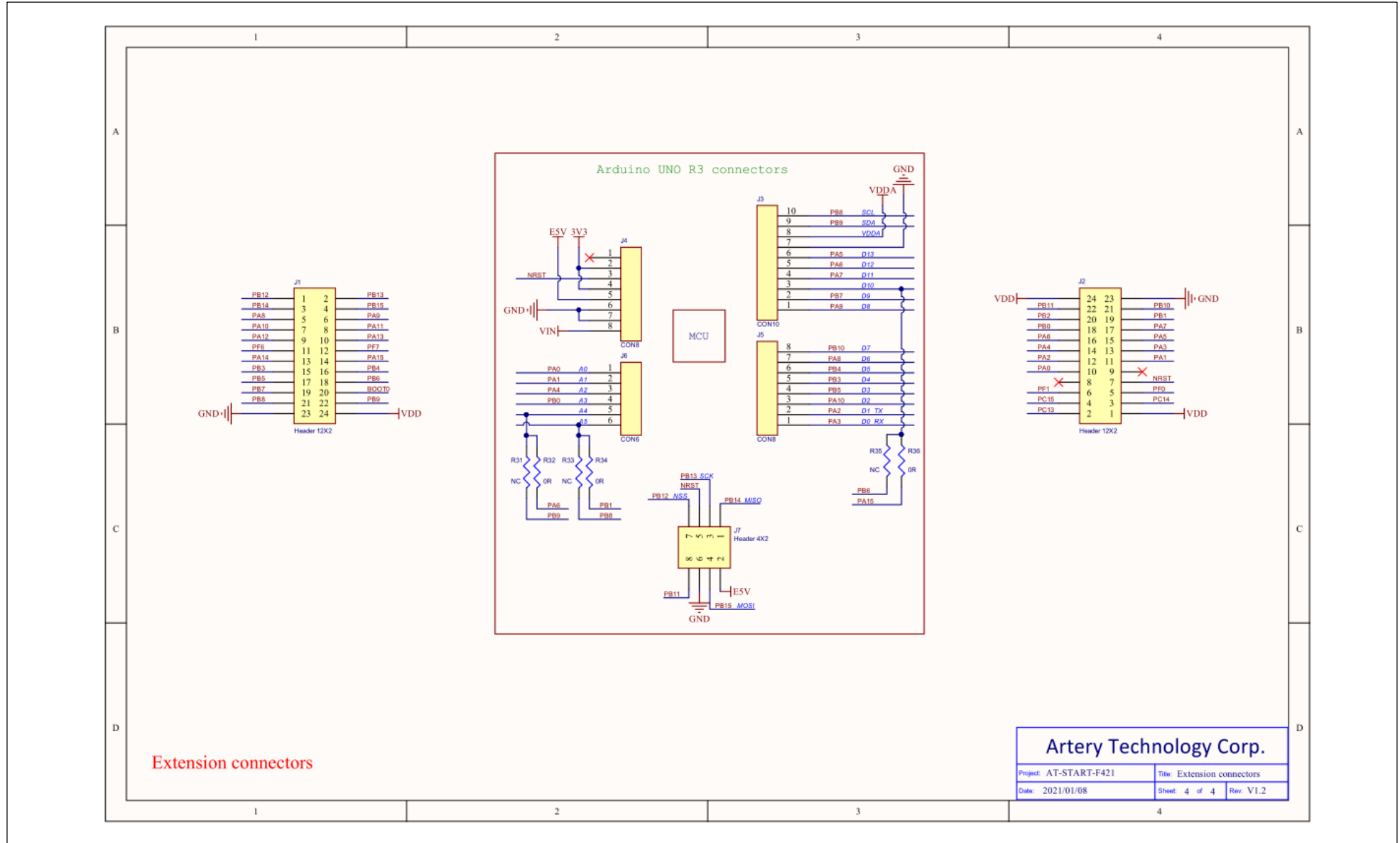


Figure 7. Schematic (extension connectors)



## 5 Revision history

**Table 4. Document revision history**

Date	Revision	Changes
2020.8.17	1.0	Initial release
2020.9.29	1.10	<ol style="list-style-type: none"> <li>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.</li> <li>2. Updated AT-Link-EZ hardware to V1.1 to support SWO debug, but AT32F421C8T7 does not support this function.</li> <li>3. Revised the GPIO corresponding to Arduino interface D3, D4, D6 and D7.</li> </ol>
2021.1.8	1.20	<ol style="list-style-type: none"> <li>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.</li> <li>2. Modified the CN2 silkscreen to match Artery development tools.</li> <li>3. Added GND test ring for measurement.</li> </ol>

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