

ERB4U Relay Module User Manual

Extensible, Programmable, Max 30VDC/32A

Product Overview

ERB4U series is a relay module that can be programmed through a USART serial port. Only 1 USB Type-C cable is required to read/control multiple relay modules simultaneously.

- **Each Relay:** max 30VDC/10A, 1 NO + 1 NC
- **Total Relays:** max 30VDC/32A
- **Working Principle:** The ERB4U device receives USART commands from the USB or J1 connector (USART1) and passes the original USART commands to downstream ERB4U devices through the J6 connector (USART2). Therefore, multiple ERB4U modules can be controlled by 1 USB type-C cable from PC. Upon receiving a command, the ERB4U will check its local address and will only execute the action if the address matches.
- **USART Functionality**
 - **USART Parameters:** 115200 baud rate, 8 data bits, 1 stop bit, odd parity, no flow control
 - **Read Commands:** read temperature, 1 or multiple relay status, PN/SN, etc
 - **Write Commands:** turn ON/OFF 1 or multiple relays
- **Address Setting:** 4-bit DIP Switch: Sets the address from 0 to 15; multiple ERB4Us can share the same address.
- **Protection Circuits**
 - **Input Reverse Polarity Protection**
 - **Optocoupler Relay Isolation:** between MCU and relay
 - **Output Protection:** support resistive (R) or inductive (L) loads
- **Python API & Example Codes:** can be downloaded from GitHub
- **Operating Temperature:** -40 to 85 °C

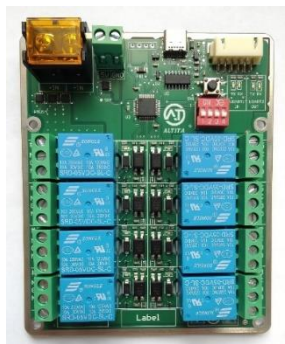


Figure 1 ERB4U-8 real top



Figure 2 ERB4U-8 real bottom

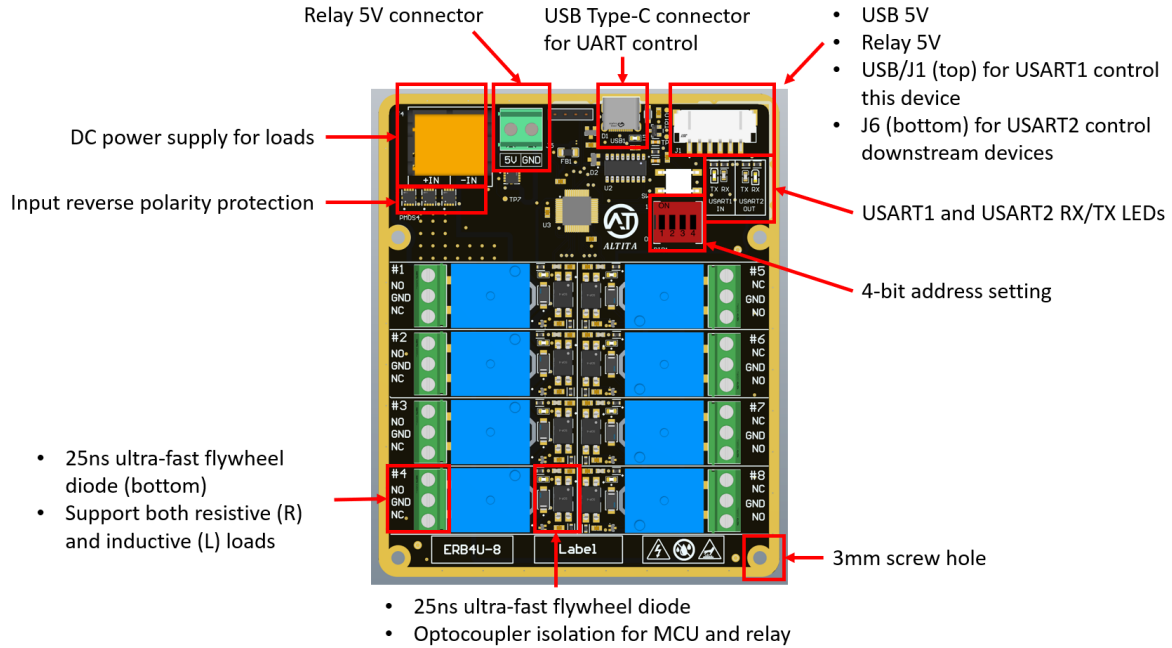


Figure 3 ERB4U-8 3D top with explanation

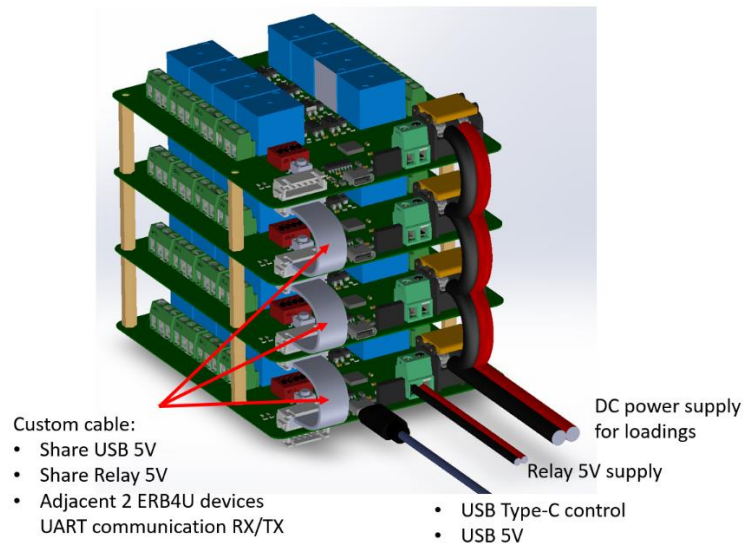


Figure 4 ERB4U stack 4 layers

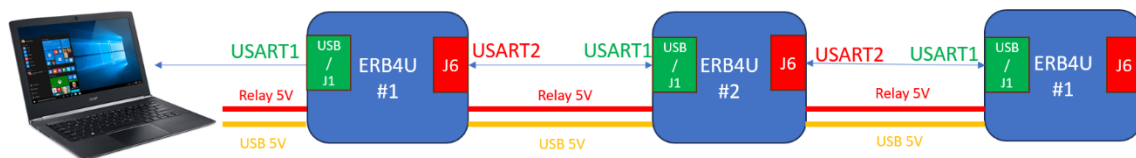


Figure 5 Multiple ERB4U-8 communication



Applications

- Industrial Automation Control
- Automated Test Equipment
- Embedded Electronic Devices
- Universities, Research Institutions, Laboratories
- STEM Education, Training Institutes

Version Control

Version	Release Date	Description and Changes
1.0	May 1, 2024	Initial release version
1.1	May 30, 2024	Added command for reading LDO VDDA



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1 Electrical Parameters

1.1 Relays

- Upon startup, all relays are OFF by default
- Each relay output: max 30VDC/10A, 1 NO + 1 NC
- Optocoupler relay isolation between MCU and relay
- Relay output includes a 25ns ultra-fast freewheeling diode, supporting both resistive and inductive loads (e.g., solenoids, motors)

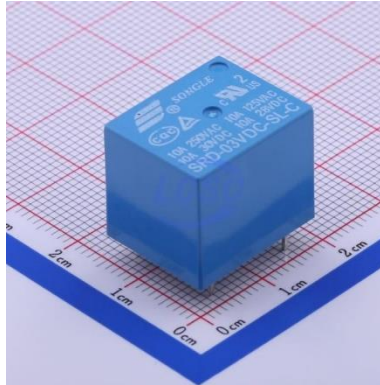


Figure 6 Relay 30VDC/10A

1.2 Address Setting

Manually select device address via 4-bit DIP switch, ranging from 0x00 to 0x0F.

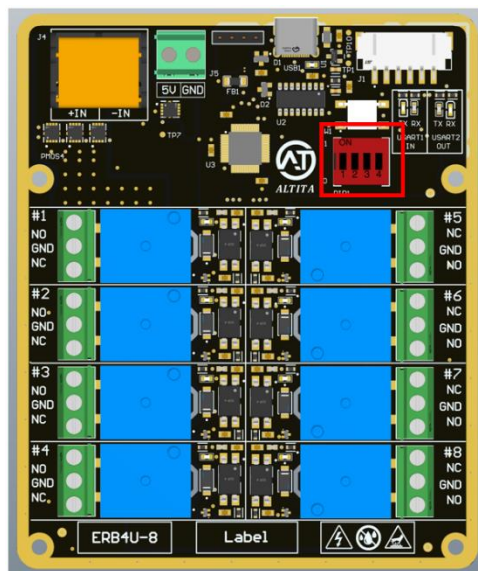


Figure 7 ERB4U 4-bit DIP switch

1.3 USART Communication

Only need 1 single USB Type-C cable connects the PC to the ERB4U module, enabling USART serial read/write functionality.

Parameter	Value
Communication Mode	<ul style="list-style-type: none"> USART1 connects to USB Type-C and J1 connector for communication with PC or upstream ERB4U relay module USART2 connects to J6 connector for communication with downstream ERB4U relay module.
Baud Rate	115200
Data Bits	8
Stop Bits	1
Parity	Odd
Flow Control	None

If additional relays are needed, connect the upstream ERB4U's J6 connector to the downstream ERB4U's J1 connector using a **custom cable (PN: S108520017, Manufacturer: Ckmtw)**. The operational principle is as follows:

- USB and J1 connector (top) connect to USART1.
- J6 connector (bottom) connects to USART2.
- When the PC or upstream ERB4U module sends a write command to the ERB4U, the command is received via USB or J1 connector (USART1) and then transmitted to the next ERB4U via J6 connector (USART2), enabling expandability.
- The custom cable is used for sharing USB 5V and relay 5V power, also used for USART RX/TX communication between 2 adjacent ERB4U modules.
- Upon receiving the command, the ERB4U checks its address. If the address matches, the ERB4U executes the corresponding action. If not, the command is ignored.
- For specific USART commands, refer to the section <[Communication Protocol](#)>.

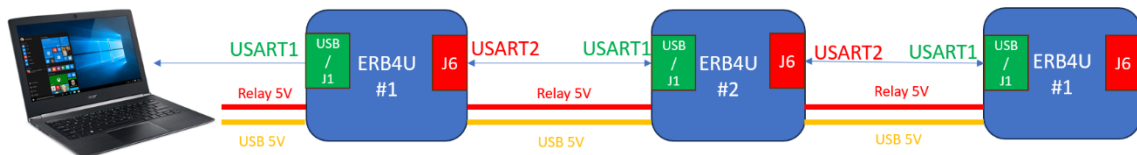


Figure 8 Multiple ERB4U-8 communication



Figure 9 Custom cable for multiple ERB4U communication

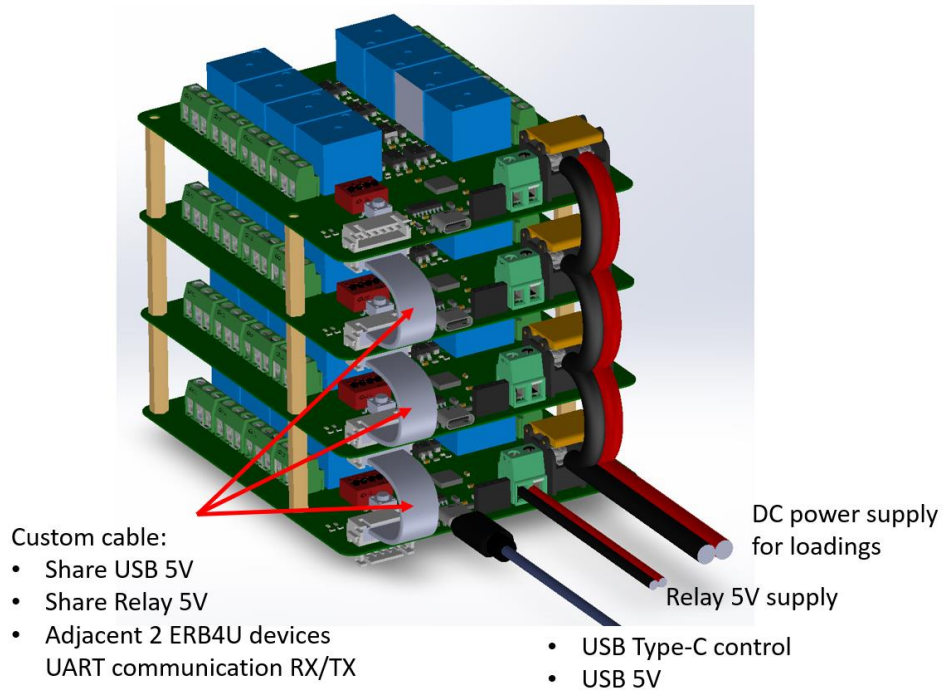


Figure 10 ERB4U stack 4 layers

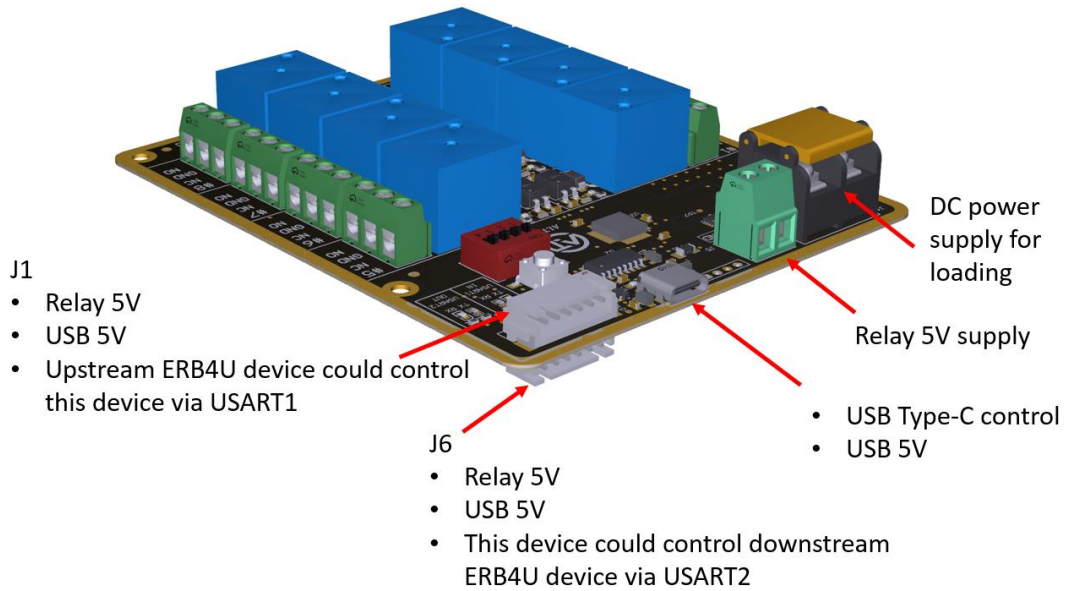


Figure 11 ERB4U-8 with explanation

1.4 LED

- USB Power: green LED
- Relay Status: green LED
- USART1 TX: blue LED
- USART1 RX: yellow LED
- USART2 RX: blue LED
- USART2 TX: yellow LED

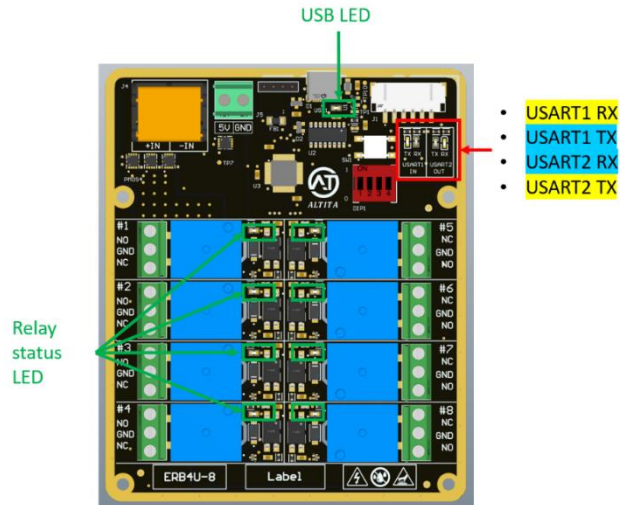


Figure 12 ERB4U-8 LEDs

1.5 Reset Button

- Pressing the reset button restarts the MCU, and all relays return to their default OFF state.

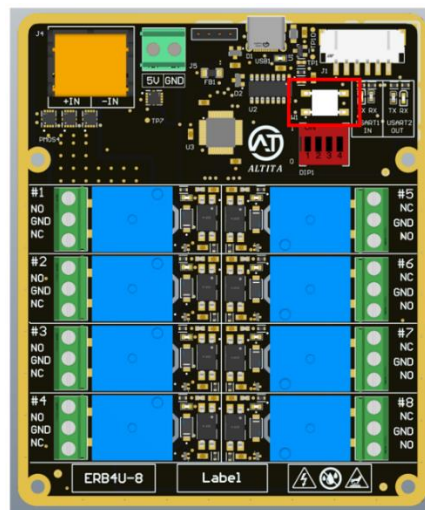


Figure 13 ERB4U-8 reset button

1.6 Operating Temperature

- -40 to 85 °C
- The MCU internal temperature sensor will measure the temperature value, and you may obtain the temperature value via [UART command \(Python API\)](#).

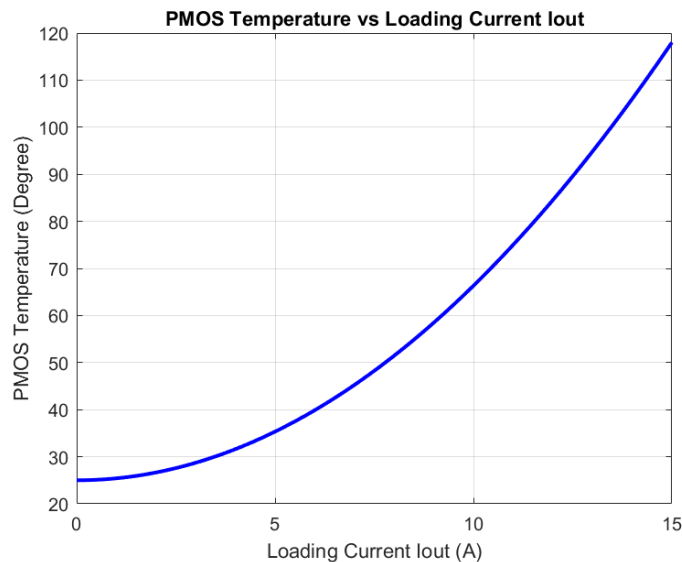
2. Protection Circuits

2.1 Input Reverse Polarity Protection

- Both relay 5V connector and DC power connector have reverse input protection.
- Due to the conduction resistance R_{ds_on} of PMOS, PMOS IC heats up when current flows through it. Typically, the PMOS is the hottest area on the ERB4U module. The temperature can be calculated using the following formula:

$$\text{PMOS Temperature} = \text{Room Temperature} + (\text{Loading Current})^2 * 0.4133$$

- **Temperature Unit:** Degree Celsius °C
- **Current Unit:** A



- It is recommended that the total continuous input current < 15A.
- If the total input current > 15A, a heat sink or cooling fan is required for PMOS.

2.2 Optocoupler Relay Isolation between MCU and Relay

Since the MCU operates at a low voltage of 3.3V and low current (mA level), while the relay operates at the high voltage and high current (such as 24VDC, 10A), an Optocoupler relay is used for isolation between MCU and relay.

- The MCU uses a 0V or 3.3V GPIO to enable or disable the Optocoupler relay.
- The Optocoupler relay output is 5V, which is used to activate the relay.

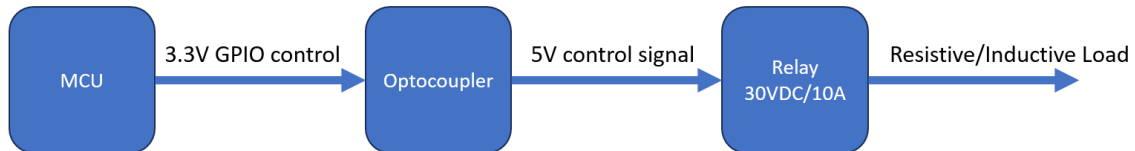


Figure 14 Optocoupler relay isolation between MCU and relay

2.3 Support Resistive (R) and Inductive (L) Loads

- For inductive loads (e.g., solenoids, motors), energy stores in the inductor while current passes through the load. When the relay suddenly turns off, the inductive load generates a very high back EMF due to the inductive characteristics. This transient reverse voltage can far exceed the normal operating voltage.
- If the continuous loading current is HIGH, you probably can see electrical spikes and arcs.
- After long time operation, the relay contacts might become blackened or stick together, leading to relay malfunction (cannot turn ON/OFF properly).
- The pure resistive load does not have this problem.

To address these issues, a 25ns ultra-fast flyback diode and a capacitor is included on output sides of the relay. This diode can quickly dissipate the energy from the inductor within 25ns, resolving the back EMF and arcing problems from inductive loads.

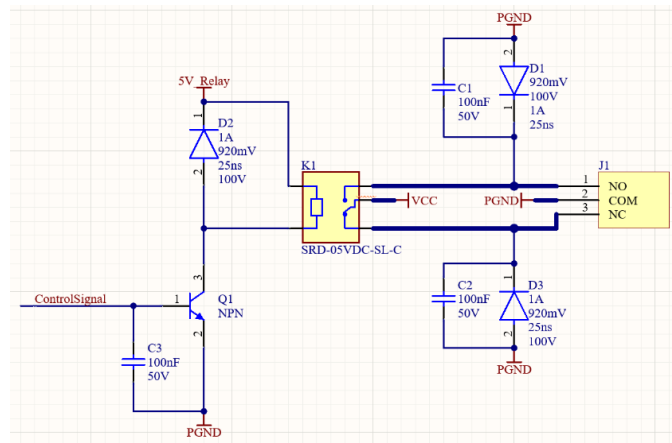


Figure 15 ERB4U relay schematic support R/L loads



3. Communication Protocol

3.1 Read Command

Read Command			
Byte	Command	Function	Remarks
Byte 0	0x00 - 0x0F	Product address, set via onboard DIP switch	/
Byte 1	0x00	Read operation	/
Byte 2	0x01 - 0x08	Read the status of a specific relay	1: Relay is ON 0: Relay is OFF
	0xA0	Read the status of all relays	If there are 8 relays in total and the 1st relay is ON and the rest are OFF, it returns "10000000"
	0xA1	Read the number of relays	If there are 8 relays in total, it returns "8"
	0xA2	Read MCU internal temperature sensor	2 decimal places (°C)
	0xA3	Read LDO VDDA voltage, nominal value is 3.3V	3 decimal places (V)
	0xF0	Read PN	Possible PNs: ERB4U-4 ERB4U-8 ERB4U-12
	0xF1	Read SN	96-bit UUID
	0xF2	Read hardware version	HW: X.Y.Z X = Major hardware changes, such as adding/removing components Y = Minor hardware updates, such as PN changes Z = Patches, such as bug fixes
	0xF3	Read firmware version	FW: X.Y.Z X = Major firmware changes, such as new features or algorithms Y = Minor firmware updates, such as minor feature improvements Z = Patches, such as bug fixes
Byte 3	Undefined	Can be filled with any byte	/



3.2 Write Command

Write Command			
Byte	Command	Function	Remarks
Byte 0	0x00 - 0x0F	Product address, set via onboard DIP switch	/
Byte 1	0x01	Write operation	/
Byte 2	0x01 - 0x08	Set the status of a specific relay	/
	0xA0	Turn OFF all relays	/
	0xA1	Turn ON all relays	/
Byte 3	0x00	Turn OFF the specified relay	/
	0x01	Turn ON the specified relay	/

3.3 Error Message

Error Message	
Byte	Error Message
Byte 1 Error	Error byte 1: unknown read/write operation
Byte 2 Error (Read)	Error byte 2: unknown read CMD
Byte 2 Error (Write)	Error byte 2: unknown write CMD
Byte 3 Error (Write)	Error byte 3: unknown relay state

4. Functional Block Diagram

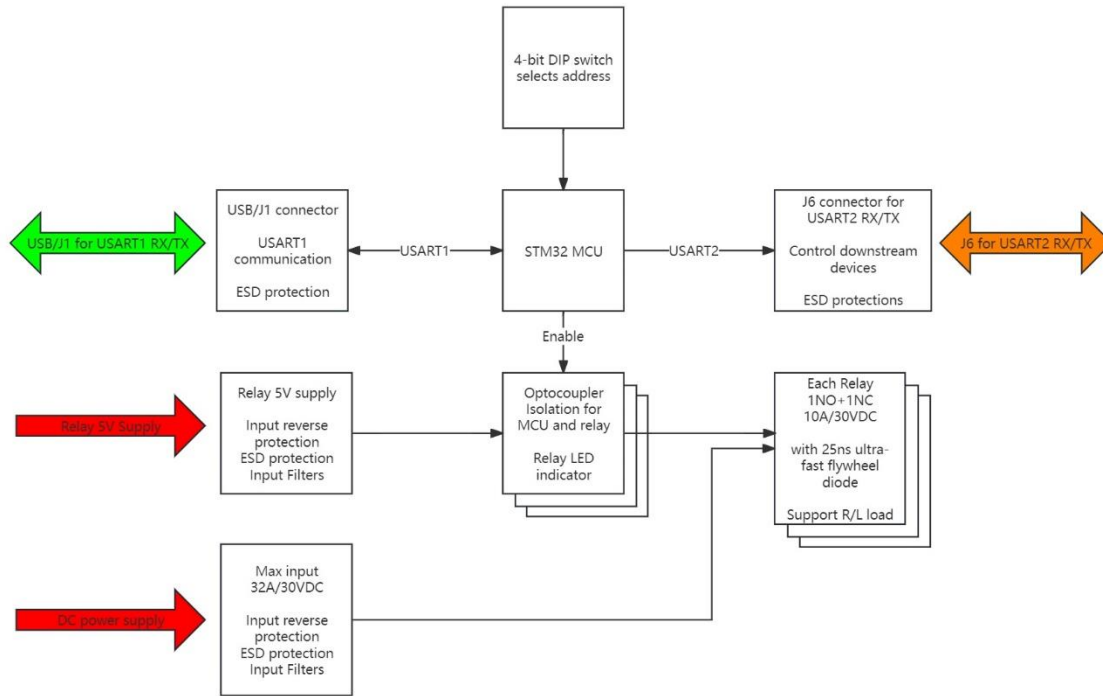


Figure 16 ERB4U functional block diagram

5. Product Images

5.1 Real Product Images

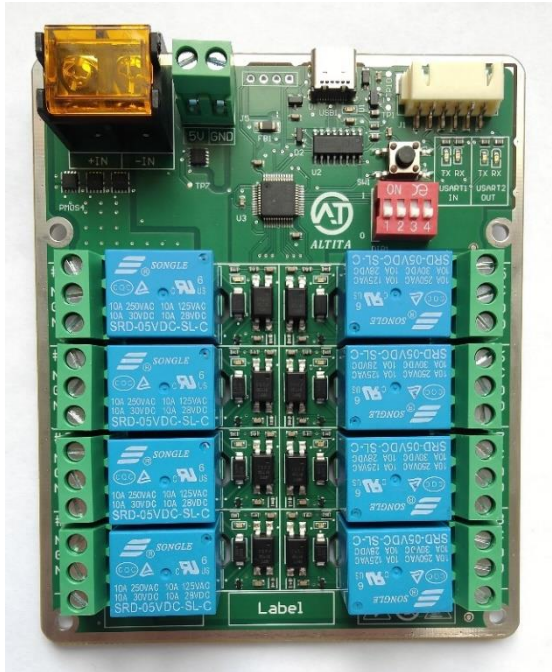


Figure 17 ERB4U-8 real top

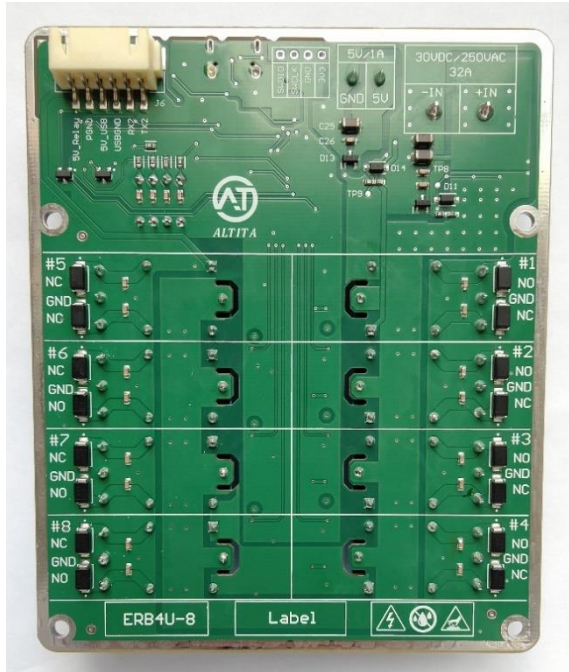


Figure 18 ERB4U-8 real bottom

5.2 2D Drawings

- **Download:** DWG, DXF, PNG
- **Unit:** mm

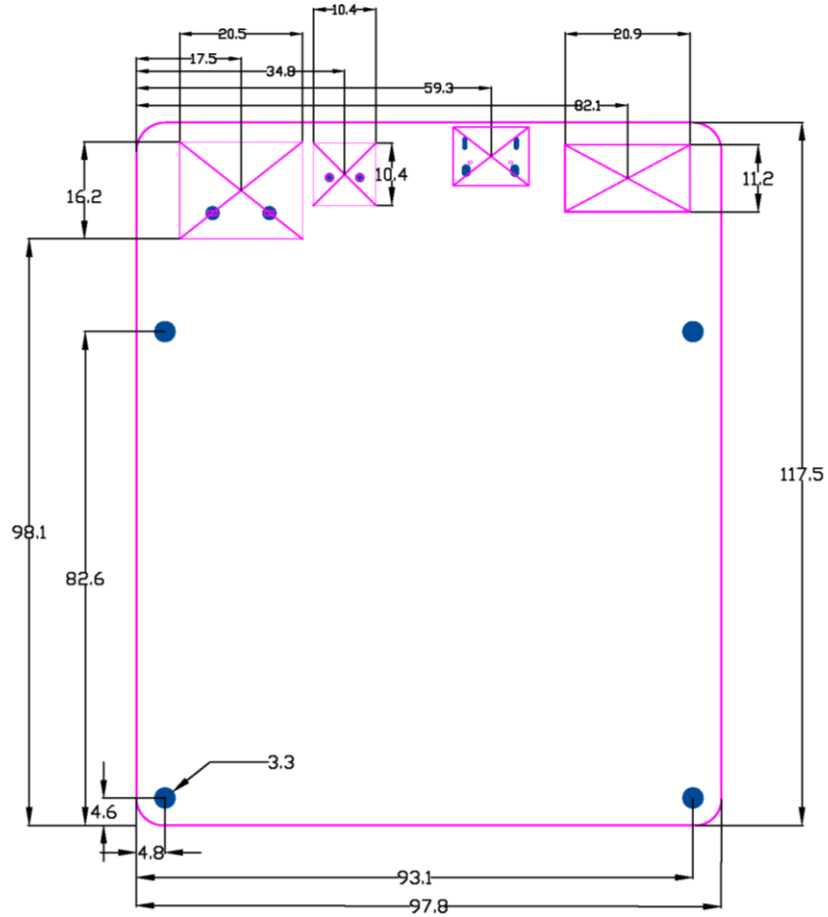


Figure 19 ERB4U-8 2D with dimension

5.3 3D Models

- **Download:** STEP, PDF 3D

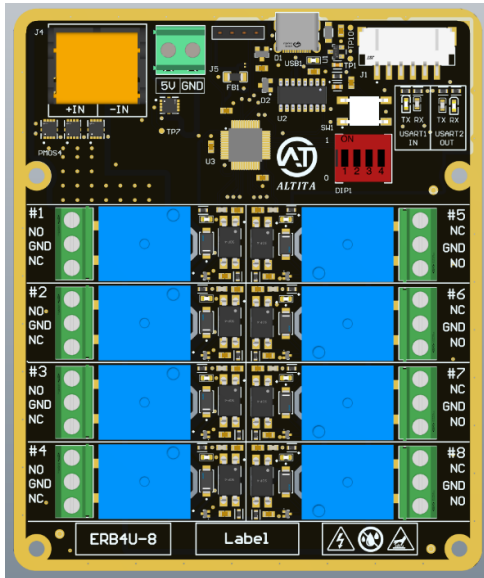


Figure 20 ERB4U-8 3D Top

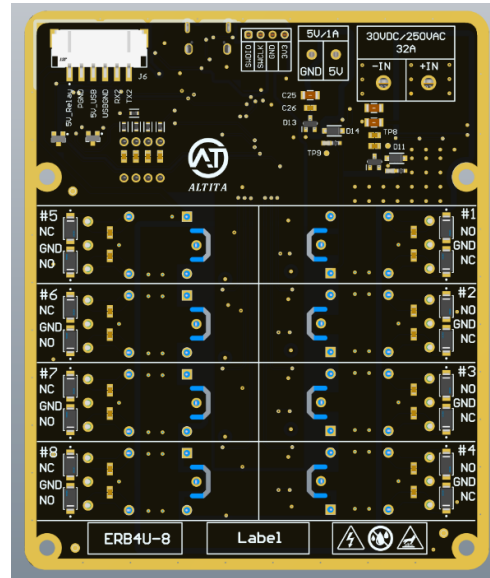


Figure 21 ERB4U-8 3D Bottom

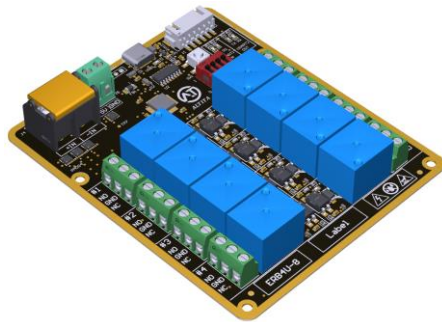


Figure 22 ERB4U-8 3D Side

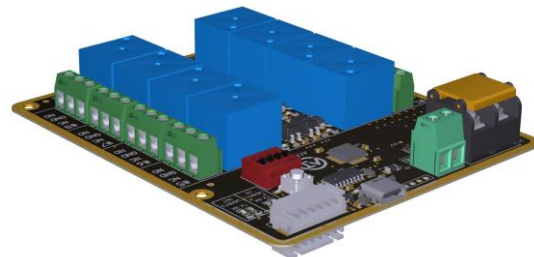


Figure 23 RB4U-8 3D Side

6. Python API & Example Code

- [GitHub Link](#)

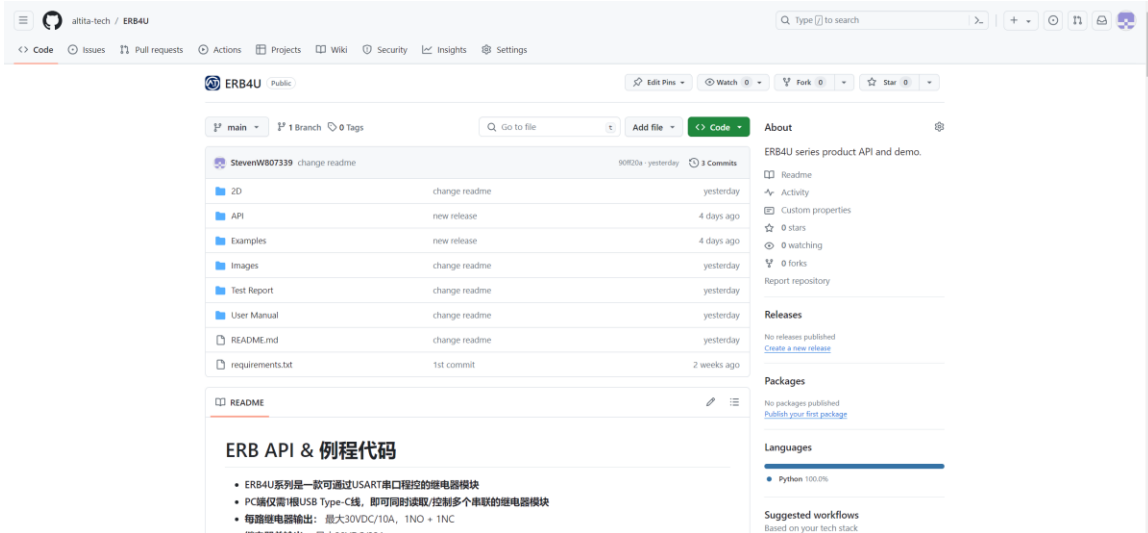


Figure 24 ERB4U GitHub repo

7. Test Report

- **Download:** ERB4U test report template

8. Contact Us

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