Getting started with AT32F437ZMT7

Introduction

AT-START-F437 is designed to help you explore the high performance of the 32-bit microcontroller AT32F437 that embeds ARM Cortex®-M4 core with FPU, and expedite application development.

AT-START-F437 is an evaluation board based on AT32F437ZMT7 microcontroller. The device contains such peripherals as LEDs, buttons, two USB micro-B connectors, type-A connector, Ethernet RJ45 connector, Arduino™ Uno R3 extension interface and 16 MB SPI Flash memory (extended through QSPI1). This evaluation board embeds AT-Link-EZ for debugging/programming without the need of other development tools.

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1 Overview

1.1 Features

AT-START-F437 has the following characteristics:

- AT-START-F437 has an on-board AT32F437ZMT7 microcontroller that embeds ARM Cortex®-M4F 32-bit core with FPU, 4032 KB Flash memory and 384 KB SRAM, in LQFP144 packages.
- On-board AT-Link interface:
  - On-board AT-Link-EZ can be used for programming and debugging (AT-Link-EZ is a simplified version of AT-Link, without offline mode support)
  - If AT-Link-EZ were disassembled from the board by bending it along the joint, this interface can be connected to an independent AT-Link for programming and debugging.
- On-board 20-pin ARM standard JTAG interface (can be connected to JTAG or SWD connector for programming and debugging)
- 16 MB SPI (EN25QH128A) is used as extended Flash memory
- Various power supply methods:
  - USB bus of AT-Link-EZ
  - OTG1 or OTG2 bus (V_{BUS1} or V_{BUS2}) of AT-START-F437
  - External 5 V power supply (E5V)
  - External 3.3 V power supply
- 4 x LED indicators:
  - LED1 (red) indicates 3.3 V power-on
  - 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
- On-board USB type-A and micro-B connectors in order to demonstrate OTG1 function
- OTG2 has micro-B connector (If the user wants to use OTG2 master mode, an adapter cable is required)
- On-board Ethernet PHY with RJ45 connector in order to demonstrate Ethernet feature
- QFN48 I/O extension interfaces
- Rich extension interfaces are available for quick prototyping
  - Arduino™ Uno R3 extension interface
  - LQFP144 I/O extension interface

1.2 Definition of terms

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

2 Quick start

2.1 Get started

Configure the AT-START-F437 board in the following sequence:

1. Check the Jumper's position on board:

   JP1 is connected to GND or OFF (BOOT0 = 0, and BOOT0 has an pull-down resistor in the AT32F437ZMT7);

   JP2 is connected to GND (BOOT1=0)

   JP4 is connected to USART1

2. Connect AT_Link_EZ to PC via a USB cable (Type A to micro-B), and supply power to the evaluation board via a USB connector CN6. LED1 (red) is always on, and three other LEDs (LED2 to LED4) start to blink in turn.
3. After pressing the user button (B2), the blinking frequency of three LEDs are changed.

2.2 AT-START-F437 development toolchains

- ARM® Keil®: MDK-ARM™
- IAR™: EWARM

3 Hardware and layout

AT-START-F437 board is designed around an AT32F437ZMT7 microcontroller in LQFP144 package.

Figure 1 shows the connections between AT-Link-EZ, AT32F437ZMT7 and their peripherals (buttons, LEDs, USB OTG, Ethernet RJ45, SPI and extension connectors)

Figure 2 and *Figure 3* shows their respective locations on the AT-Link-EZ and AT-START-F437 board.

Figure 1. Hardware block diagram

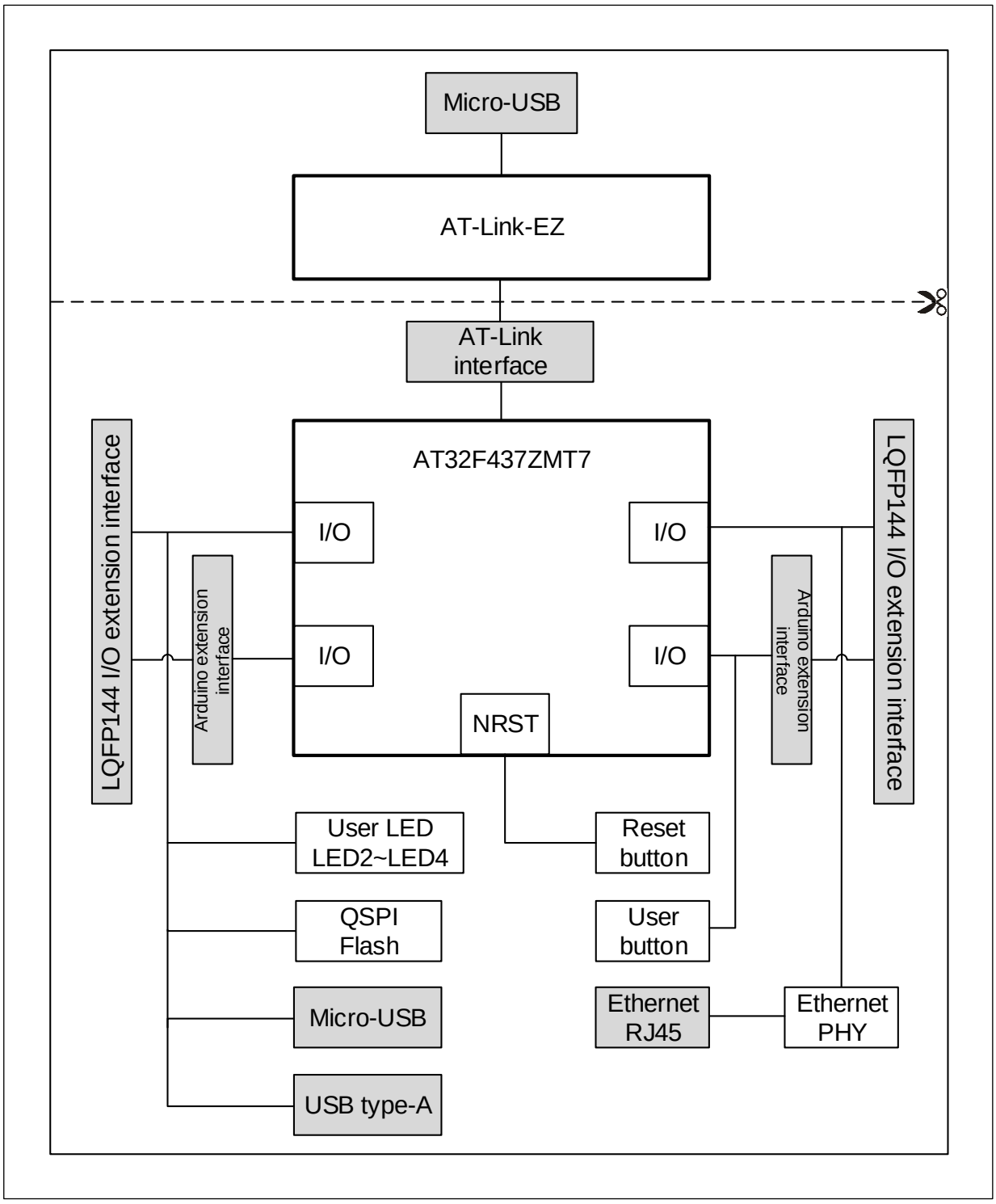


Figure 2. Top layer

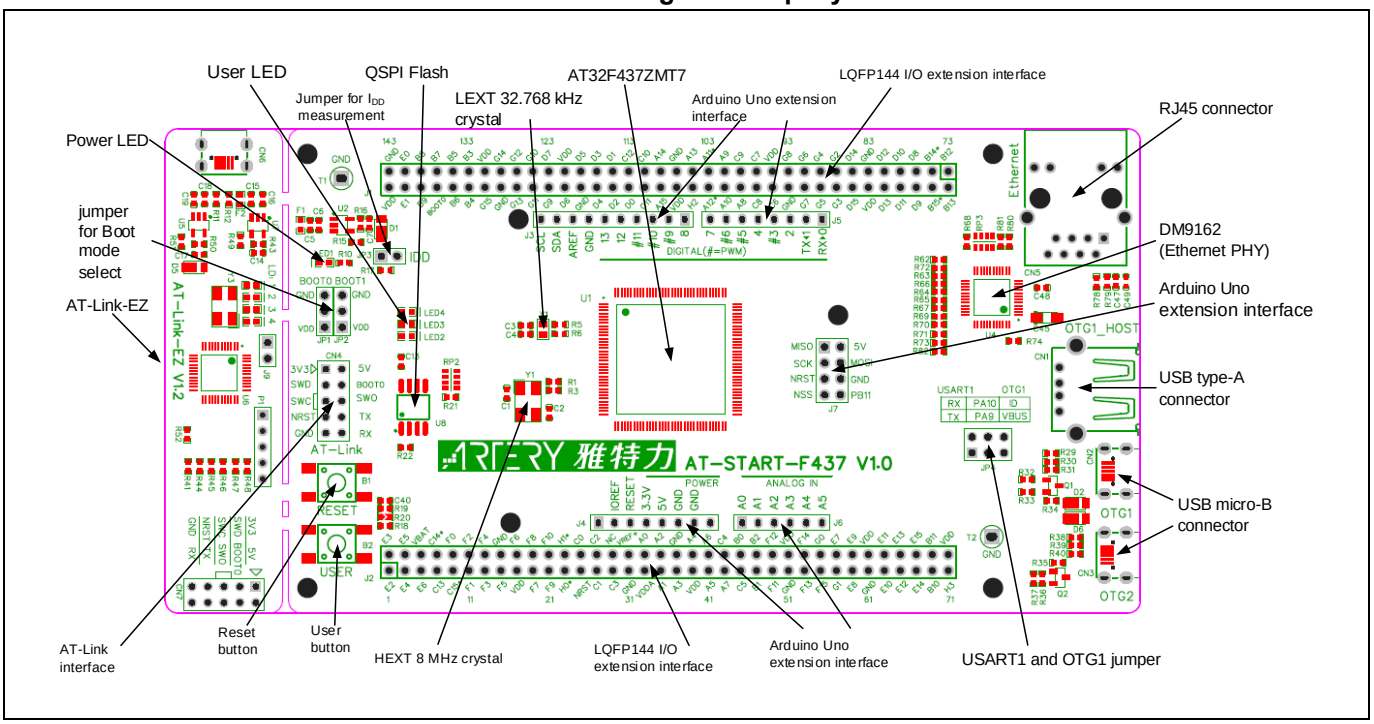
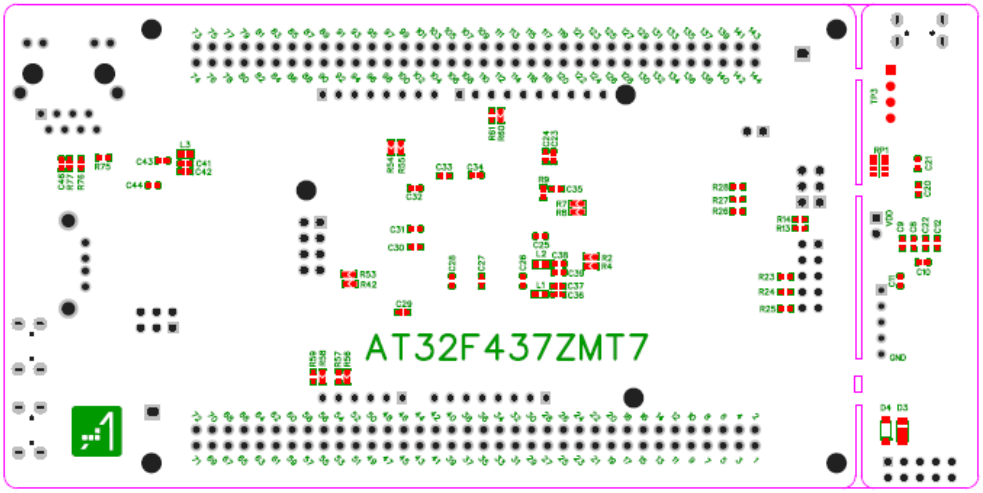


Figure 3. Bottom layer



3.1 Power supply selection

The AT-START-F437 can not only be provided with 5 V through a USB cable (either through USB connector CN6 on AT-Link-EZ or USB connector CN2/CN3 on AT-START-F437), but also be provided with an external 5 V power supply (E5V). Then 5 V power provides 3.3 V for the microcontroller and its peripherals using on-board 3.3 V voltage regulator (U2).

5 V pin of J4 or J7 can also be used as an input power, so the AT-START-F437 board can be supplied through a 5 V power unit.

The 3.3 V pin of J4, or the VDD of J1 and J2 can be used as 3.3 V input directly, so AT-START-F437 board can also be supplied by a 3.3 V power unit.

Note: 5 V power supply must be provided through USB connector (CN6) on AT-Link-EZ. Any other method cannot power the AT-Link-EZ.

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

3.2 IDD

When JP3 OFF (symbol IDD) and R17 OFF, an ammeter can be connected to measure the power consumption of AT32F437ZMT7.

- **JP3 OFF, R17 ON:**

  AT32F437ZMT7 is powered. (Default setting and JP3 plug is not mounted before shipping)
- **JP3 ON, R17 OFF:**

  AT32F437ZMT7 is powered.
- **JP3 OFF, R17 OFF:**

  An ammeter must be connected. If there is no ammeter available, the AT32F437ZMT7 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 AT32F437ZMT7 on the AT-START-F437 board. AT-Link-EZ supports SWD interface mode, SWO debug, and a set of virtual COM ports (VCP) to connect to the USART1_TX/USART1_RX (PA9/PA10) of AT32F437ZMT7.

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

The AT-Link-EZ on board can be disassembled or separated from the AT-START-F437. In this case, the AT-START-F437 can still be connected to the CN7 interface (not mounted before leaving factory) of AT-Link-EZ through CN4 interface (not mounted before leaving factory), or to AT-Link, in order to continue to program and debug the AT32F437ZMT7.

3.4 Boot mode selection

At startup, three different boot modes are available for selection through pin configuration.

Table 1. Boot mode selection jumper settings

Jumper	Pin configuration		Boot mode
	BOOT1	BOOT0	
JP1 to GND or be OFF JP2 optional or be OFF	X	0	Boot from internal Flash memory (factory default setting)
JP1 to VDD JP2 to GND	0	1	Boot from system memory
JP1 to VDD JP2 to VDD	1	1	Boot from internal SRAM

3.5 External clock source

3.5.1 HEXT clock source

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

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

  On-board 8 MHz crystal is used as HSE clock source. The hardware must be configured: R1 and R3 ON, R2 and R4 OFF.

- **Oscillator from external PH0**

  External oscillator is injected from the pin_23 of J2. The hardware must be configured: R2 ON, R1 and R3 OFF. To use PH1 as GPIO, R4 ON can be connected to the pin_24 of J2.

- **HSE unused**

  PH0 and PH1 are used as GPIOs. The hardware must be configured: R14 and R16 ON, R1 and R15 OFF.

3.5.2 LEXT clock source

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

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

  On-board 32.768 kHz crystal is used as LEXT clock source. The hardware must be configured: R5 and R6 ON, R7 and R8 OFF

- **Oscillator from external PC14**

  External oscillator is injected from the pin_3 of J2. The hardware must be configured: R7 and R8 ON, R5 and R6 OFF.

- **LEXT unused**

  MCU PC14 and PC15 are used as GPIOs. The hardware must be configured: R7 and R8 ON, R5 and R6 OFF.

3.6 LEDs

- **Power LED1**
  Red LED indicates that the AT-START-F437 is powered by 3.3 V.
- **User LED2**
  Red LED is connected to the PD13 pin of AT32F437ZMT7.
- **User LED3**
  Yellow LED is connected to the PD14 pin of AT32F437ZMT7.
- **User LED4**
  Green LED is connected to the PD15 pin of AT32F437ZMT7.

3.7 Buttons

- **Reset B1: Reset button**
  It is connected to NRST to reset AT32F437ZMT7 microcontroller.
- **User B2: User button**
  It is connected to the PA0 of AT32F437ZMT7 to act as a wakeup button (R19 ON and R21 OFF), or to the PC13 to acts as TAMPER-RTC button (R19 OFF and R21 ON)

3.8 OTGFS configuration

AT-START-F437 board supports OTGFS1 and OTGFS2 full-speed/low-speed host or full-speed device mode via a USB micro-B connector (CN2 or CN3). In device mode, AT32F437ZMT7 can be directly connected to the host through USB micro-B, and V_{BUS1} or V_{BUS2} can be used as 5 V input of AT- START-F437 board. In host mode, an external USB OTG cable is needed to connect to the external device. The device is powered via USB micro-B interface, which is done by PH3 and PB10 controlling SI2301 switch.

AT-START-F437 board has a USB type-A extension interface (CN1). This is a OTGFS1 host interface for connecting to U disk and other devices, without the need of USB OTG cable. The USB type-A interface has no power switch control.

When the PA9 or PA10 of the AT32F437ZMT7 is used as OTGFS1_VBUS or OTGFS1_ID, the JP4 jumper must select OTG1. In this case, the PA9 or PA10 is connected to USB micro-B CN2 interface, but disconnected from AT-Link interface (CN4).

3.9 QSPI1 interfacing Flash memory

On-board SPI (EN25QH128A), connecting to the AT32F437ZMT7 via QSPI1 interface, is used as an extended Flash memory.

The QSPI1 interface is connected to Flash memory with PF6~10 and PG6. If these GPIOs are used for other purposes, it is recommended to turn off RP2, R21 and R22 in advance.

3.10 Ethernet

AT-START-F437 embeds an Ethernet PHY connecting to DM9162EP (U4) and RJ45 interface (CN5, with an internal isolation transformer), for 10/100 Mbps Ethernet communication.

By default, the Ethernet PHY is connected to the AT32F437ZMT7 in RMII mode. In this case, the CLKOUT (PA8 pin) of the AT32F437ZMT7 provides 25 MHz clock for PHY's XT1 pin to meet PHY requirements, while the 50 MHz clock of the RMII_REF_CLK (PA1) on the AT32F437ZMT7 is provided by PHY's 50 MCLK pin. The 50MCLK pin must be pulled on during power-on.

In order to simply PCB design, the PHY is not externally connected to Flash memory to allocate the PHY address [3:0] during power-on. The PHY address [3:0] is configured to be 0x3, by default. After power-on, it is possible to define a PHY address via PHY's SMI interface by software.

Refer to the reference manual and datasheet for more information on Ethernet MAC and DM9162 of the AT32F437ZMT7.

If the user wants to use LQFP144 I/O extension interfaces J1 and J2 instead of DM9162 to connect to other Ethernet boards, refer to *Table 2* in order to disconnect the AT32F437ZMT7 from DM9162.

When the Ethernet interface is unused, it is good advice to keep DM9162NP in reset state by PC8 output low level.

3.11 0Ω resistors

Table 2. 0Ωresistor settings

Resistors	State(1)	Description
R17 (MCU power consumption measurement)	**ON**	When JP3 OFF, 3.3V is connected to the microcontroller power to supply microcontroller.
	OFF	When JP3 OFF, 3.3V can be connected to an ammeter to measure the power consumption of the microcontroller. (The microcontroller cannot be powered without ammeter)
R9 (V_{BAT})	**ON**	V_{BAT} is connected to VDD
	OFF	V_{BAT} is supplied by the pin_6 (VBAT) of J2.
R1, R2, R3, R4 (HEXT)	**ON, OFF, ON, OFF**	HEXT clock source comes from on-board crystal Y1
	OFF, ON, OFF, OFF	HEXT clock source: external oscillator from PH0, PH1 is unused.
	OFF, ON, OFF, ON	HEXT clock source: external oscillator from PH0, PH1 is used as GPIO; or PH0, PH1 are used as GPIOs.
R5, R6, R7, R8 (LEXT)	**ON, ON, OFF, OFF**	LEXT clock source comes from on-board crystal X1
	OFF, OFF, ON, ON	LEXT clock source: external oscillator from PC14; or PC14, 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.
R54, R55 (PA11, PA12)	**OFF, OFF**	As OTGFS1, PA11 and PA12 are not connected to the pin_31 and pin_32 of J1.
	ON, ON	When PA11 and PA12 are not used as OTGFS1, They are connected to the pin_31 and pin_32 of J1.
R42, R53 (PA11, PA12)	**OFF, OFF**	As OTGFS2, PB14 and PB15 are not connected to the pin_3 and pin_4 of J1.
	ON, ON	When PB14 and PB15 are not used as OTGFS2, They are connected to the pin_3 and pin_4 of J1.
RP3, R62~R65, R69~R71, R73 (Ethernet PHY DM9162)	**All ON**	Ethernet MAC of the AT32F437ZMT7 is connected to DM9162 in RMII mode.
	All OFF	Ethernet MAC of the AT32F437ZMT7 is disconnected from DM9162 (This is more suitable to AT-START-F435 board at this time)
R56, R57, R58, R59 (Arduino™ A4, A5)	**OFF, ON, OFF, ON**	Arduino™ A4 and A5 are connected to ADC123_IN11 and ADC123_IN10.
	ON, OFF, ON, OFF	Arduino™ A4 and A5 are connected to I2C1_SDA，I2C1_SCL.
R60, R61 (Arduino™ D10)	**OFF, ON**	Arduino™ D10 is connected to SPI1_CS.
	ON, OFF	Arduino™ D10 is connected to PVM (TMR4_CH1).

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

3.12 Extension interfaces

3.12.1 Arduino™ Uno R3 interface

Female plug J3~J6 and male J7 support Arduino™ Uno R3 connector. Most of the daughter boards built on Arduino™ Uno R3 are applicable to AT-START-F437 board.

Note: The I/Os of the AT32F437ZMT7 is 3.3 V-compatible with Arduino™ Uno R3, but not 5 V.

Table 3. Arduino™ Uno R3 extension interface pin definition

Connector	Pin number	Arduino Pin name	AT32F437 Pin name	Description
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	-	-	-
J6 (Analog input)	1	A0	PA0	ADC123_IN0
	2	A1	PA1	ADC123_IN1
	3	A2	PA4	ADC12_IN4
	4	A3	PB0	ADC12_IN8
	5	A4	PC1 or PB9(1)	ADC123_IN11 or I2C1_SDA
	6	A5	PC0 or PB8(1)	ADC123_IN10 or I2C1_SCL
J5 (Logic input/output low byte)	1	D0	PA3	USART2_RX
	2	D1	PA2	USART2_TX
	3	D2	PA10	-
	4	D3	PB3	TMR2_CH2
	5	D4	PB5	-
	6	D5	PB4	TMR3_CH1
	7	D6	PB10	TMR2_CH3
	8	D7	PA8(2)	-
J3 (Logic input/output high byte)	1	D8	PA9	-
	2	D9	PC7	TMR3_CH2
	3	D10	PA15 or PB6(1)	SPI1_CS or TMR4_CH1
	4	D11	PA7	TMR3_CH2 / SPI1_MOSI
	5	D12	PA6	SPI1_MISO
	6	D13	PA5	SPI1_SCK
	7	GND	-	Ground
	8	AREF	-	V_{REF+} output
	9	SDA	PB9	I2C1_SDA
	10	SCL	PB8	I2C1_SCL
J7 (Others)	1	MISO	PB14	SPI2_MISO
	2	5V	-	5 V input/output
	3	SCK	PB13	SPI2_SCK

Connector	Pin number	Arduino Pin name	AT32F437 Pin name	Description
	4	MOSI	PB15	SPI2_MOSI
	5	RESET	NRST	External reset
	6	GND	-	Ground
	7	NSS	PB12	SPI2_CS
	8	PB11	PB11	-

(1) Refer to *Table 2* for details on 0Ω resistors.

3.12.2 LQFP144 I/O extension interface

The I/Os of AT-START-F437 microcontroller can be connected to external devices through extension interfaces J1 and J2. All I/Os on the AT32F437ZMT7 are available on these extension interfaces. J1 and J2 can also be measured with oscilloscope, logic analyzer or voltmeter probe.

4 Schematic

Figure 4. Schematic (AT-Link-EZ)

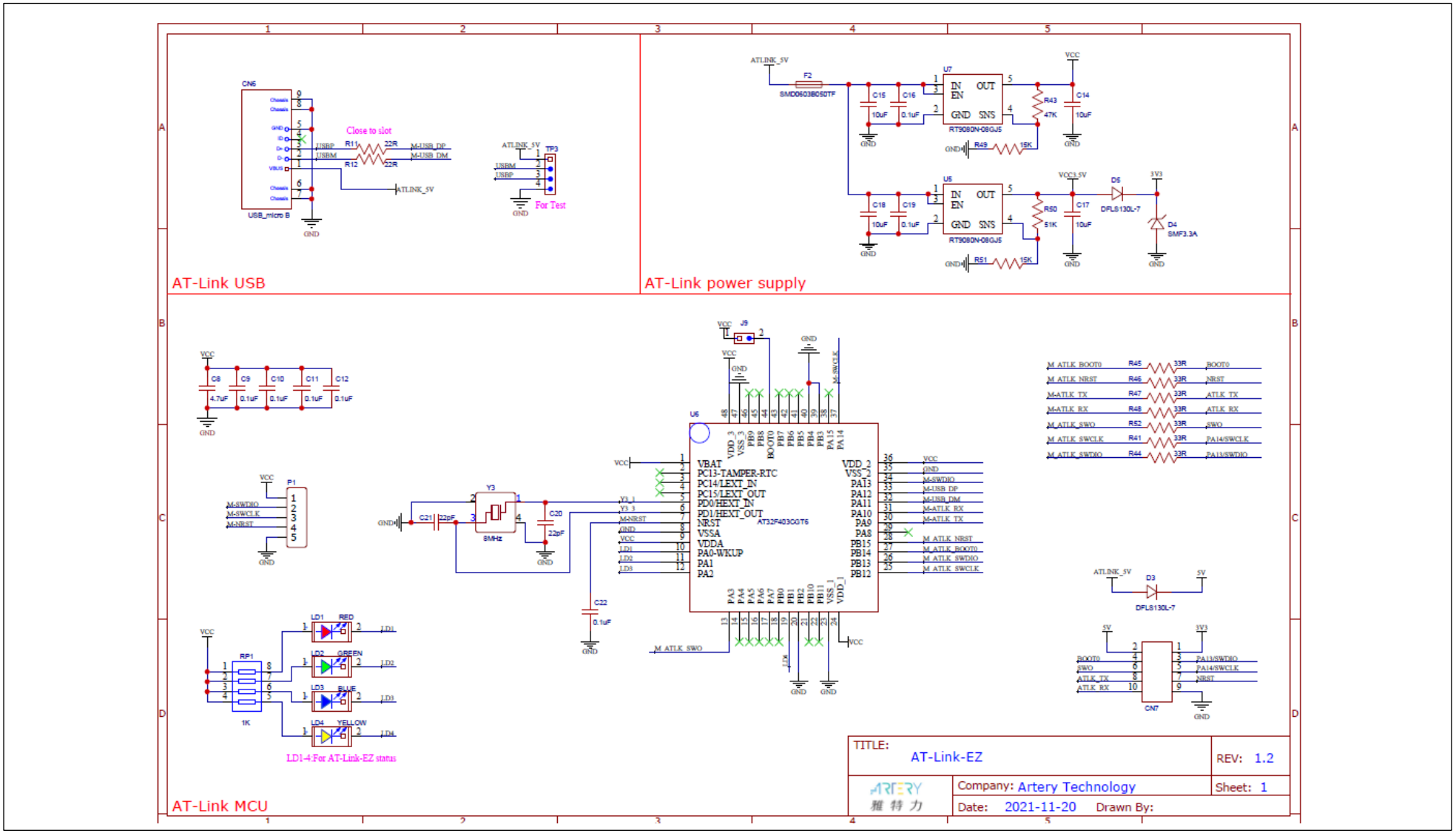


Figure 5. Schematic (microcontroller)

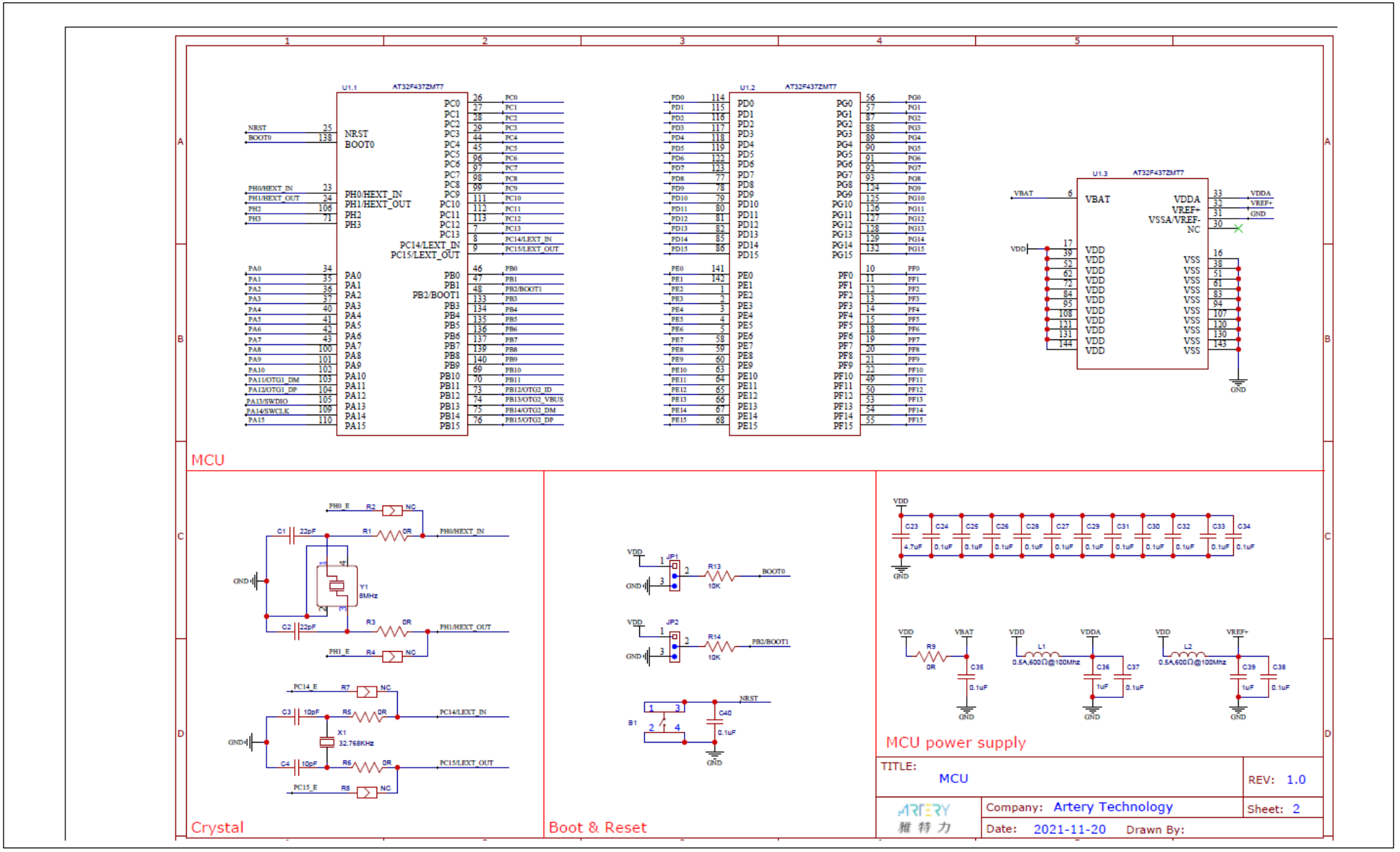


Figure 6. Schematic (power supply and peripherals)

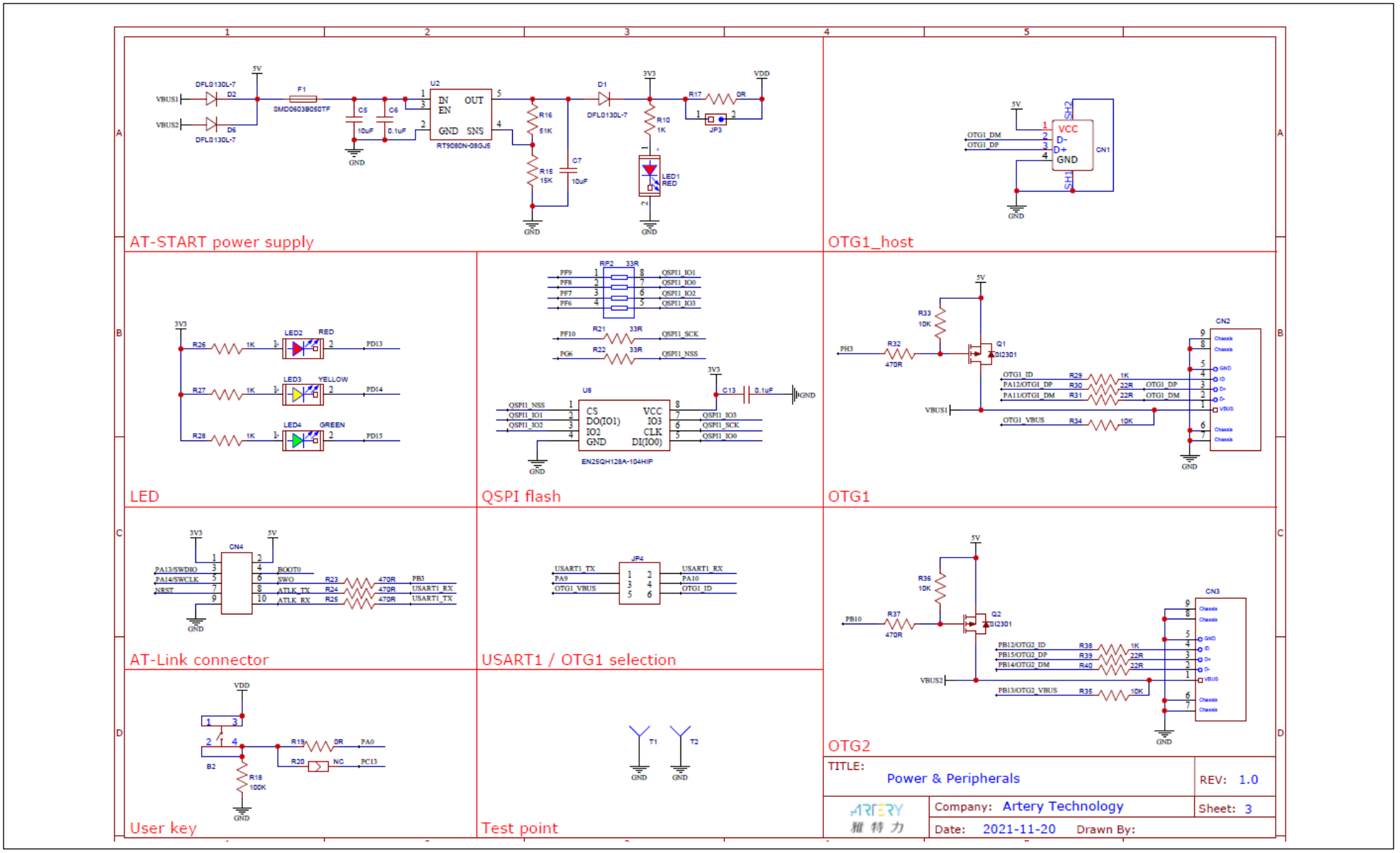


Figure 7. Schematic (extension interfaces)

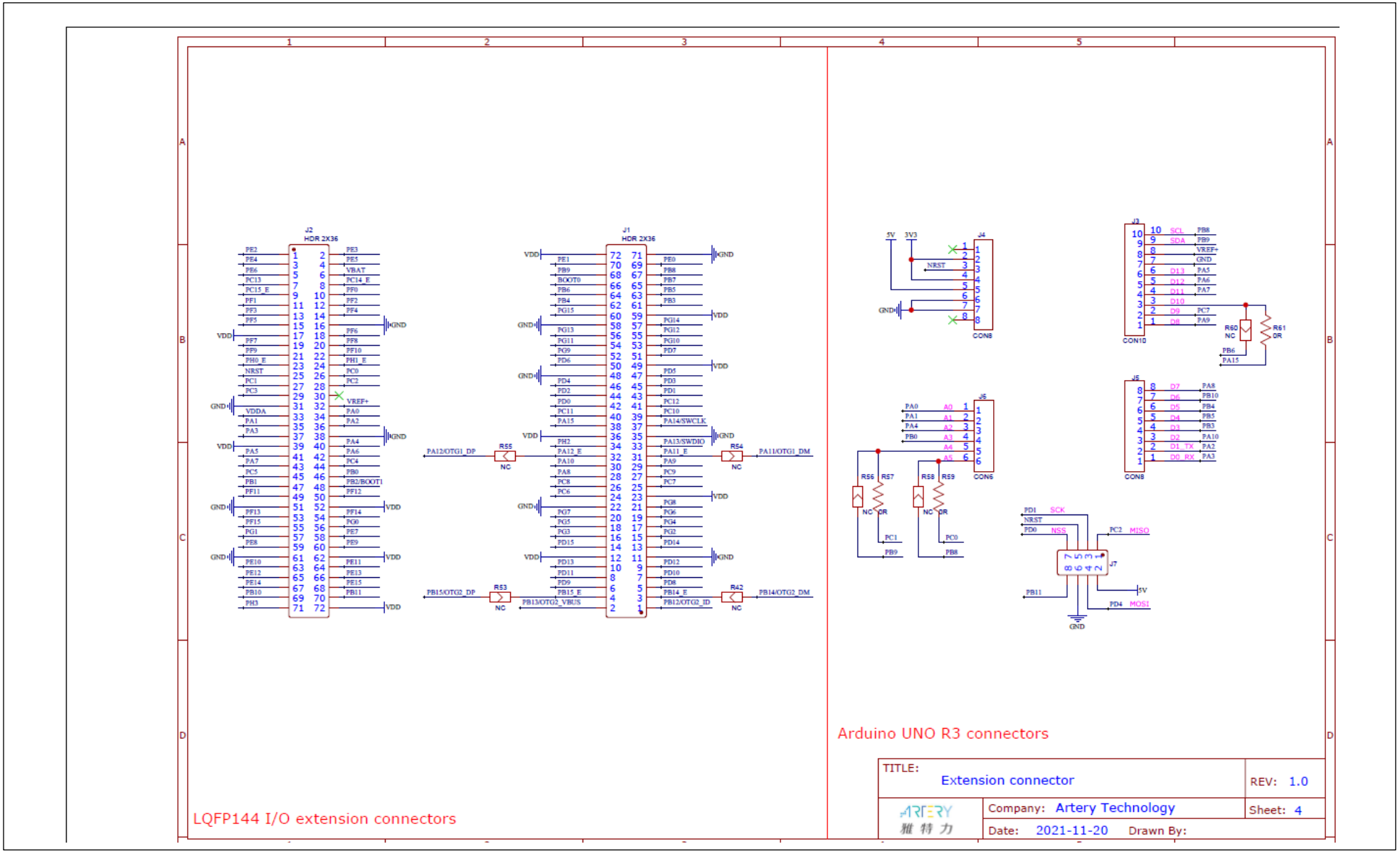
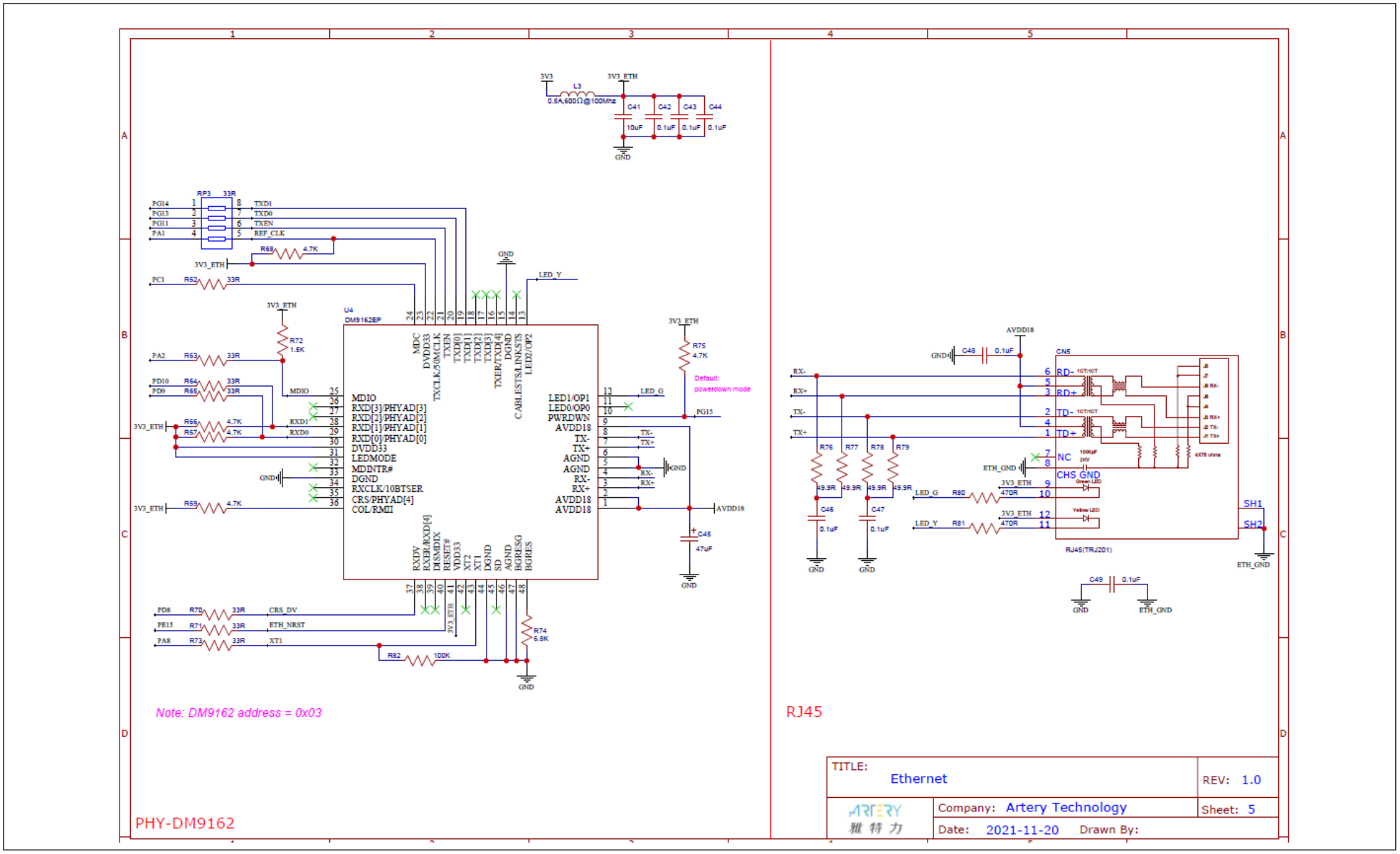


Figure 8. Schematic (Ethernet PHY and RJ45 connector)



5 Revision history

Table 4. Document revision history

Date	Revision	Changes
2021.11.20	1.00	Initial release

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