



AirRob Control Bin User Manual

(LBAirBox)

V1.0



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Before installing and using the equipment, the user must carefully read the "manual" to understand the functional characteristics of the equipment, and master the operating procedures after pre-job training, and pass the assessment before operating the equipment.

Keep for future reference.

Original instructions

Safety signals and symbols

 <p>Danger</p>	<p>During installation and commissioning or during operation, the operating procedures must be complied with and safety matters must be paid attention to.</p>
 <p>Danger High voltage</p>	<p>When operating the power supply or other electrical components, beware of electric shock.</p>
 <p>Grounding</p>	<p>Body grounding symbol.</p>
 <p>Caution Falling objects</p>	<p>When the case puller is working, beware of accidental dropping of items.</p>
 <p>Warning Mind your hands</p>	<p>When commissioning or repairing equipment, prevent accidental pinching of equipment components.</p>
 <p>Warning Mechanical injury</p>	<p>When installing, debugging or repairing equipment, pay attention to safety to prevent accidental falling or sliding of the equipment and injuring personnel.</p>

 <p>No Stacking</p>	<p>It is forbidden to stack any items on the path space where the AirRob is running.</p>
 <p>No Linger</p>	<p>When the AirRob is running, it is forbidden for personnel to stay on the path to prevent injury caused by accidental impact.</p>
 <p>Must fasten safety belt</p>	<p>During equipment installation or maintenance operations, climbers must wear seat belts.</p>
 <p>Must wear safety helmet</p>	<p>When the equipment is installed or repaired, the construction personnel must wear safety helmets.</p>
 <p>Keep out</p>	<p>When the equipment is running, please keep the track and ground clean to prevent falling objects from affecting the operation of the equipment.</p>



Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

The user manual for local area network devices shall contain instructions related to the restrictions mentioned in the above sections, namely that:

- (i) the device for operation in the band 5150-5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
- (ii) the maximum antenna gain permitted for devices in the band 5725-5825 MHz shall comply with the e.i.r.p. limits specified for point-to-point and non point-to-point operation as appropriate.

(i) Les dispositifs fonctionnant dans la bande 5150-5250 MHz sont réservés uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux.

(ii) le gain d'antenne maximal autorisé pour les appareils dans la bande 5725-5825 MHz doivent respecter le pire limites spécifiées pour le point-à-point et l'exploitation non point à point, le cas échéant.

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- (1) This device may not cause interference.
- (2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'appareil contient des émetteurs/récepteurs exempts de licence qui sont conformes aux CNR exempts de licence d'Innovation, Sciences et Développement économique Canada. L'exploitation est soumise aux deux conditions suivantes :

- (1) l'appareil ne doit pas produire de brouillage,
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with FCC/IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

ce matériel est conforme aux limites de dose d'exposition aux rayonnements, FCC / CNR-102



énoncée dans un autre environnement. cette équipement devrait être installé et exploité avec distance minimale de 20 entre le radiateur et votre corps.

Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados. Para maiores informações, consulte o site da ANATEL – www.anatel.gov.br

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前述合法通信，指依電信管理法規定作業之無線電通信。

低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。



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Chapter 1. Overview

The company has increased investment and conducted in-depth research in warehouse automation and retrieval technology, developing the "Li Biao" warehouse automation and retrieval technology. The control bin is mainly composed of a supercapacitor board, a power control board, a main control board, an inclinometer, and a communication antenna. The control bin is one of the important components of the AirRob system and is a key device for achieving automated storage and retrieval of warehouse bins.

1.1 Model Definition

Control Box Model: LBAirBox, This operating manual applies to the control box model of this rail machine.

1.2 Features

- ◆ Simple structure design, low cost, easy to install and deploy.
- ◆ Optimize power usage efficiency

The power control within the control box ensures the supply and stability of power, guaranteeing that all components of the rail machine receive a stable power supply.

- ◆ Automatic tilt correction

The rail machine is equipped with an internal tilt sensor that can detect the tilt angle of the machine body in real time. Based on the tilt angle, the rail machine automatically corrects itself to maintain vertical alignment at all times.

1.3 Technical Parameters

The basic technical parameters are as follows:

Category	Project	Parameter	Illustrate
Mechanical parameters	Altitude	2500 mm~9000 mm	Highly customizable
	Width	764 mm	
	Depth	820 mm	
	Weight	50~65kg	Based on height variations
Electrical parameters	Operating voltage	DC25V~DC29V	
	Operating current	5.6A, 12A	12A for charging current
	Operating power	150W,350W	350W for charging power

	Power supply mode	Pure copper wire static contact	Pure silver contact touch
	Communication interfaces	900M wireless, WIFI (2.4G/5G)	
	Driving mode	DC servo motor	
Movement speed	Horizontal (X)	Velocity $\leq 2.0\text{M/S}$, Acceleration $\leq 2.0\text{M/S}^2$	
	Vertical (Z)	Velocity $\leq 1.0\text{M/S}$, Acceleration $\leq 0.8\text{M/S}^2$	
	Bin pulling time	4.5 seconds/time	
	Pushing the bin takes time	4.5 seconds/time	
Features	Bin specifications	Length \times width: 530mm \times 410mm	There must be handholds on the front and rear sides
	Payload	$\leq 30\text{kg}$	
	Barcode supported	1D and 2D codes	
Environmental conditions	Operating temperature	-20°C - 55°C	
	Operating humidity	$\leq 95\%RH$	
	Storage temperature	-45°C - 65°C	
	Storage humidity	$\leq 90\%RH$	
	Altitude	≤ 3000 meters	

Table 1. Basic Technical Parameters of the Control Box

Chapter 2. Composition and Working Principle of the Control Box

2.1 Main Body of the Control Bin

The main control bin is primarily composed of a super capacitor board, power control board, main control board, inclinometer, and communication antenna, as shown in the diagram below.



Figure 1. Main Control Bin Body

2.2 Super Capacitor Board

The super capacitor board consists of three units grouped together, operating within a voltage range of 21V to 29V. These super capacitor boards are monitored by the power control board to ensure they function within a safe voltage range. The primary role of the super capacitor board is akin to an energy storage reservoir. When the motor is ascending and needs to overcome gravity, the power demand is high. At this time, the super capacitor board can provide additional power support to prevent the motor from stopping or falling due to insufficient power supply. The super capacitor board remains fully charged during normal operation, ready to quickly release energy when the motor requires it. During motor descent, the power demand is lower due to the assistance of gravity. The super capacitor board can recover and store the excess energy generated during motor descent

through an energy recovery mechanism. This method not only improves energy utilization efficiency but also reduces dependence on external power sources. Each super capacitor board is equipped with a battery management chip that monitors the charging and discharging status in real-time. The battery management chip can detect whether the charging and discharging processes are normal, and if any abnormalities are detected, it can promptly shut down the charging and discharging circuits to ensure system safety. This monitoring and management mechanism ensures the reliability and longevity of the super capacitor board. The super capacitor board works in conjunction with the power control board to ensure a stable power supply. The power control board continuously monitors the status of the super capacitor board and dynamically adjusts power distribution to optimize system performance. The electrical control bin provides the basic power supply for the motor, and when the control bin cannot meet the motor's demand, the super capacitor board offers additional support. This interaction ensures that the motor receives adequate power support under various operating conditions.



Figure 2. Super Capacitor Board

2.3 Power Control Board

The power control board is responsible for charging and supplying power to peripheral devices. It is the core power controller of the rail machine system, managing the entire system's power supply. It ensures that all components of the rail machine receive a stable power supply. The power control board continuously monitors the power status, including parameters such as voltage and current. Through monitoring, it can promptly detect power abnormalities, preventing power issues from affecting the normal operation of the rail machine. The power

control board is responsible for power distribution and management, ensuring that the power needs of various components are reasonably met. It can dynamically adjust power distribution according to the needs of different components, optimizing power usage efficiency. The power control board directly controls the power supply to the motor, ensuring the motor receives stable power support. It monitors the power status of the motor to prevent motor failures due to power issues.

Among the components, the CAN interface on the power control board is very common in the rail machine system and plays an important integrative role. It simplifies the system's power and communication wiring, enhancing system reliability and maintainability. The two power lines in the CAN interface are responsible for providing power control functions, ensuring power supply and stability. The two communication lines in the CAN interface are responsible for data transmission, facilitating information exchange between various components within the system. Through CAN communication, the power control board can interact with other system components in real-time, ensuring coordinated operation of the system.



Figure 3. Power Control Board

2.4 Main Control Board

The main control board governs the entire operation of the rail machine. All logical control and external communications of the rail machine are achieved through internal connections, with no external connection wires. The modules on the main control board are divided into a WiFi module and a 900 MHz communication module. The WiFi module's function is to provide a virtual WiFi network. Its characteristic is strong data transmission capability but weak anti-interference ability. The 900 MHz communication module's function is to

provide communication in the 900 MHz frequency band. Its characteristic is strong anti-interference ability but it cannot handle large data transmissions. The two modules operate in different frequency bands (WiFi and 900 MHz), complementing each other. The main control board plays a role in action control and data collection. It can receive commands and collect data, receiving commands from the vehicle service system and gathering data from other sensors, including radar, control motors, batteries, etc., ensuring the normal operation of the system.



Figure 4. Main Control Board

2.5 Tilt Sensor

The tilt sensor is primarily used to adjust the posture of the rail machine, ensuring that it remains upright while operating on the rail. It also helps detect speed discrepancies between the upper and lower wheels, preventing the rail machine from tilting due to inconsistent speeds. By continuously monitoring and adjusting in real-time, the tilt sensor ensures all wheels operate synchronously, maintaining the balance of the rail machine. The tilt sensor continuously monitors changes in the rail machine's posture and provides feedback data to the control system. Based on the data from the tilt sensor, the control system makes necessary adjustments to ensure the rail machine remains stable throughout its operation, without any tilting or deviation.

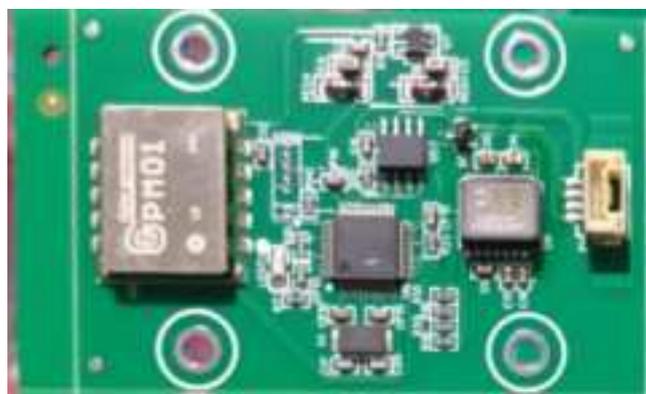


Figure 5. Tilt Sensor

Chapter 3. Principles of Electrical (Wiring)

3.1 Electrical (wiring) Schematic

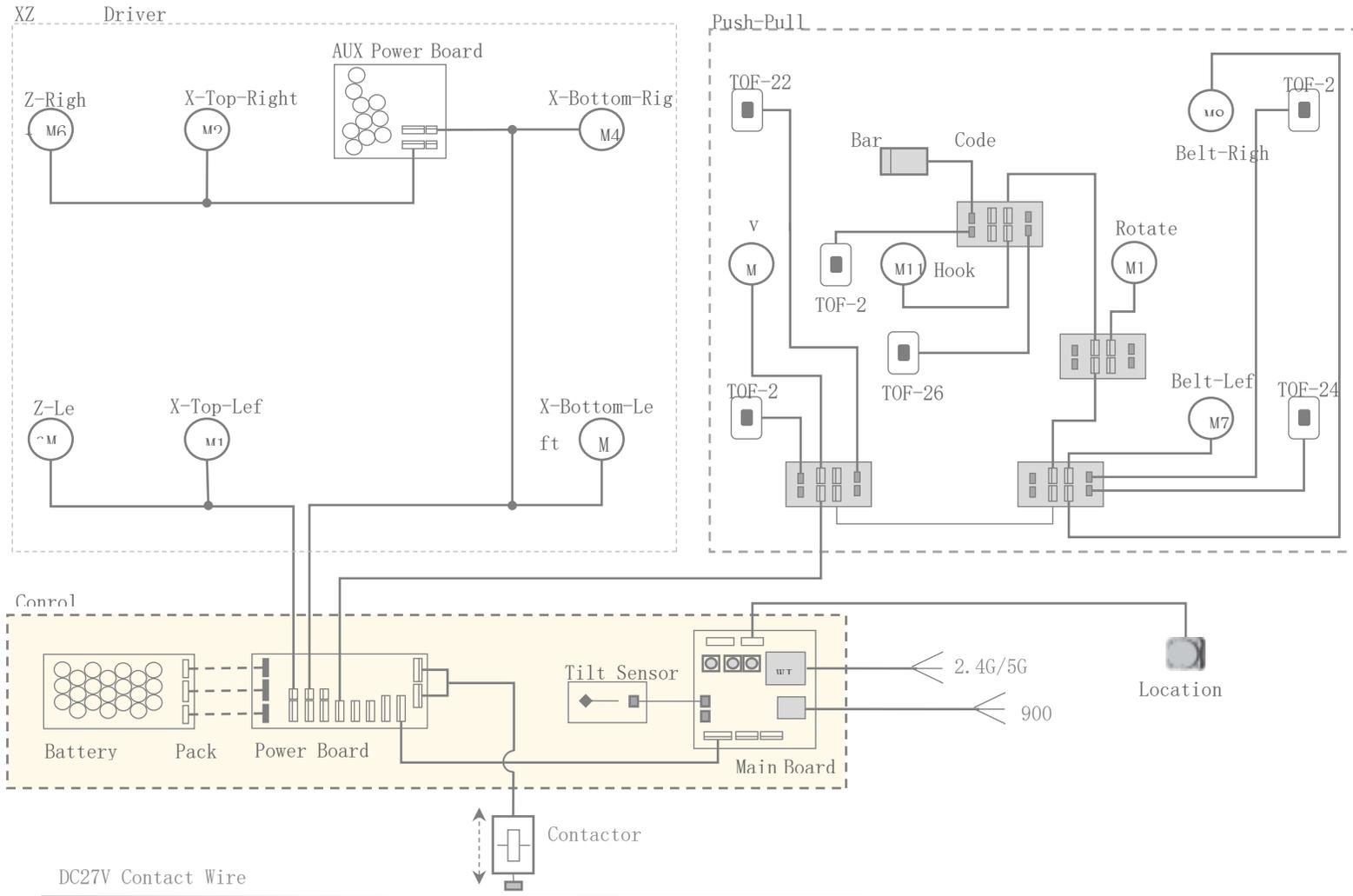


Figure 6. Electrical (Wiring) Schematic Diagram

3.2 Device and Address

Serial number	Name	Illustrate
1	Main Board	Server communication address
2	Power Board	CAN communication address
3	Tilt Sensor	

Table 4. Control Box Equipment and Communication Addresses

The operating voltage of the control box is DC 27V (nominal voltage, actual range DC 25V - DC 29V). The communication interfaces use 900M wireless communication and WiFi (2.4G/5G). Communication between the main control board and the equipment is via CAN bus.

Item RF Type	Modulation	RF Frequency	RF Power
SRD	GFSK	902MHz-928MHz	6.15dBm
2.4G WIFI (802.11a/b/g/n 20BW)	DSSS/OFDM	2412MHz-2472MHz	18.43dBm
5.0G WIFI (802.11a/n 20BW)	OFDM	5180MHz-5240MHz	9.8dBm
5.0G WIFI (802.11a/n 20BW)	OFDM	5745MHz-5825MHz	10.19dBm

3.3 CAN-Plus Interface

The CAN-Plus interface is based on the standard CAN bus and adds 2P power supply, that is, VH-4+VH-2.

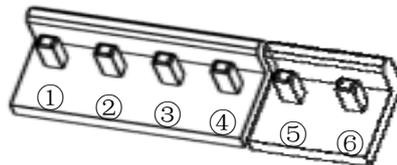


Figure 7. CAN-Plus interface definition

①: DC27V+ ②: CAN-H ③: DC27V- ④: CAN-L ⑤: DC27V+ ⑥: DC27V-

Chapter 4. Installation and Debugging

4.1 Installation

As shown in the figure below, use M36+6 hex standoffs, M311+6 hex standoffs, and M3*5 pan head screws to securely mount the finished circuit board onto the circuit board bracket.

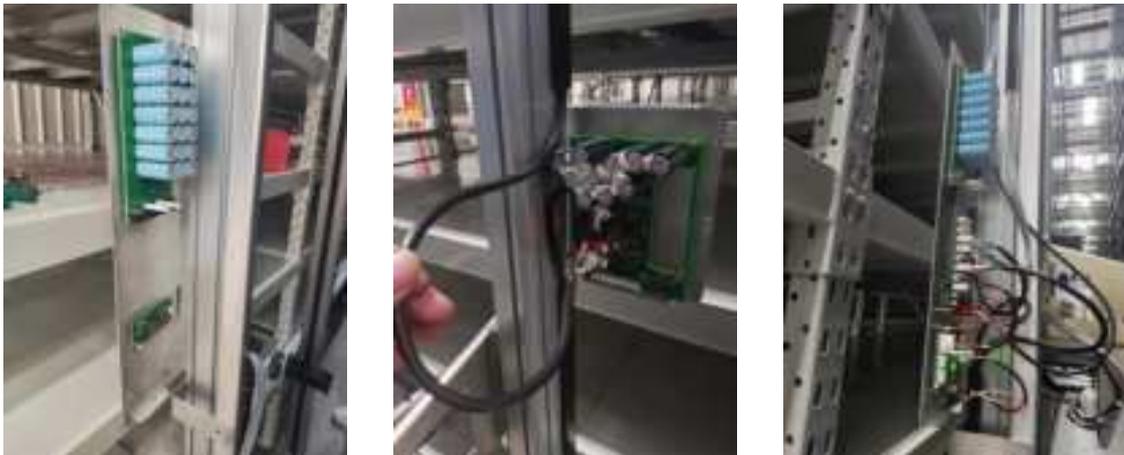


Figure 8. Circuit Board Installation Diagram

Pay attention to the usage positions of the two types of hex standoffs; ensure that the WIR000617 cable is pre-inserted into the tilt sensor board.

For the connection positions of each terminal on the circuit board, see the diagram below.



Figure 9. Circuit Board Connection Diagram

4.2 Debugging

4.2.1 Check Before Powering On

Before powering on the control box, a comprehensive inspection must be carried out. This includes checking whether all components are installed, whether any screws are missing or not tightened properly; also, check if the wiring is correct, if the cables are properly secured with zip ties, and finally, use a multimeter to measure if there is a short circuit between the DC 27V connections.

4.2.2 Powering on the equipment

Observe whether all devices and sensors in the control box are powered on and functioning normally (this can be verified through the status of the LED indicators). All devices other than the main control board should have their LED indicators flashing rapidly if they are working normally. If the LEDs are flashing slowly, check whether the CAN-H and CAN-L connections of the CAN bus are correct.

4.2.3 Changing the address of the main control board

After all the equipment is powered on, the equipment address (IP) of the AirBox needs to be changed according to the actual on-site network configuration. To change the address, you need a PC and a USB to CAN tool, as well as the configuration software (RackRailTool.exe) of the AirBox.

Connect the USB to CAN tool to the computer, then plug in into any CAN bus interfaces (VH-4) on the rail machine and open the configuration software:



Figure 10. Basic Parameter Change Interface



①: Select USB2CAN to start the connection, after normal connection, both the CAN bus status and the AirRob status are displayed online.

②: Select the parameters you want to change, and click Save when the changes are complete.

Basic parameter list:

Parameter	Default value	Illustrate
Address car number	104101	The IP address of the device is 192.168.104.101
Broadcast address	238238	LB-AP Broadcast address for wireless communication
HOME channel	0	LB-AP Channel for wireless communication startup
Fundamental frequency	902	LB-AP The starting frequency of the wireless communication
Frequency interval	250	LB-AP Frequency interval when communicating wirelessly
Power range	120	LB-AP The transmit power of wireless communication
World coordinates-X	0	Default X coordinate of the orbiter in the AirRob system
World coordinates - Y	0	Default Y coordinate of the orbiter in the AirRob system
Z-axis height above the ground	150	The height of the synchronous belt conveyor surface from the ground when the push-pull bin machine is placed at the lowest location, measured in millimeters.
Push-pull camera height difference	0	The height difference in the front-to-back direction of the push-pull box machine, measured in millimeters.

Table 2. Basic Parameters List

*: Because the push-pull bin machine is fixed on the column on one side, the height of the outer side is often a little lower than that of the column side, resulting in a little deviation from the height of the reverse rack operation, and the parameter of this height difference is needed to correct and compensate.

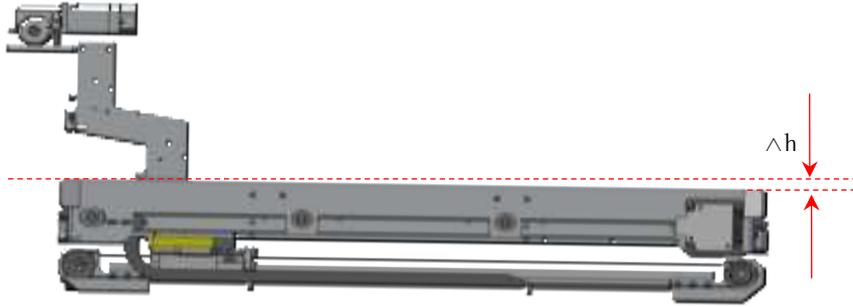


Figure 11. Schematic diagram of the front-to-back height difference of the push-pull bin machine

Note: After the above parameters are saved, you need to restart the main board to take effect, and the restart method is referred to the corresponding section below.

4.2.4 Profile Download

In addition to the basic parameters, you also need to download the corresponding pcfg configuration file (rackrail.pcfg). The main network parameters, motor parameters, running speed, lidar and other related general parameters of the AirRob in this configuration file.

Note: The main control board needs to be restarted after the parameters have been downloaded for them to take effect. Refer to the following section for the restart method.

4.2.5 Inclination Zero Calibration

When powering on for the first time, the rail machine requires an inclination zero calibration. There are two specific methods for correction: using the main control board buttons or the rail machine interface on the server software.

(1) Main board buttons

The main board is equipped with 3 buttons and communication transceiver indicators, as shown in the following figure:

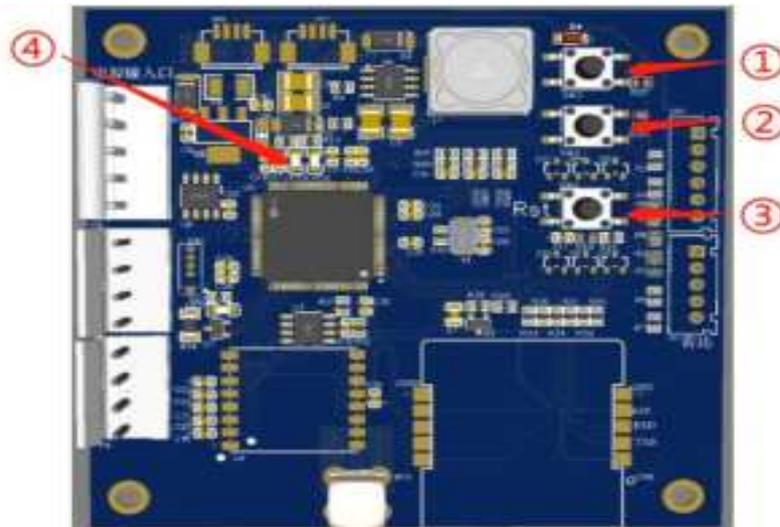


Figure 12. Rail Machine Main Control Board

①②: The function keys 1 and 2 of the main board have different functions in different states;

③: The motherboard reset button is used to reset and restart the main board;

④: The communication LED indicator of the main board, and the communication transmission and reception correspond to an LED indicator.

The method and specific steps of tilt zero calibration through the main board are as follows:

a. Press and hold the keys ① and ② at the same time and do not let go, and then press the keys ③ again to reset and restart the board;

b. After seeing ④ the two LED indicators flash synchronously for 0.5 seconds, let go of ① and ②, and then you can correct the tilt zero location;

c. Push the AirRob to the vicinity of the rack column, and the reference column straightens the AirRob until it is 90 degrees vertical;

d. Then press ① and ② at the same time until ④ the two LED indicators turn off, and the calibration of the saved data is completed.

Chapter 5. Software Upgrade

The electrical control equipment in the control box includes the supercapacitor board, power control board, main control board, inclination sensor, and other devices. The specific upgradable contents are listed in the table below:

Equipment	Upgrade content	Illustrate
Main board	RackRail_xxx.up、 RackRail_xxx.pcfg	The up file is the encrypted program file of the device, and the PCFG file is the configuration file of the main board.
Power Board	TrackPower_xxx.up	
Tilt sensor	LBRackRailGyroAcc_xxx.up	

Table 3.Device upgrade files

The upgrade files listed in the above table can be upgraded either locally or remotely.

5.1 Local Method

Tools required for local upgrade method: computer, adjustable power supply, USB to CAN tool and connecting cables, tool software, etc.

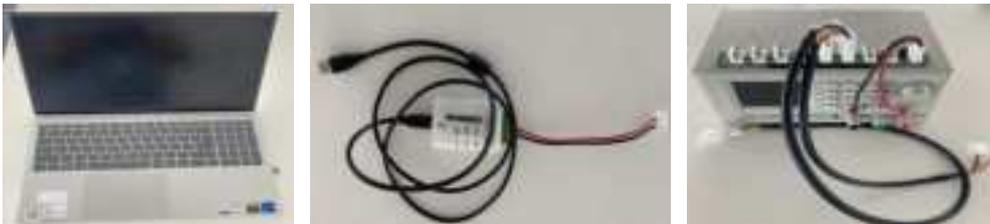
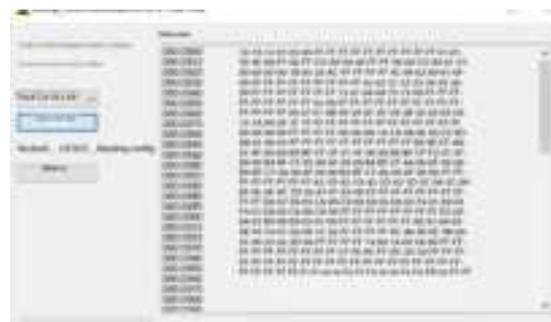


Figure 13.Upgrade tool

The local upgrade is mainly to use the USB to CAN tool to download up files or other data to the storage flash of the device through the CAN bus interface of the device and the corresponding tool software. Tools include:



Device Registration Software (dev_register.exe)



Configure the download tool (LBRobotConfigTool.UI.exe)



The device registration software is used to upgrade the “UP” program file, and the configuration download tool is used to download the pcfg configuration file.

5.1.1 Main board

The upgrade of the main board includes two types: the “UP” program file and the pcfg configuration file.

(1).up program file

To upgrade the file of the up program, you need to use the device registration software (dev_register.exe), connect the device, open the tool, select the corresponding up file, and click on the update program.



Figure 14.Up program file download

The tool will find a device and start downloading the UP data to the device, when the progress is 100.0% complete, the upgrade is complete.

(2).pcfg configuration file

The main board also has a pcfg configuration file (general configuration parameters of the AirRob) that also needs to be updated, and can also be downloaded to the control board through the tool software.



Figure 15.Pcfg configuration file download



Select the device type as rail Machine (0x30). During the configuration file download process, there is a certain probability that "Download Failed" may be displayed. In this case, click "Write" again until the download shows "100.0% Success" to ensure the download is successful.

5.1.2 Power Board

The local upgrade method for the power board is the same as the UP program method for the main control board.

5.1.3 Inclinometer

The local upgrade method for the inclinometer is the same as the UP program method for the main control board. The voltage is DC 5V, and it uses a GH-4 interface.