

Getting started with AT32F423VCT7

Introduction

AT-START-F423 is designed to help you explore the high performance of the 32-bit microcontroller AT32F423 that embeds ARM Cortex®-M4 core, and expedite application development cycle.

AT-START-F423 is an evaluation board based on AT32F423VCT7 microcontroller. It features such peripherals as LEDs, buttons, USB type-C connector and type-A connector, as well as Arduino™ Uno R3 extension connectors. It also comes with an embedded AT-Link-EZ for debugging and programming without the need of other extra development tools.

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1 Overview

1.1 Features

AT-START-F423 has the following characteristics:

- On-board AT32F423VCT7 microcontroller that embeds ARM® Cortex®-M4 32-bit core, 256 KB Flash memory and 48 KB SRAM, in LQFP100 14 x 14 mm package.
- On-board AT-Link interface:
 - Use on-board AT-Link-EZ for programming and debugging purposes (AT-Link-EZ is a simplified version of AT-Link, without offline mode support)
 - AT-Link-EZ can be disassembled from the board by bending it along the joint, and then connect the board to a separate AT-Link for programming and debugging
- Various power supply methods:
 - USB bus of AT-Link-EZ
 - USB OTG bus (V_{BUS}) of AT-START-F423
 - 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) for indicating running status
- User button and Reset button
- 8 MHz HEXT crystal
- 32.768 kHz LEXT crystal
- On-board USB type-C and type-A connectors for OTG function purpose
- Rich extension connectors for quick prototyping:
 - Arduino™ Uno R3 extension connectors
 - LQFP100 I/O extension connectors

1.2 Definition of terms

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

2 Quick start

2.1 Get started

Configure the AT-START-F423 board in the following sequence:

1. Check the Jumper position on board:
JP1 is connected to GND or OFF (BOOT0 = 0, and BOOT0 has a pull-down resistor in the AT32F423VCT7);
JP2 is connected to USART1_TX.
2. Connect AT_Link_EZ to PC via a USB cable (Type A to type-C), 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 User button (B2), the blinking frequency of three LEDs are changed.

2.2 AT-START-F423 development toolchains

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

3 Hardware and layout

AT-START-F423 board is designed around an AT32F423VCT7 microcontroller in LQFP100 14x14 mm package.

[Figure 1](#) shows the connections between AT-Link-EZ, AT32F423VCT7 and their peripherals (buttons, LEDs, USB OTG, and extension connectors)

[Figure 2](#) and [Figure 3](#) shows their respective locations on the AT-Link-EZ and AT-START-F423 board.

Figure 1. Hardware block diagram

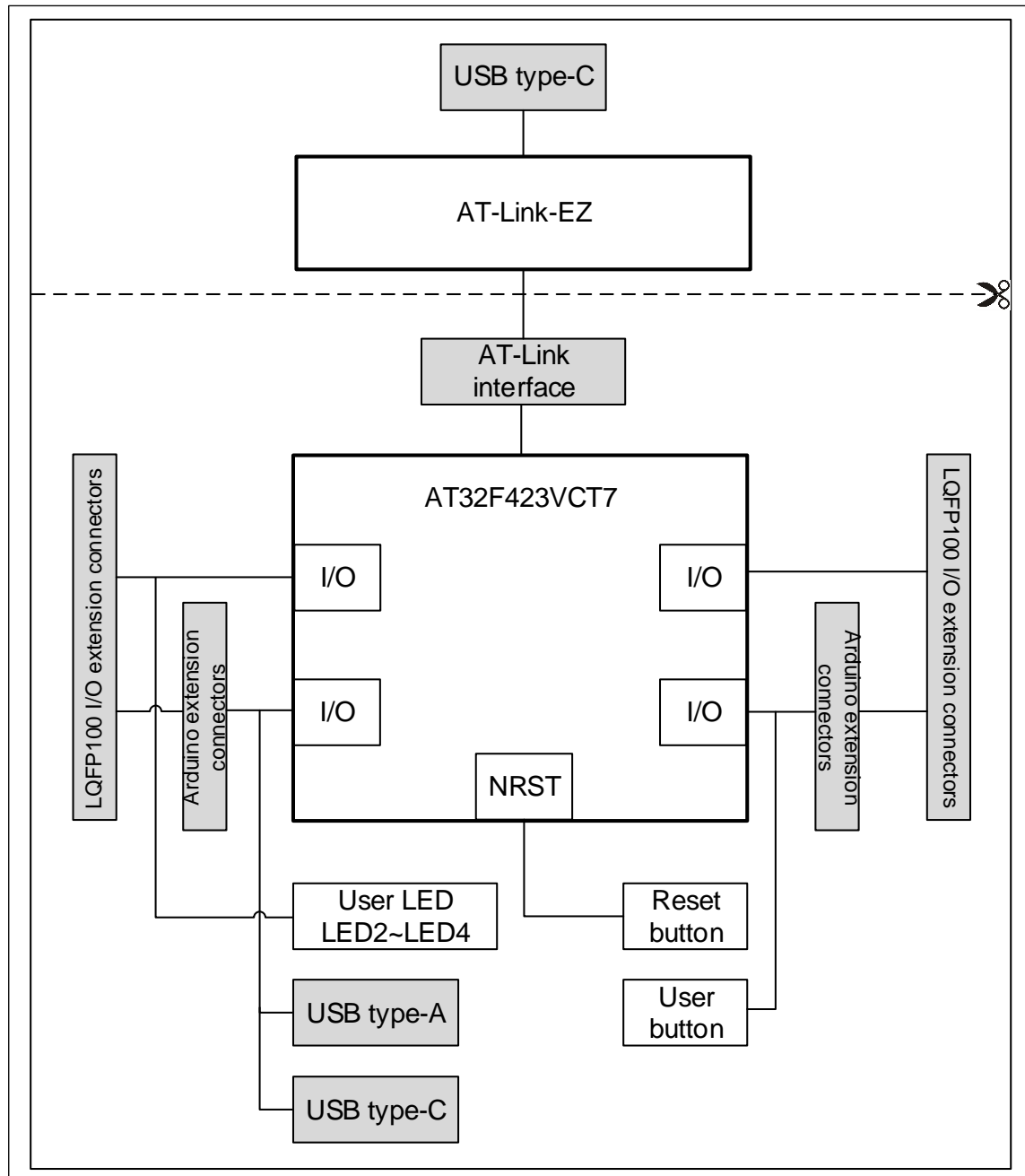


Figure 2. Top layer

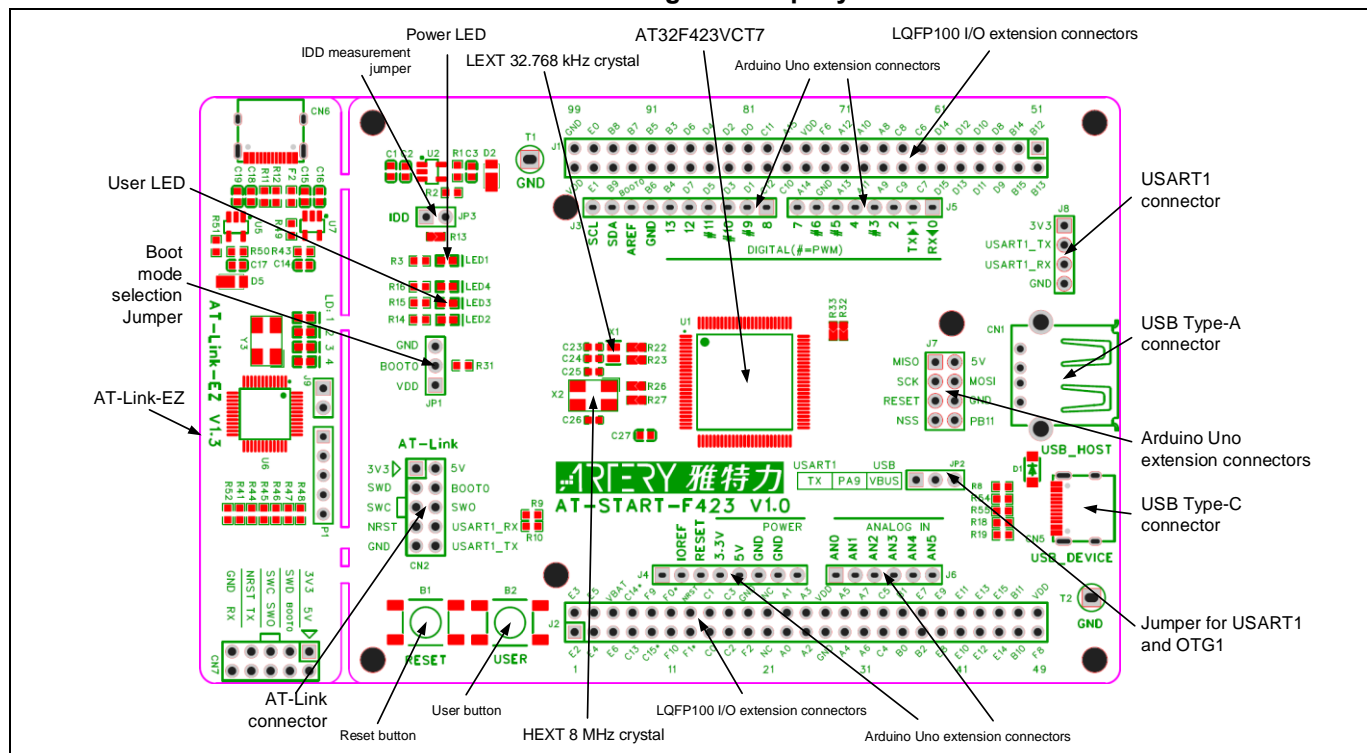
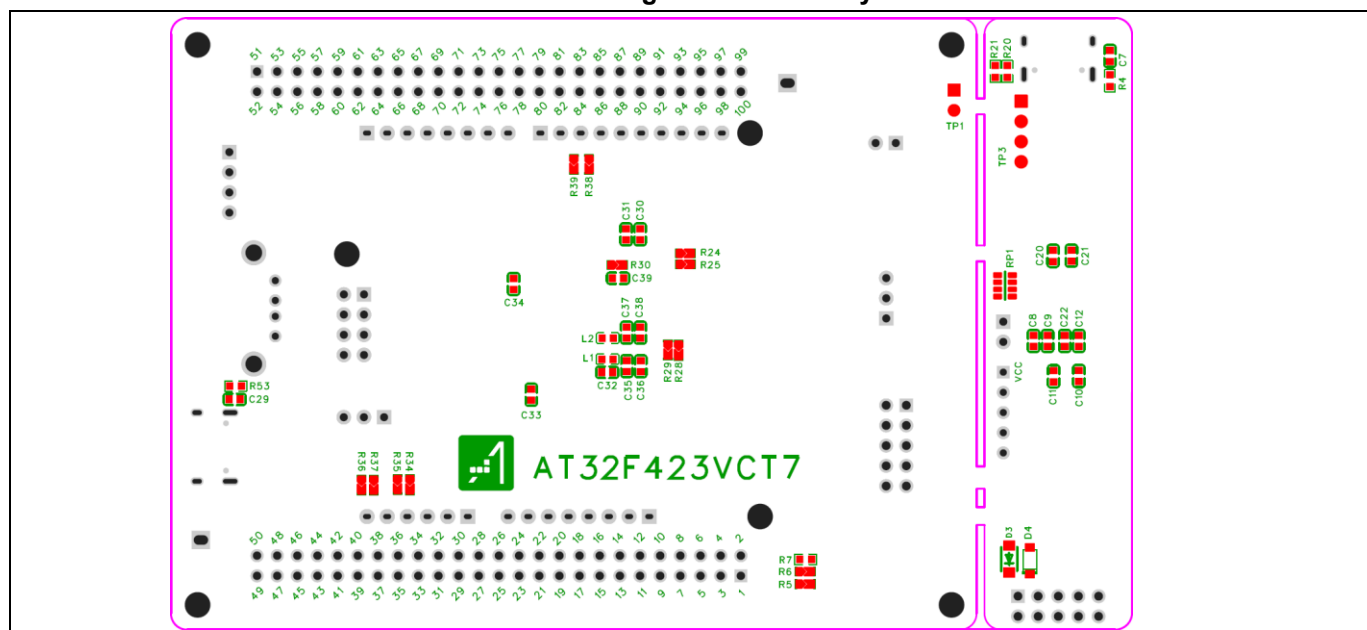


Figure 3. Bottom layer



3.1 Power supply selection

The AT-START-F423 can be provided with 5 V through a USB cable (either USB connector CN6 on AT-Link-EZ or USB OTG connector CN5 on AT-START-F423). It can also be supplied through an external 5 V power supply (E5V). The 5 V provides 3.3 V for the microcontroller and its peripherals using on-board 3.3 V voltage regulator (U2).

The 5 V pin on J4 or J7 can also be used as an input power, meaning that AT-START-F423 board can be supplied via a 5 V supply unit.

The 3.3 V pin on J4, or the VDD pins on J1 and J2, can be directly used as 3.3 V input, meaning that AT-START-F423 board can be supplied through a 3.3 V supply unit.

Note: AT-Link-EZ can only be powered only when 5V is supplied through USB connector CN6 on AT-Link-EZ. Else, the AT-Link-EZ cannot be used.

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

3.2 IDD

When JP3 OFF (symbol IDD) and R13 OFF, an ammeter can be connected to measure the power consumption of AT32F423VCT7.

- **JP3 OFF, R13 ON:**

AT32F423VCT7 is powered on. (JP3 plug is not mounted before shipping, by default)

- **JP3 ON, R13 OFF:**

AT32F423VCT7 is powered on.

- **JP3 OFF, R13 OFF:**

An ammeter must be connected to measure the power consumption of AT32F423VCT7.

(Without ammeter, the AT32F423VCT7 cannot be powered).

3.3 Embedded AT-Link-EZ for programming and debugging

The evaluation board integrates Artery AT-Link-EZ for users to program/debug the AT32F423VCT7 on the AT-START-F423 board. AT-Link-EZ supports SWD interface mode, SWO debugging, and a set of virtual COM port (VCP) that is connected to the USART1_TX/USART1_RX (PA9/PA10) of AT32F423VCT7.

Please refer to [AT-Link User Manual](#) for complete details on AT-Link-EZ.

The on-board AT-Link-EZ can be disassembled or separated from the AT-START-F423. In this case, the AT-START-F423 can use CN2 (not mounted before leaving factory) to be linked to the CN7 (not mounted before leaving factory) of AT-Link-EZ, or to AT-Link, so as to program and debug the AT32F423VCT7.

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	BOOT0 pin configuration	Boot mode
JP1 to GND or OFF	0	Boot from internal Flash memory (factory default setting)
JP1 to VDD	1	Boot from boot memory or internal SRAM ⁽¹⁾

(1) Depending on the nBOOT1 bit of the user system data area.

3.5 External clock sources

3.5.1 HEXT clock sources

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

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

The on-board 8 MHz crystal is used as HEXT clock source when R26 and R27 ON, R28 and R29 OFF.

- **External oscillator PF0**

External oscillator is injected from the 12th pin of J2 when R28 and R29 ON, R26 and R27 OFF.

- **HEXT unused**

PF0 and PF1 are used as GPIOs when R28 and R29 ON, R26 and R27 OFF.

3.5.2 LEXT clock sources

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

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

The on-board 32.768 kHz crystal is used as LEXT clock source when R22 and R23 ON, R24 and R25 OFF.

- **External oscillator PC14**

External oscillator is injected from the 8th pin of J2 when R24 and R25 ON, R22 and R23 OFF.

- **LEXT unused**

PC14 and PC15 are used as GPIOs when R24 and R25 ON, R22 and R23 OFF.

3.6 LED

- **Power LED1**

Red LED indicates that the AT-START-F423 is powered by 3.3 V.

- **User LED2**

Red LED is a user LED that is connected to the PD13 pin of AT32F423VCT7.

- **User LED3**

Yellow LED is a user LED that is connected to the PD14 pin of AT32F423VCT7.

- **User LED4**

Green LED is a user LED that is connected to the PD15 pin of AT32F423VCT7.

3.7 Buttons

- **Reset B1: Reset button**

It is connected to NRST to reset AT32F423VCT7 microcontroller.

- **User B2: User button**

It is connected to the PA0 of AT32F423VCT7 as a wakeup button (R5 ON and R6 OFF). It can also be connected to PC13 to function as TAMPER-RTC button (R5 OFF and R6 ON).

3.8 OTGFS

AT-START-F423 board uses USB type-C connector (CN5) to support USB full-speed device mode, which can directly be connected to a host via USB type-C. The V_{BUS} can be used as 5 V input for AT-START-F423 board.

AT-START-F423 board offers a USB type-A extension connector (CN1) which is a USB full-speed/low-speed host interface used to connect with U disk or mouse.

If the PA9 on the AT32F423VCT7 is to be used as OTG_FS_VBUS, it is necessary to select USB side for JP2 jumper. The PA9 is then connected to USB type-C interface, disconnecting itself from AT-Link interface (CN2).

3.9 0 Ω resistors

Table 2. 0 Ω resistor settings

Resistors	State ⁽¹⁾	Description
R13 (MCU power consumption measurement)	ON	When JP3 OFF, 3.3V is connected to the microcontroller power to supply AT32F423VCT7.
	OFF	When JP3 OFF, 3.3V can be connected to an ammeter to measure the power consumption of the AT32F423VCT7. (AT32F423VCT7 cannot be powered without ammeter)
R26, R27, R28, R29 (HEXT)	ON, ON, OFF, OFF	HEXT clock source comes from on-board crystal X2
	OFF, OFF, ON, ON	HEXT clock source: external oscillator PF0, or when PF0 and PF1 are used as GPIOs.
R22, R23, R24, R25 (LEXT)	ON, ON, OFF, OFF	LEXT clock source comes from on-board crystal X1
	OFF, OFF, ON, ON	LEXT clock source: external oscillator PC14, or when PC14 and PC15 are used as GPIOs.
R5, R6 (User button B2)	ON, OFF	User button B2 is connected to PA0
	OFF, ON	User button B2 is connected to PC13
R33, R32 (PA11, PA12)	OFF, OFF	When used as OTGFS1, PA11 and PA12 are disconnected from the 20 th and 21 th pins of J1.
	ON, ON	When not used as OTGFS1, PA11 and PA12 can be connected to the 20 th and 21 th pins of J1.
R34, R35, R36, R37 (Arduino TM A4, A5)	ON, OFF, OFF, ON	Arduino TM A4 and A5 are connected to ADC1_IN11 and ADC1_IN10
	OFF, ON, ON, OFF	Arduino TM A4 and A5 are connected to I2C1_SDA and I2C1_SCL
R38, R39 (Arduino TM D10)	OFF, ON	Arduino TM D10 is connected to SPI1_CS
	ON, OFF	Arduino TM D10 is connected to PWM (TMR4_CH1)

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

3.10 Extension connectors

3.10.1 Arduino™ Uno R3 connectors

Female plug J3~J6 and male plug J7 support Arduino™ Uno R3 connectors. Most of the daughter boards built on Arduino™ Uno R3 are applicable to AT-START-F423 board.

Note 1: AT32F423VCT7 I/Os are 3.3 V-compatible with Arduino™ Uno R3, but not 5 V.

Note 2: The 8th pin of J3 is AREF pin, used as VREF+ output, equivalent level to VDD and VDDA, without Arduino™ Uno R3-defined AREF feature.

Table 3. Arduino™ Uno R3 extension connector pin definition

Connector	Pin number	Arduino pin name	AT32F423 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	NC	-	-
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	PC1 or PB9 ⁽¹⁾	ADC1_IN11 or I2C1_SDA
	6	A5	PC0 or PB8 ⁽¹⁾	ADC1_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	-
J3 (Logic input/output high byte)	1	D8	PA9	-
	2	D9	PC7	TMR1_CH2
	3	D10	PA15 or PB6 ⁽¹⁾	SPI1_CS or TMR4_CH1
	4	D11	PA7	TMR3_CH2 or SPI1_MOSI
	5	D12	PA6	SPI1_MISO
	6	D13	PA5	SPI1_SCK
	7	GND	-	Ground
	8	AREF	VREF+	VREF+ output
	9	SDA	PB9	I2C1_SDA
	10	SCL	PB8	I2C1_SCL
J7	1	MISO	PB14	SPI2_MISO

Connector	Pin number	Arduino pin name	AT32F423 pin name	Description
(Others)	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_CS
	8	PB11	PB11	-

(1) Refer to [Table 2](#) for details on 0Ω resistors.

3.10.2 LQFP100 I/O extension connectors

The I/O ports of AT32F423VCT7 can be connected to external devices through extension connectors J1 and J2. All I/Os on the AT32F423VCT7 are applicable to such extension connectors. Both J1 and J2 can be measured with oscilloscope, logic analyzer or voltmeter.

4 Revision history

Table 4. Document revision history

Date	Revision	Changes
2023.3.12	1.00	Initial release

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