Getting started with AT32A403AVGT7

Introduction

AT-START-A403A evaluation board is designed to help you experience the high-performance of the 32-bit microcontroller, the ARM Cortex®-M4-based AT32A403A with FPU, and expedite development cycles and shorten the time to the market.

AT-START-A403A is an evaluation board based on AT32A403AVGT7 microcontroller. It features LEDs, buttons, a USB micro-B connector, Ethernet RJ45 connector, Arduino™ Uno R3 extension connectors and an extended 16 MB SPI Flash memory. 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.

Contents

List of tables

List of figures

1 Overview

1.1 Features

AT-START-A403A has the following features:

- ARM Cortex®-M4 core-based 32-bit AT32A403AVGT7 microcontroller that is certified by AEC Q-100 Grade 2, with 1024 KB internal Flash memory and 96+128 KB SRAM, in LQFP100 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 edition of AT-Link, without offline support mode)
  - If AT-Link-EZ is separated from the board by bending it along the joint, the AT-START-A403A can be connected to an independent AT-Link for programming and debugging
- On-board 20-pin ARM standard JTAG connector (connected to JTAG or SWD for programming/debugging)
- 16 MB SPI Flash (model EN25QH128A) is used as an extended Flash memory Bank 3
- Power supply source:
  - USB bus of AT-Link-EZ
  - USB bus (V_{BUS}) of AT-START-A403A
  - 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
- USB micro-B connector
- Ethernet PHY with RJ45 connector
- Rich extension connectors:
  - Arduino™ Uno R3 extension connectors
  - LQFP100 I/O extension connectors

1.2 Definition of terms

- **Jumper JPx ON**

  Jumper fitted
- **Jumper JPx OFF**

  Jumper 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-A403A board in the following sequence:

1. Check the Jumpers' position on board:

   JP1 is connected to GND or OFF (BOOT0 = 0, and BOOT0 has an internal pull-down resistor in the AT32A403AVGT7)

   JP4 is connected to GND (BOOT1= 0)

   JP8 one-piece jumper is connected to the I/O on the right side

2. Connect the AT-Link-EZ 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 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-A403A

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

3 Hardware layout and configuration

AT-START-A403A board is designed around AT32A403AVGT7 microcontroller in LQFP100 package.

Figure 1 shows the connection between AT-Link-EZ, AT32A403AVGT7 and their peripherals (buttons, LEDs, USB, Ethernet RJ45, SPI and extension connectors)

Figure 2 and *Figure 3* show their respective positions on the AT-Link-EZ and AT-START-A403A.

Figure 1. Hardware block diagram

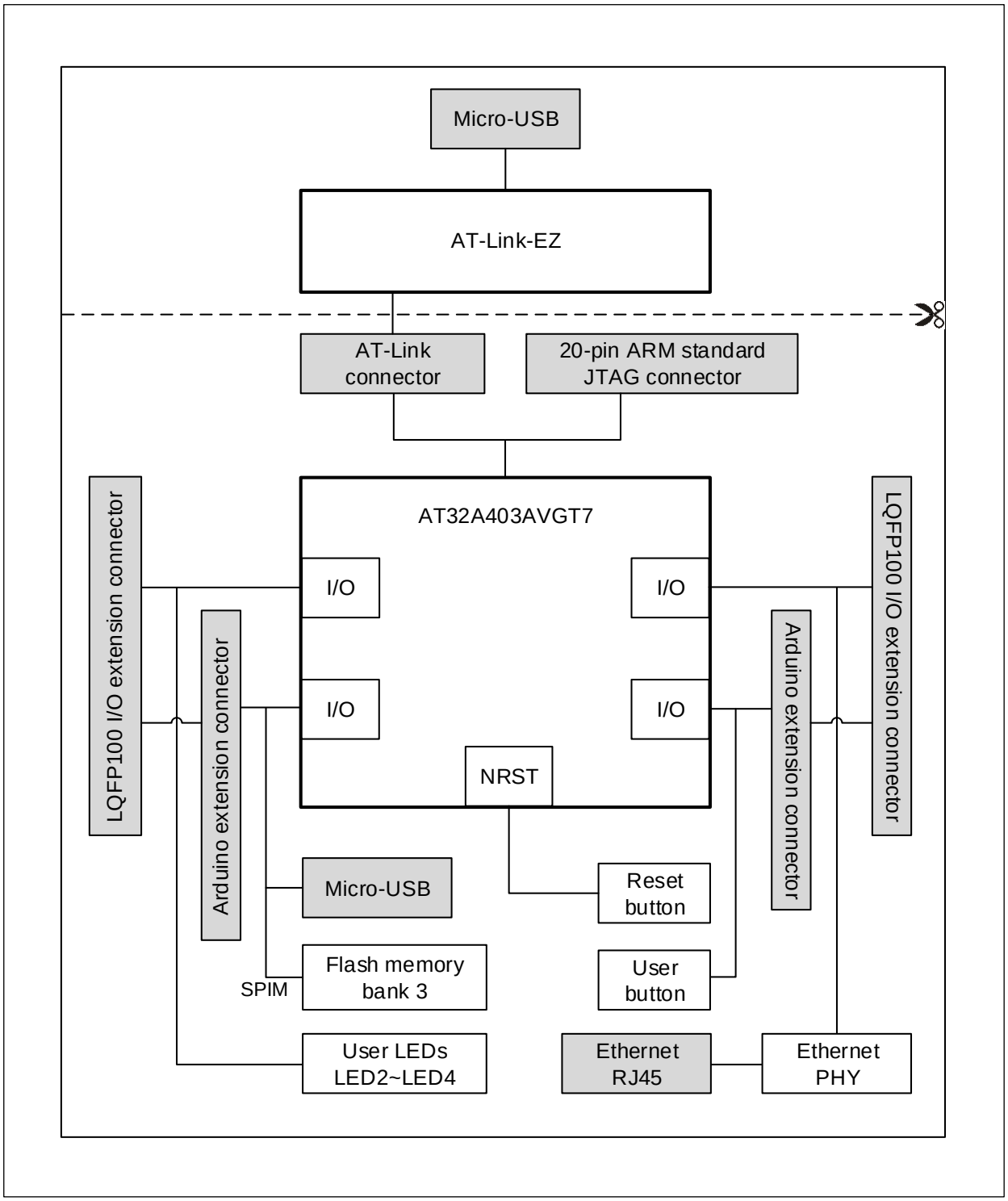


Figure 2. Top layer

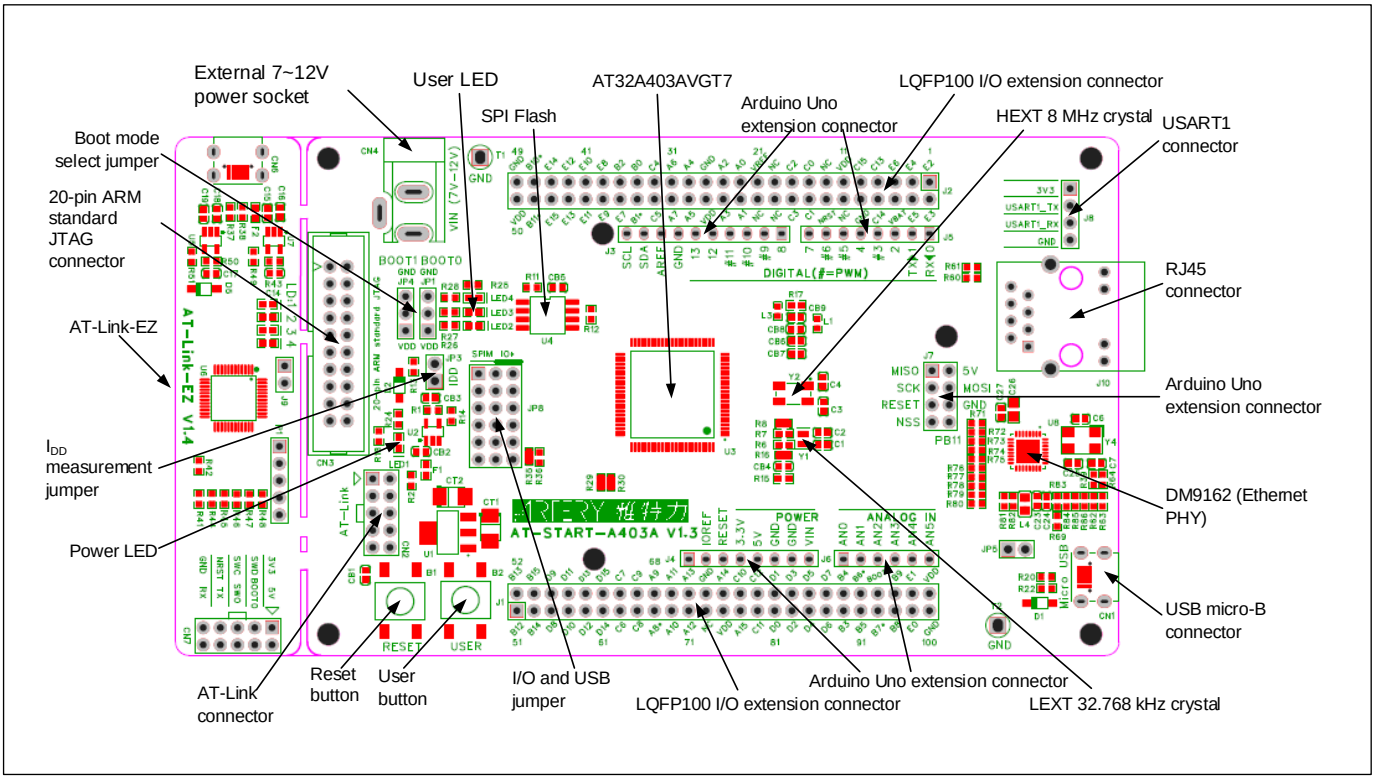
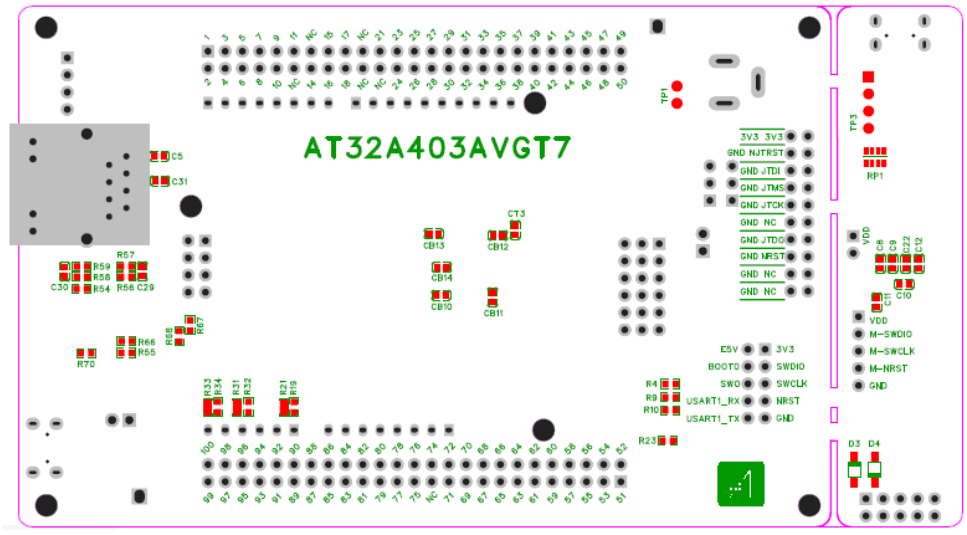


Figure 3. Bottom layer



3.1 Power supply sources

The 5 V power supply source required for AT-START-A403A can be from the USB cable (through USB connector CN6 on the AT-Link-EZ or USB connector CN1 on the AT-START-A403A), from an external 5 V (E5V), or from an external 7~12 V (VIN) which can provide the desired 5 V through 5 V voltage regulator (U1) on board. Then the 5 V power supply provides the 3.3 V to the microcontroller and peripherals via 3.3 V voltage regulator U2 on board.

The 5 V pin of J4 or J7 can also be used as an input power source. Then the AT-START-A403A 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-A403A 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, 5 V and 3.3 V pins can be used as output power supply, 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 AT32A403AVGT7.

- **JP3 OFF, R13 ON**

  AT32A403AVGT7 is powered. (Default setting, and JP3 plug is not mounted before shipping)

- **JP3 ON, R13 OFF**

  AT32A403AVGT7 is powered.

- **JP3 OFF, R13 OFF**

  An ammeter must be connected to measure the power consumption of AT32A403AVGT7 (if no ammeter, the AT32A403AVGT7 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 AT32A403AVGT7 on the AT-START-A403A board. AT-Link-EZ supports SWD interface mode, and SWO debugging. It offers a virtual COM port (VCP) to be connected to the USART1_TX/USART1_RX (PA9/PA10) of the AT32A403AVGT7.

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

The AT-Link-EZ PCB on board can be separated from the AT-START-A403A by bending it along the joint. In this case, the AT-START-A403A can still be connected to the connector CN7 of AT-Link-EZ through CN2 (it is not mounted before shipping). Besides, it can be connected with another AT-Link tool to continue programming and debugging the AT32A403AVGT7.

3.3.2 20-pin ARM® standard JTAG connector

AT-START-A403A also reserves JTAG or SWD general-purpose connector as programming/debugging tool. If the user wants to use this interface to program and debug the AT32A403AVGT7, it is necessary to separate the AT-Link-EZ from the board or turn R41, R44 and R46 OFF, and then connect CN3 (not mounted before shipping) to the programming and debugging tool.

Artery microcontrollers are highly compatible with most of the third-party development tools in the market. However, it is still recommended to use AT-Link related tools for better debugging experience.

3.4 Boot mode selection

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

Table 1. Boot mode selection

Jumper	Pin configuration		Description
	BOOT1	BOOT0	
JP1 connected to GND or OFF; JP4 connected to an arbitrary position or OFF	X(1)	0	Boot from the internal Flash memory (Factory default setting)
JP1 connected to VDD JP4 connected to GND	0	1	Boot from the system memory
JP1 connected to VDD JP4 connected to VDD	1	1	Boot from SRAM

(1) JP4 connected to GND is recommended when PB2 function is not use.

3.5 External clock source

3.5.1 HEXT clock source

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

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 on-board 32.768 kHz crystal is used as LEXT clock source.
  Hardware settings: R6 and R7 must be ON, and R5, R8 OFF.

- **External 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, indicates that the board is powered by 3.3 V

- **User LED2**

  Red color, connected to the PD13 pin of the AT32A403AVGT7

- **User LED3**

  Yellow color, connected to the PD14 pin of the AT32A403AVGT7

- **User LED4**

  Green color, connected to the PD15 pin of the AT32A403AVGT7

3.7 Buttons

- **Reset button B1**

  Connected to NRST to reset AT32A403AVGT7

- **User button B2**

  By default, it is connected to the PA0 of the AT32A403AVGT7 and used as a wake-up button (R19 ON, R21 OFF) as alternate function; or it is connected to PC13 and used as TAMPER-RTC button (R19 OFF, R21 ON) as alternate function.

3.8 USB device

AT-START-A403A board supports USB full-speed device communication via USB micro-B connector (CN1). The V_{BUS} can be used as 5 V power supply of the AT-START-A403A board.

3.9 Connecting Flash memory Bank 3 via SPIM interface

The SPI Flash EN25QH128A on board, which is connected to the AT32A403AVGT7 via SPIM interface, is used as an extended Flash memory bank 3.

To use Flash memory bank 3, the one-piece jumper JP8 must be connected to SPIM on the left side as shown in *Table 2*. The PB1, PA8, PB10, PB11, PB6 and PB7 are not connected to the external LQFP100 I/O extension connector. These 6 pins are marked by adding [*] after the pin name of extension connectors on the PCB silkscreen.

Table 2. GPIO and SPIM jumper settings

Jumper	Description
JP8 connected to I/O	Used as I/Os and Ethernet MAC function (Default setting before shipping)
JP8 connected to SPIM	Used as SPIM

3.10 Ethernet

The AT-START-A403A embeds an Ethernet PHY DM9162 (U8) and RJ45 connector (J10, internal isolation transformer) to support 10/100 Mbps dual-speed Ethernet communication.

To use Ethernet MAC, the JP8 one-piece jumper must be connected to the IO on the right side, as shown in *Table 2*. The PA8, PB10 and PB11 are connected to the external LQFP100 I/O extension connector.

By default, Ethernet PHY is connected to the AT32A403AVGT7 in RMII mode. In this case, the 25 MHz clock required for PHY is provided by Y4 crystal, by default. In addition, it is possible to solder 49.9 Ω and 100 kΩ onto R39 and R64 respectively, and then desolder Y4, C6 and C7. In such case, it is the CLKOUT (PA8) pin of the AT32A403AVGT7 that provides 25 MHz clock to the XT1 pin of PHY. For RMII_REF_CLK (PA1) of the AT32A403AVGT7, its 50 MHz clock source is provided by the 50MCLK pin of PHY. Note that the 50MCLK pin must be pulled up at power-on.

Besides, Ethernet PHY and AT32A403AVGT7 can be connected in MII mode. To do so, users need to modify resistors according to the footnotes shown in Schematics on page 5. In this case, the TXCLK and RXCLK of PHY are connected to the MII_TX_CLK (PC3) and MII_RX_CLK (PA1) of the AT32A403AVGT7, respectively.

Note that the AT32A403AVGT7 is connected to the PHY based on remapping 1 pin configuration.

To simplify PCB design, the PHY does not have an external Flash memory to allocate the PHY address [3:0] at power-on. The PHY address [3:0] is set to 0x0 by default. After power-on, it is possible to re-configure PHY address through the SMI interface of PHY.

For complete information on Ethernet MAC and DM9162 of the AT32A403AVGT7, please refer to their respective technical manual and data sheet.

If the LQFP100 I/O extension connectors J1 and J2, rather than DM9162, are used to connect to other Ethernet application board, please refer to *Table 3* to disconnect AT32A403AVGT7 from DM9162.

While evaluating other functions of the AT32A403AVGT7 without using Ethernet, it is recommended to put DM9162 in reset state by enabling PC8 output low.

3.11 0 Ω resistors

Table 3. 0 Ω resistor settings

Resistors	State(1)	Description
R13 (Microcontroller power consumption measurement)	**ON**	When JP3 OFF, the microcontroller is directly powered by 3.3 V
	OFF	When JP3 OFF, an ammeter can be connected to 3.3 V to measure power consumption of the microcontroller (if no ammeter, the microcontroller cannot be powered)
R4 (V_{BAT} power supply)	**ON**	V_{BAT} is connected to VDD
	OFF	V_{BAT} can be powered by the pin_6 V_{BAT} of J2
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 external PC14, or PC14, and PC15 is used as GPIO.
R17 (V_{REF+})	**ON**	V_{REF+} is connected to VDD
	OFF	V_{REF+} is connected to the pin_21 of J2, or to the AREF of Arduino™ connector J3
R19, R21 (User button B2)	**ON, OFF**	User button B2 is connected to PA0
	OFF, ON	User button B2 is connected to PC13
R29, R30 (PA11, PA12)	**OFF, OFF**	When PA11 and PA12 are used as USB, they are not connected to the pin_20 and pin_21 of J1.
	ON, ON	When PA11 and PA12 are not used as USB, they can be connected to the pin_20 and pin_21 of J1.
R62~R63, R66~R86 (Ethernet PHY DM9162 signals)	**See the footnotes of Schematics on page 5**	Ethernet MAC of AT32A403AVGT is connected to DM9162 through RMII mode (R66 and R70 are 4.7 kΩ)
	See the footnotes of Schematics on page 5	Ethernet MAC of AT32A403AVGT is connected to DM9162 through MII mode
	All OFF except R66 and R70	Ethernet MAC of AT32A403AVGT is disconnected from DM9162
R39, R64 (Ethernet PHY DM9162 clock input)	**OFF, OFF**	Y4 crystal is used as DM9162 clock source
	ON, ON	The CLKOUT (PA8) of the AT32A403AVGT is used as DM9162 clock source
R31, R32, R33, R34 (Arduino™ A4, A5)	**OFF, ON, OFF, ON**	Arduino™ A4, A5 are connected to ADC_IN11 and ADC_IN10
	ON, OFF, ON, OFF	Arduino™ A4, 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 (TMR4_CH1)

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

3.12 Extension connectors

3.12.1 Arduino™ Uno R3 extension connectors

Female plug J3~J6 and male J7 support standard Arduino™ Uno R3 connectors. Most of the daughterboards designed around Arduino™ Uno R3 are applicable to AT-START-A403A.

Note 1: The I/O ports of AT32A403AVGT7 are 3.3 V compatible with Arduino™ Uno R3, but 5V not.

Note 2: R17 must be OFF if there is a need to supply the pin 8 (AREF) of the J3 on the AT-START-A403A to the V_{REF+} on the AT32A403AVGT7 through the Arduino™ Uno R3 daughterboard.

Table 4. Arduino™ Uno R3 extension connectors

Connectors	Pin No.	Arduino pin name	AT32A403A pin name	Function
J4 (Power)	1	NC	-	-
	2	IOREF	-	3.3V reference voltage
	3	RESET	NRST	External reset
	4	3.3V	-	3.3V input/output
	5	5V	-	5V input/output
	6	GND	-	Ground
	7	GND	-	Ground
	8	VIN	-	7~12V input/output
J6 (Analog input)	1	AN0	PA0	ADC123_IN0
	2	AN1	PA1	ADC123_IN1
	3	AN2	PA4	ADC12_IN4
	4	AN3	PB0	ADC12_IN8
	5	AN4	PC1 or PB9(1)	ADC123_IN11 or I2C1_SDA
	6	AN5	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)(2)	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	-	V_{REF+} input/output
	9	SDA	PB9	I2C1_SDA
	10	SCL	PB8	I2C1_SCL

Connectors	Pin No.	Arduino pin name	AT32A403A pin name	Function
J7 (Others)	1	MISO	PB14	SPI2_MISO
	2	5V	-	5V 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) 0 Ω resistor settings are shown in *Table 3*.
(2) SPIM must be disabled and JP8 must select I/O side, otherwise PA8 and PB6 cannot be used.

3.12.2 LQFP100 I/O extension connectors

The extension connectors J1 and J2 are used to connect the IO ports of the AT-START-A403A to external devices. All the I/O ports of AT32A403AVGT7 are accessible. Besides, J1 and J2 can be measured with the oscilloscope, logic analyzer or voltmeter probe.

Note 1: R17 must be OFF if it is necessary to supply the pin 21 (V_{REF+}) of the J2 on the AT-START-A403A with an external power supply.

4 Revision history

Table 5. Document revision history

Date	Revision	Changes
2020.2.14	1.0	Initial release
2020.5.12	1.1	1.Changed LED3 to yellow 2. Connected the TXEN of DM916 to PB11_E, not directly linked to AT32A403A 3. Changed the 51 Ω wire-wound resistor between AT32A403A and DM9162 to 0 Ω bridge so that AT32A403A can be completely disconnected from DM9162.
2020.9.23	1.11	1. Changed the revision code of this document to 3 digits, with the first two indicating AT-START hardware version, and the last one for the document version. 2. Added recommendation on DM9162 usage in Section 3.9.
2020.11.20	1.20	1. Updated the version of AT-Link-EZ to 1.2, and adjusted two rows of CN7 signals, and modified the silkscreen. 2. Changed the CN2 silkscreen according to Artery development tools. 3. Added GND test pin ring for measurement purposes 4. Optimized power layout and added a pull-down resistor R39 of DM9162 XT1 pin to eliminate the disturbance from DM9162 TXCLK clock. 5. Removed the 0 Ω resistor between the unused pins and microcontroller when DM9162 is in RMII mode.
2023.11.27	1.30	Added Ethernet MAC function

IMPORTANT NOTICE – PLEASE READ CAREFULLY

Purchasers are solely responsible for the selection and use of ARTERY's products and services, and ARTERY assumes no liability whatsoever relating to the choice, selection or use of the ARTERY products and services described herein

No license, express or implied, to any intellectual property rights is granted under this document. If any part of this document deals with any third party products or services, it shall not be deemed a license granted by ARTERY for the use of such third party products or services, or any intellectual property contained therein, or considered as a warranty regarding the use in any manner of such third party products or services or any intellectual property contained therein.

Unless otherwise specified in ARTERY's terms and conditions of sale, ARTERY provides no warranties, express or implied, regarding the use and/or sale of ARTERY products, including but not limited to any implied warranties of merchantability, fitness for a particular purpose (and their equivalents under the laws of any jurisdiction), or infringement on any patent, copyright or other intellectual property right.

Purchasers hereby agree that ARTERY's products are not designed or authorized for use in: (A) any application with special requirements of safety such as life support and active implantable device, or system with functional safety requirements; (B) any aircraft application; (C) any aerospace application or environment; (D) any weapon application, and/or (E) or other uses where the failure of the device or product could result in personal injury, death, property damage. Purchasers' unauthorized use of them in the aforementioned applications, even if with a written notice, is solely at purchasers' risk, and Purchasers are solely responsible for meeting all legal and regulatory requirements in such use.

Resale of ARTERY products with provisions different from the statements and/or technical characteristics stated in this document shall immediately void any warranty grant by ARTERY for ARTERY's products or services described herein and shall not create or expand any liability of ARTERY in any manner whatsoever.