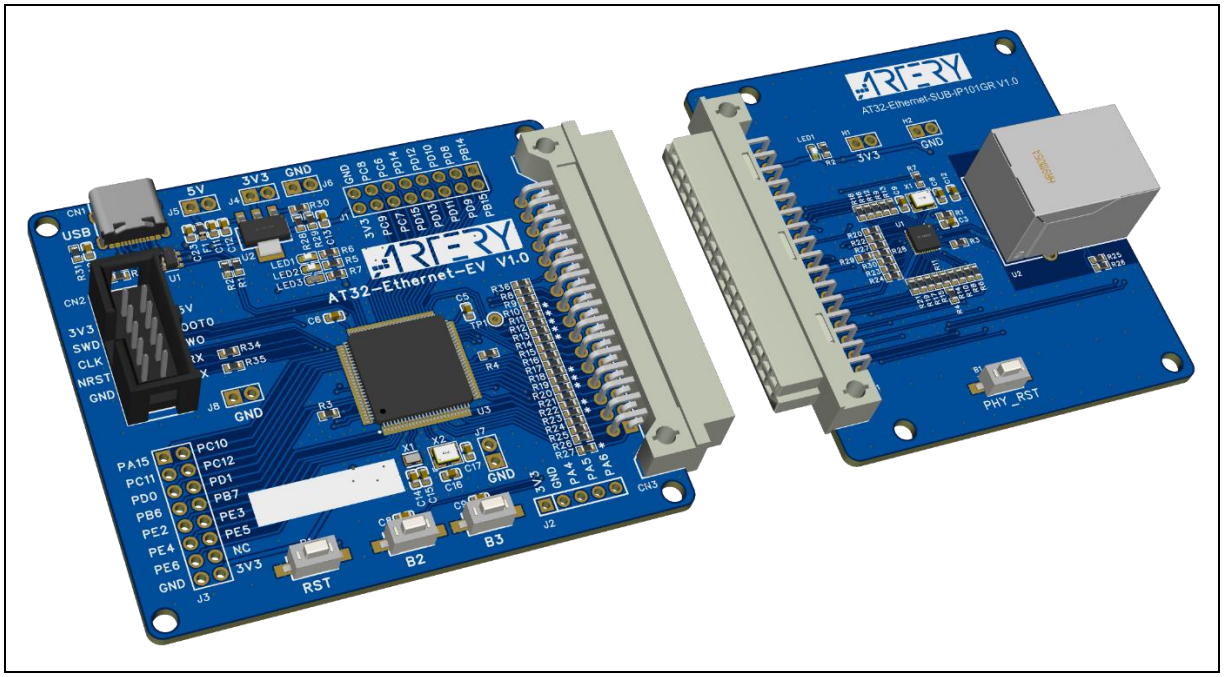
Introduction

The AT32-Ethernet-EV evaluation board is designed to help users shorten development cycle of Ethernet application solutions and expedite project development. It consists of a main board and a daughterboard. The main board features an ARTERY's microcontroller with EMAC function. It is connected to a PHY chip daughterboard for Ethernet communication. The AT32-Ethernet-EV also offers a rich set of daughterboards (named AT32-Ethernet-Sub-xxxxx) to be compatible with common used Ethernet PHY chips, so as to meet the minimum system application design requirements.

Figure 1. AT32-Ethernet-EV evaluation board and daughterboard



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1 Overview

AT32-Ethernet-EV has the following features:

- AT32 microcontroller with EMAC, in LQFP100 package
- Multiple power-supply options:
  - AT-Link connector with +5V or 3V3 pin (CN2)
  - USB connector (CN1)
  - External 5 V power supply
  - External 3.3 V power supply
- Clock sources:
  - 25 MHz HEXT crystal
  - 32.768 kHz LEXT crystal
- Color LEDs:
  - LED1 (red) indicates that the 3.3 V power of the board is supplied
  - LED2 (green) and LED3 (blue) indicate operation status
- User interfaces:
  - 2x User buttons and 1x Reset button

The daughterboard (AT32-Ethernet-Sub-xxxxx) has the following features:

- Connected to AT32 MCU on the main board in RMII mode by default. MII mode connection is also supported by soldering/de-soldering several components
- Different daughterboards use different PHY chips, which include:
  - DP83848C (TI)
  - IP101GR (IC Plus)
  - KSZ8041TL (Microchip)
  - LAN8720A (Microchip), for RMII mode only
  - RTL8201F (Realtek)
  - YT8512 (MotorComm)
- RJ45 connector with status LEDs
- Some daughterboards with 50 MHz oscillator or reserved 25 MHz crystal, optional PHY clock sources
- 1x Reset button for PHY chip

2 Quick start guide

2.1 Getting started

Configure the AT32-Ethernet-EV board in the following sequence:

1. Connect the main board and the daughterboard, and confirm that the AT32 MCU is programmed with corresponding PHY driver firmware
2. Connect USB connector CN1 to PC via USB cable (Type-A to Type-C) so that the board is powered
3. Two LED1 (red) are always being ON, respectively on the main board and the daughterboard
4. Connect RJ45 connector to the internet, getting ready for data transmission

2.2 Development toolchains

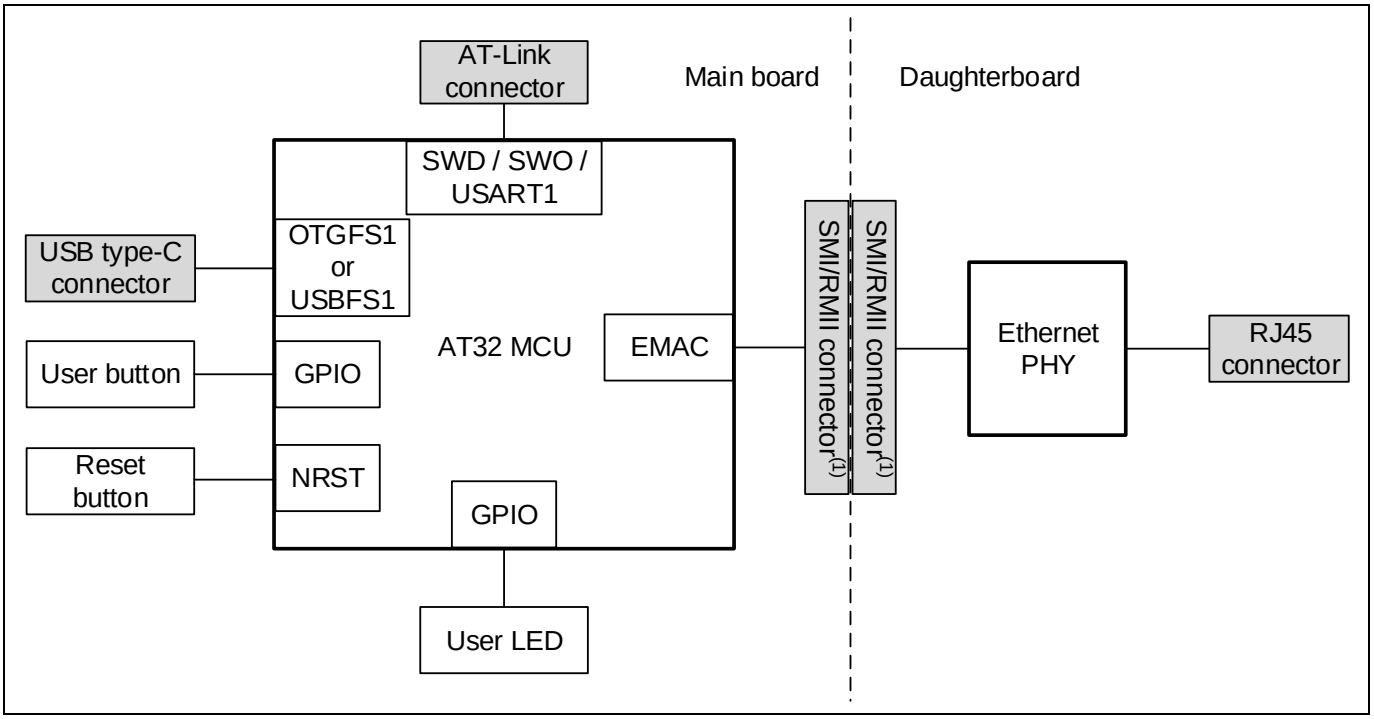
- ARM® Keil®: MDK-ARM™
- IAR™: EWARM
- AT32 IDE

3 Hardware layout and configuration

The AT32-Ethernet-EV board is designed around an AT32 MCU with EMAC feature, with the aim of better demonstrating Ethernet communication. It is designed in a way where a main board gets docked with a daughterboard so as to achieve connection between AT32 MCU and various PHY chips, taking into account the fact that there is a low level of compatibility among PHY chips of different manufacturers, and their differences in pins, features and configuration. The combination mode of main board and daughterboard allows users to select the daughterboard with desired PHY for development and verification. At the same time, ARTERY will continue to develop a wide range of PHY daughterboards to meet diversified market needs.

Figure 2 illustrates the connection between AT32 MCU and the peripherals on the AT32-Ethernet-EV board. *Figure 3* and *Figure 4* can help users to locate these features on the evaluation board.

Figure 2. Hardware block diagram



(1) Default settings before shipping.

Figure 3. Top layer

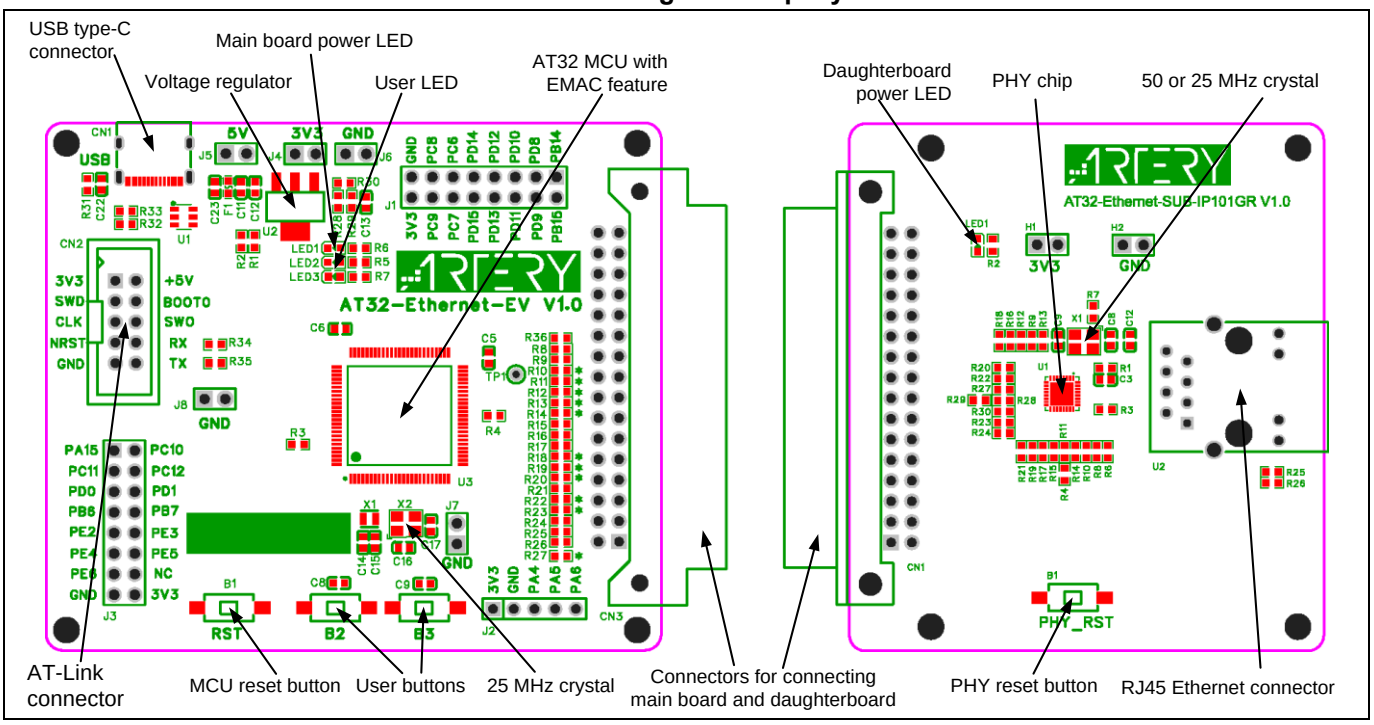
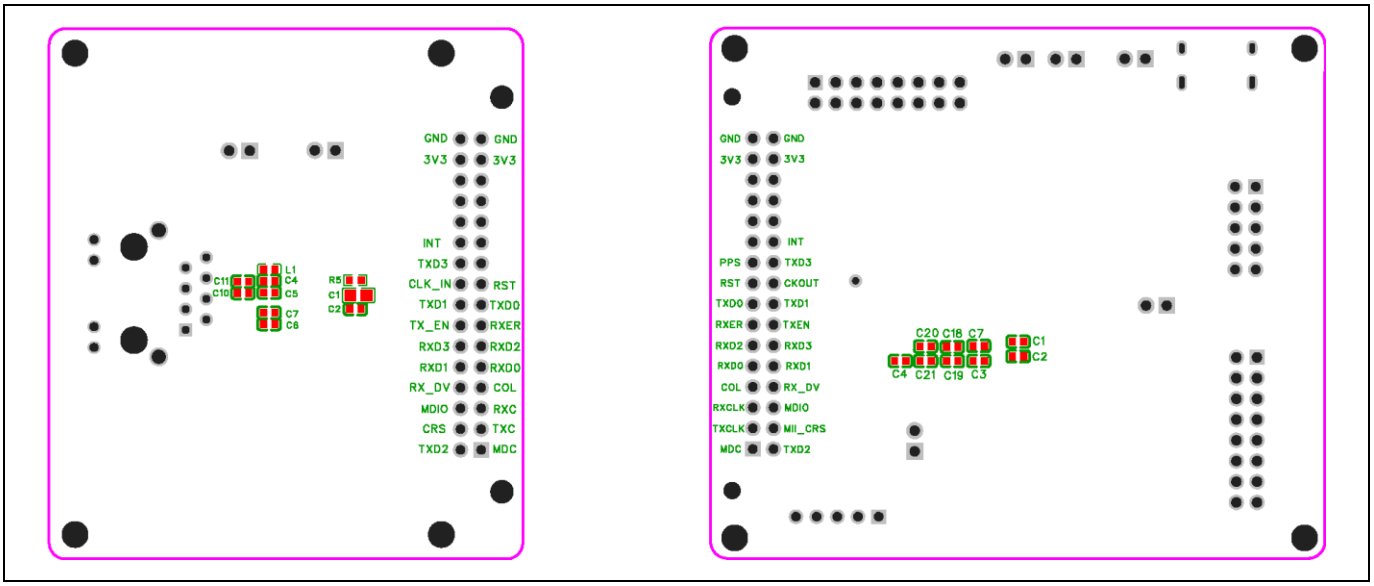


Figure 4. Bottom layer



3.1 Power supply sources

The 5 V power supply required for the AT32-Ethernet-EV board can be provided by connecting USB type-C connecter (CN1) to PC via USB cable, or by the AT-Link connector (CN2) on the main board. Then the 5 V power supply provides the 3.3 V to the microcontroller through a power voltage regulator (U2) on board, which is then used to supply the daughterboard via the CN3 (connected to CN1 on the daughterboard).

When the AT32-Ethernet-EV is being powered, both LED1 (red) on the main board and the daughterboard will be always ON.

3.2 AT-Link connector for programming and debugging

The evaluation board offers an AT-Link connector (CN1) for users to connect it with AT-Link tool for programming/debugging the AT32 microcontroller on the AT32-Ethernet-EV main board. The AT-Link supports SWD interface mode and SWO debugging. It also supports a virtual COM port (VCP) to be connected to the USART1_TX/USART1_RX (PA9/PA10) of the AT32 microcontroller.

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

3.3 Ethernet

The AT-Ethernet-EV can work in conjunction with daughterboards with various types of Ethernet PHY chips. The RJ45 connector (with an internal isolation transformer) is available on the daughterboard for 10/100 Mbps Ethernet communication.

By default, the Ethernet PHY is connected to the AT32 microcontroller in RMII mode. Users can also change it to MII mode according to their needs by soldering/de-soldering several resistors based on the schematics of the corresponding daughterboard.

In order to simply PCB design, the PHY is not externally connected to Flash memory to allocate the PHY address during power-on. Thus the PHY address is set to 0x01 by default. After a power-on session, it is possible to define a new PHY address by software through PHY's SMI interface.

For details on AT32 microcontroller's EMAC features and PHY chips, please refer to their datasheet and reference manual at ARETERY's official website.

3.4 External clock source

The master clock of the Ethernet chip must be provided by an external precise clock source. For the AT32 microcontroller, its HEXT can be provided by a 25 MHz crystal (X2) on the main board, while its LEXT comes from a 32.768 kHz crystal (X1) on the main board. If RMII mode is to be used, the 50 MHz clock for the EMAC_RMII_REF_CLK is provided by an oscilltor or PHY reference clock output on the daughterboard.

For the daughterboard, different PHY chips have different clock requirements. If the PHY requires a 50 MHz clock, it can be provided by an oscillator on the daughterboard; if it requires a 25 MHz clock, it is provided through the CLKOUT output on the AT32 microcontroller of the main board, by default. At the same time, it can also be provided by a 25 MHz crystal oscillator that is reserved on the daughterboard as a flexible and alternative option. (Note that 25 MHz crystal oscillator and its capacitors are not mounted by default).

3.5 LEDs

- **Power LED1 on main board and daughterboard**

  Red LED indicates that the AT32-Ethernet-EV board is being powered.
- **User LED2 on main board**

  Green User LED is connected to the PE0 pin of the AT32 microcontroller.
- **User LED3 on main board**

  Blue User LED is connected to the PE1 pin of the AT32 microcontroller.

3.6 Buttons

- **Main board Reset button B1: reset microcontroller**

  It is connected to the NRST pin of the AT32 microcontroller for reset purpose.
- **Daughterboard Reset button B1: reset PHY**

  It is connected to the reset pin of the PHY chip for reset purpose.
- **Main board Use button B2: user button**

  It is connected to the PE13 pin of the AT32 microcontroller.
- **Main board User button B3: user button**

  It is connected to the PE14 pin of the AT32 microcontroller.

3.7 OTGFS or USBFS connector

The AT32-Ethernet-EV main board is connected to the OTGFS1 or USBFS1 interface of the AT32 microcontroller through USB type-C connector (CN1) for data transmission. The V_{BUS} of CN1 is used as a 5 V power input of the AT32-Ethernet-EV board.

4 Pin assignment

The table below presents the GPIO assignment of the AT32 microcontroller and their connection with other components.

Table 1. AT32 microcontroller pin assignment and connection with components

Pin number	Pin name	Function of AT32 microcontroller	Function of PHY chip	Other components
1	PE2	PE2	-	Extension connector (J3)
2	PE3	PE3	-	Extension connector (J3)
3	PE4	PE4	-	Extension connector (J3)
4	PE5	PE5	-	Extension connector (J3)
5	PE6	PE6	-	Extension connector (J3)
8	PC14	LEXT_IN	-	32 kHz crystal oscillator (X1)
9	PC15	LEXT_OUT	-	32 kHz crystal oscillator (X1)
12	PH0 or PD0	HEXT_IN	-	8 MHz crystal oscillator (X2)
13	PH1 or PD1	HEXT_OUT	-	8 MHz crystal oscillator (X2)
16	PC1	EMAC_MDC	MDC	-
17	PC2	EMAC_MII_TXD2	TXD2	-
18	PC3	EMAC_MII_TX_CLK	TXCLK	-
23	PA0	EMAC_MII_CRS	CRS	-
24	PA1	EMAC_RMII_REF_CLK EMAC_MII_RX_CLK	RMII: 50 MHz reference clock output MII: RXCLK	-
25	PA2	EMAC_MDIO	MDIO	-
26	PA3	EMAC_MII_COL	COL	-
29	PA4	PA4	-	Extension connector (J2)
30	PA5	PA5	-	Extension connector (J2)
31	PA6	PA6	-	Extension connector (J2)
32	PA7	EMAC_RMII_CRS_DV EMAC_MII_RX_DV	RMII: CRS_DV MII: RXDV	-
33	PC4	EMAC_RMII_RXD0 EMAC_MII_RXD0	RXD0	-
34	PC5	EMAC_RMII_RXD1 EMAC_MII_RXD1	RXD1	-
35	PB0	EMAC_MII_RXD2	RXD2	-
36	PB1	EMAC_MII_RXD3	RXD3	-

Pin number	Pin name	Function of AT32 microcontroller	Function of PHY chip	Other components
44	PE13	PE13	-	User button (B2)
45	PE14	PE14	-	User button (B3)
46	PE15	PE15	INT	-
47	PB10	EMAC_MII_RX_ER	RXER	-
48	PB11	EMAC_RMII_TX_EN EMAC_MII_TX_EN	TXEN	-
51	PB12	EMAC_RMII_TXD0 EMAC_MII_TXD0	TXD0	-
52	PB13	EMAC_RMII_TXD1 EMAC_MII_TXD1	TXD1	-
53	PB14	PB14	-	Extension connector (J1)
54	PB15	PB15	-	Extension connector (J1)
55	PD8	PD8	-	Extension connector (J1)
56	PD9	PD9	-	Extension connector (J1)
57	PD10	PD10	-	Extension connector (J1)
58	PD11	PD11	-	Extension connector (J1)
59	PD12	PD12	-	Extension connector (J1)
60	PD13	PD13	-	Extension connector (J1)
61	PD14	PD14	-	Extension connector (J1)
62	PD15	PD15	-	Extension connector (J1)
63	PC6	PC6	-	Extension connector (J1)
64	PC7	PC7	-	Extension connector (J1)
65	PC8	PC8	-	Extension connector (J1)
66	PC9	PC9	-	Extension connector (J1)
67	PA8	CLKOUT	25 MHz master clock input	-
68	PA9	USART1_TX	-	AT-Link connector (CN2)
69	PA10	USART1_RX	-	AT-Link connector (CN2)
70	PA11	OTGFS1_D- or USBFS1_D-	-	USB type-C connector (CN1)
71	PA12	OTGFS1_D+ or USBFS1_D+	-	USB type-C connector (CN1)
72	PA13	SWDIO	-	AT-Link connector (CN2)
76	PA14	SWCLK	-	AT-Link connector (CN2)
77	PA15	PA15	-	Extension connector (J3)

Pin number	Pin name	Function of AT32 microcontroller	Function of PHY chip	Other components
78	PC10	PC10	-	Extension connector (J3)
79	PC11	PC11	-	Extension connector (J3)
80	PC12	PC12	-	Extension connector (J3)
81	PD0	PD0	-	Extension connector (J3)
82	PD1	PD1	-	Extension connector (J3)
89	PB3	SWO	-	AT-Link connector (CN2)
90	PB4	PB4	PHY reset pin	-
91	PB5	EMAC_PPS_OUT	Reserved for future use	-
92	PB6	PB6	-	Extension connector (J3)
93	PB7	PB7	-	Extension connector (J3)
95	PB8	EMAC_MII_TXD3	TXD3	-
97	PE0	PE0	-	LED2 (green)
98	PE1	PE1	-	LED3 (blue)

5 Revision history

Table 2. Document revision history

Date	Revision	Changes
2024.2.22	1.00	Initial release

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