

F140 Forklift (CE)

User Manual



V1.0.0

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Preface

The following are requirements for the correct use of the product. To prevent danger and property loss, please read carefully before using the product and strictly comply with them during use.

Symbol Conventions

The following symbols may appear in this document and their meanings are as follows:

Logo	Description
 DANGER	Indicates a highly hazardous situation which, if not avoided, could result in death or serious injury.
 WARNING	Indicates a moderate or low potential hazard which, if not avoided, could result in minor or moderate injury to personnel.
 CAUTION	Indicates a potential risk that, if ignored, could result in damage to the device, loss of data, degradation of the device, or unpredictable results.
 ELECTRIC SHOCK	Indicates high voltage hazard.
 LASER RADIATION	Indicates strong laser radiation.
 ESD	Indicates electrostatic sensitive device (ESD).
 MECHANICAL HAZARD WARNING	Indicates mechanical hazard.
 TIPS	It means it can help you solve a problem or save you time.
 NOTE	It indicates additional information to the main text, which emphasizes and supplements the main text.

Revision History

Version Number	Revisions	Releasing Date
V1.1.0	First Publication.	2024.3

Safety Instructions for Use

This equipment is an Automated Guided Transport Forklift designed for unmanned operation. However, in actual operation, there are scenarios involving human-machine collaboration and maintenance activities. This section primarily outlines safety instructions for use during human-machine collaboration and by maintenance personnel.

Terminology Explanation in Safety Instructions:

- Maintenance Operator: Personnel who have undergone relevant training and obtained qualifications, responsible for the maintenance and operation of the narrow-aisle forklift (Model: F140).
- Danger Zone: Areas where personnel may be injured due to the movement of the industrial vehicle, its working devices, load-handling attachments (e.g., attachments), or cargo.



CAUTION

The danger zone also includes areas that could be reached by cargo, working equipment or load handling equipment during descent or fall.

The equipment and vehicle refer to the object in this manual, the narrow-aisle forklift (Model: F140).

1. Basic Safety Instructions

1. The vehicle shall only be operated by personnel who have received qualified technical training.
2. Installation of any equipment not provided by the manufacturer on the vehicle is strictly prohibited.
3. Maintain the vehicle in good condition to minimize risks.
4. Safeguard the labels on the vehicle and promptly replace any damaged labels.
5. Read and adhere to the vehicle's safety instructions carefully.
6. Ensure that the cargo handled by the equipment does not exceed the rated load capacity.
7. When the equipment is not in use, it should be parked in the rest area with the platform correctly positioned.
8. If the vehicle is damaged or cannot be maintained in a safe condition, report it immediately.
9. Using a single fork leg to lift cargo is prohibited.
10. When handling cargo, ensure the cargo is positioned as close as possible to the backrest of the fork to keep the overall center of gravity within the load center.
11. Ensure the lateral center of gravity of the cargo is between the two fork legs.
12. Operating the vehicle with cargo whose lateral or longitudinal center of gravity is not aligned with the centerline is prohibited.
13. Driving on uneven, obstructed ground or on stairs is prohibited.
14. During manual operation, driving with the cargo raised more than 300 mm is prohibited.
15. Spinning in place on a slope is prohibited.
16. If the vehicle is to be used under conditions other than those specified in the user manual, prior approval from the manufacturer must be obtained to avoid hazards.
17. Appropriate fire prevention measures should be implemented in the vehicle's operating area based on its usage, and additional fire prevention measures or facilities should be applied to the vehicle according to its operating environment.
18. If the vehicle has damage or defects that affect safety, it must be stopped immediately and

shall not be put back into operation until fully repaired.

19. Regardless of whether the vehicle is loaded, no personnel shall pass or stand under raised attachments (e.g., forks) or other elevated components. During vehicle operation, do not place any part of the body, such as arms, legs, or head, within the mast mechanism or other moving parts of the vehicle, nor climb on or touch parts of the vehicle with relative motion.
 20. Within the areas of F140 forklift operation, travel, rest, and maintenance, clearly visible warning signs (yellow or red) must be posted and printed on the ground and overhead, such as "F140 Forklift Travel Hazard Warning" and "F140 Forklift Operation Hazard Warning."
 21. During vehicle operation, personnel must not stay on the vehicle's preset path, and no objects should be placed on the vehicle's preset path.
 22. During vehicle operation, keep a safe distance from the vehicle to ensure personal safety.
 23. It is prohibited to set storage locations on slopes. The vehicle is prohibited from performing pick-up or placement operations on slopes. Unloaded operations, tilted stacking of cargo, or any actions that cause the load center to shift are prohibited, as they may lead to vehicle tipping.
 24. Personnel are prohibited from staying under or above the forks, standing on the fork legs, riding on the F140 forklift, or allowing the F140 forklift to carry any non-work-related items on its fork legs.
 25. Personnel are prohibited from placing any part of their body near moving components such as forks, drive wheels, or chains. During maintenance, ensure these components do not move.
 26. After the vehicle stops operating, the key switch must be turned off.
 27. In case of vehicle malfunction, the vehicle must be stopped, marked with a warning sign, and the key switch turned off. Notify professional personnel for maintenance. If the vehicle leaks oil, it must not be used until repaired. Exercise caution during inspection and maintenance to avoid injuries.
 28. Any foreign objects are prohibited from contacting the positive and negative terminals of the vehicle's battery to prevent sparks or short circuits.
 29. The F140 forklift is prohibited from being used for non-work-related purposes, such as transporting people or cargo.
 30. If the vehicle needs to enter an elevator for operation, confirm the elevator's load capacity first, and do not exceed the load limit.
 31. Strictly follow the load curve diagram in the product manual for operation. Overloading, exceeding weight limits, or operating beyond capacity is strictly prohibited.
 32. The product must undergo regular maintenance and servicing. Refer to the maintenance manual for details.
 33. Manual operation is only permitted in emergencies and must not be used for normal operation. Before manual operation, ensure the entire system is fully activated.
2. Requirements for Operators
 1. The operator shall understand their rights and responsibilities, be familiar with all safety instructions, including the user manual.
 2. The operator shall pay attention to the working environment, including other personnel nearby as well as fixed or moving objects.
 3. The operator shall be responsible for the vehicle during operation and shall not allow unauthorized personnel to operate the vehicle. When leaving the vehicle, measures shall be taken to prevent its use by unauthorized personnel.
 4. Standing on the equipment is strictly prohibited.

5. The operator shall warn all personnel near the vehicle of potential hazards. Before starting the vehicle, ensure no one remains in the hazard zone. During vehicle operation, if any potential danger to personnel is detected, a warning signal shall be issued promptly. If personnel do not leave the hazard zone after the warning, the operator shall immediately stop the vehicle.
3. Road Surface Requirements
 1. Although the vehicle is equipped with a shock absorption system, it is still required to operate on flat road surfaces. Ramps should be provided when necessary to avoid collisions with wheels, which may cause rigid damage.
 2. Do not use the vehicle on cracked or damaged surfaces.
 3. The road surface in the workplace should be sufficiently firm, flat, and free of obstacles.
 4. The slope of the ramp on which the vehicle operates should not exceed the gradient value specified in the performance parameter table, and measures should be taken to prevent the vehicle from slipping.
 5. The operating surface in narrow aisles should be flat, dry, level, free of cracks or damage, and clear of obstacles. The aisle size should comply with the parameters specified in the performance parameter table, such as turning radius.
 6. When the vehicle is carrying cargo, sufficient clearance should be maintained between the vehicle and fixed objects in the surrounding environment. The outline or boundary of the passage should be clear. If the cargo size differs from the specified value, confirm whether a wider passage width is required.
4. Regular Inspection

Maintenance operators need to perform regular maintenance on the equipment in accordance with the maintenance instructions. Please refer to the "Maintenance Instructions" of this manual for details. Equipment that is not regularly inspected and maintained poses a safety hazard.

Operating Requirements

1. Operation on Slopes
 1. Operation is only permitted on slopes that can be climbed as specified in the performance parameter table.
 2. U-turns, diagonal operation and diagonal parking on slopes are prohibited..
2. Operation in Elevators or Lifts
 1. Before driving the vehicle into an elevator or lift, ensure that the elevator or lift can bear the total weight of the vehicle and its load.
 2. Ensure that no part of the vehicle comes into contact with the walls of the elevator or lift cabin.
 3. Ensure that the vehicle does not move unexpectedly.
3. Load Handling
 1. Ensure that no personnel remain in the operating path or direction of travel.
 2. Provide appropriate auxiliary tools for load control when necessary.
 3. When handling loads with unstable or excessively high centers of gravity, observe the following precautions:
 - Operate at a low speed, brake and turn carefully to avoid load instability;
 - Do not operate on slopes with loads that have unstable or excessively high centers of gravity.

4. Forklift Parking and Storage Safety

1. The forklift should be stored in a dry, ventilated, and cool environment, avoiding direct sunlight, high temperatures, high humidity, corrosive gases, severe vibration, and stacking. Stacking is strictly prohibited; one vehicle per stack is required.
2. Since the forklift contains a battery, ensure the equipment is powered off during storage. Any form of discharge during storage is prohibited. Clearly visible warning and hazard signs must be posted in the storage area.
3. The forklift must not be stored with flammable materials such as packaging. Immersing the forklift in water is prohibited.
4. For long-term storage, perform routine charging maintenance every 6 months using the original charger, as specified in the manual, by trained personnel (consult the manufacturer for details).
5. Note that the ambient temperature during charging should be between 5°C and 35°C. Charging in environments below 0°C is prohibited, as it may cause irreversible damage to the battery.
6. During storage, maintain the ambient temperature between 10°C and 35°C, with humidity between 20% and 80%.
7. Avoid storage exceeding 1 year. If stored for more than 1 year, check the battery charge and ensure all other components are functioning properly before use. The vehicle must pass inspection before being put back into operation.

5. Operational Safety Instructions

1. Be familiar with the vehicle so that when the vehicle breaks down you can accurately describe the problem and help maintenance personnel quickly repair it. Trained operators must be familiar with all functions of the vehicle.
2. Report any vehicle malfunctions (abnormal sounds, hydraulic oil leaks, etc.). Ignoring minor malfunctions may result in greater damage.



CAUTION

Hydraulic oil and electrolyte leaks must be reported as they are dangerous and may cause pollution.



CAUTION

If a burnt odor is detected, immediately perform the following actions: stop the vehicle, cut off power, disconnect the battery's charge/discharge connectors, and swiftly identify the source of the malfunction.

Material Safety Instructions

1. Hydraulic Oil
 - Avoid contact with skin.
 - Do not breathe hydraulic fluid vapors.
 - Do not dump hydraulic oils in the outside world at will, as they will pollute the environment. Collect them and pour them into designated containers.
 - Please wear protective clothing during maintenance to prevent hydraulic oil from contacting your skin.



DANGER

Hydraulic oil poses severe hazards upon skin contact. If exposure occurs, seek immediate medical attention.

2. Lithium Battery Safety Protocols

- Inhaling electrolyte vapor (neurotoxic) is strictly prohibited.
- Implement protective measures (e.g., wearing PPE) to avoid skin contact.
- In case of skin contact, immediately flush with copious water for at least 15 minutes.
- Storage areas must comply with legal requirements (e.g., designated fire-resistant zones).
- Smoking, open flames, high-temperature equipment, or ignition sources are prohibited in battery storage areas.



CAUTION

For more detailed information, please refer to the battery manual.

6. Main Labels

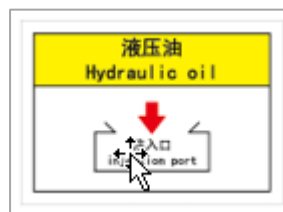
1. Lifting mark



2. Operation precautions



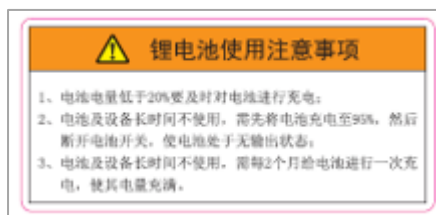
3. Hydraulic oil filling



4. No standing under forks



5. Lithium battery safety precautions



6. No stepping on surface



7. Warning, hands pinching



7. Safety Devices

Safety devices are used to ensure maximum safety and minimum risk. The safety devices on the vehicle are as follows:

- Emergency Stop Button
- Anti-Collision Edge

目录

Safety Instructions for Use	III
1 Safety Overview	1
1. 1 Disclaimer	1
1. 2 Environmental Requirements	1
1. 3 Fire Safety Requirements	2
1. 4 Operation Requirements	2
1. 5 Machine Inspection	3
1. 6 Load Requirements	4
1. 7 Parking Requirements	4
1. 8 Battery Requirements	4
1. 9 Repair and Maintenance	5
1. 10 Elevator/Lift Requirements	6
1. 11 Safety Devices	6
2 Product Overview	7
2. 1 Product Introduction	7
2. 2 Features	7
2. 3 Product Specifications	9
2. 3. 1 Product Parameter Table	9
2. 3. 2 Product Dimensional Drawing	10
2. 3. 3 Overall View	11
3 Operating Instructions	12
3. 1 Equipment Start-up and Emergency Stop	12
3. 2 Manual Operation	13
3. 3 Implementation	13
3. 3. 1 Map Scanning and Editing	13
3. 4 Charging	13
3. 4. 1 Automatic Charging	14
4 Introduction to Forklift Components	14
4. 1 Status Indicator Light and Blue Light	14
4. 2 LCD Screen Menu Instructions	15
4. 2. 1 Home Page Information	15
4. 2. 2 Real-time Information	16
4. 2. 3 Operation and Control	17
4. 2. 4 System Information	18
4. 3 Power Switch	19
4. 4 Emergency Stop Button	19
4. 5 Lifting&Lowering Button	19
4. 6 Auto/Manual Mode Knob	20
4. 7 Confirm Button	20
4. 8 Navigation Laser Sensor	20
4. 9 Safety Laser Sensors	20
4. 9. 1 Purpose	20

4. 9. 2 Protected Areas	20
4. 9. 3 Protected Area Settings	21
4. 10 Collision Mechanism	21
4. 10. 1 Anti-Collision Edge.....	21
4. 10. 2 Mechanical Anti-Collision Mechanism of Fork	21
4. 11 Pallet Position Detection Module	21
5 Alarm Description	22
6 Obstacle Avoidance Instructions	23
Appendix 1 Frequently Asked Questions	25
Appendix 2 Wireless Network Requirements.....	29
Appendix 2.1 Key Points for Wireless AP Point Layout	29
Appendix 2.2 Configuration Requirements for Wireless Network.....	31
Appendix 3 Legal Statement	32
Appendix 4 Cybersecurity Recommendations.....	33

1 Safety Overview

1.1 Disclaimer

- All losses caused by unreasonable use are the responsibility of the user himself, and HuaRay Technology does not bear any responsibility.
- However, even if all operations are carried out in accordance with the safety instructions, it cannot be guaranteed that the machine will not cause any personal injury or property loss.
- HuaRay Technology is not responsible for personal injury or property loss caused by replacing or modifying Parts.

1.2 Environmental Requirements

- The robot is designed for automated operation within enclosed workspaces and is exclusively intended for indoor cargo transportation.
- Operating temperature: 0°~40° (with heated battery: -10°~+40°), operating humidity: 10%~90%, no condensation.
- Use of the robot is strictly prohibited in environments with explosion hazards.
- Use of the robot is strictly prohibited in sites that do not meet Huarui Technology's installation requirements.
- Install isolation barriers in the robot's operating area and strictly prohibit personnel from entering.
- The operating site must be kept clean, free of water, oil, or other substances that may cause the robot to slip. Any scattered materials on the ground must be cleared immediately.
- Operation of the robot is strictly prohibited in damaged sites to prevent cargo tipping due to bumps.
- During project implementation, ensure that aisles, ceilings, and other dimensions are suitable, allowing the robot to operate smoothly in aisles and preventing the fork from scraping the ceiling during lifting.

Transportation and Unpacking:

- Before transportation, check the wooden crate for sturdiness to prevent damage to the robot due to loose packaging.
- Avoid severe vibration and jolts during transportation to prevent mechanical impact on the robot.
- During loading and unloading, throwing, rolling, or heavy pressing is strictly prohibited.
- Do not expose the wooden crate to outdoor conditions, direct sunlight, or rain.

- Use a crane or forklift to move the robot's wooden crate.
- Tilted placement of the wooden crate is strictly prohibited.
- Stepping on the wooden crate is strictly prohibited.
- Wear protective gloves during unpacking to avoid cuts from tools or sharp parts of the crate.
- After unpacking, first verify the functionality of the emergency stop button, pneumatic collision strip, and obstacle avoidance laser sensor.
- Always use a ramp to transfer the robot from the crate to the ground. Manual handling of the robot is strictly prohibited.
- After unpacking, properly store the original packaging, paper manuals, etc., for future transportation of the robot.

1. 3 Fire Safety Requirements

- During project planning, design fire safety measures (e.g., fire extinguishers, sand buckets, emergency exits, firewalls) in accordance with the national standard "Code for Fire Protection Design of Buildings".
Recommended fire safety solution for charging piles: Equip each charging pile with a dry powder fire extinguisher or sand bucket within a 5-square-meter area; or design a dedicated safety room.
- In the event of a robot fire, firefighters must wear a filtering gas mask (full-face) or an isolation respirator, and a full-body firefighting and anti-toxic suit, and extinguish the fire from the upwind direction. Available extinguishing agents include: mist water, foam, dry powder, carbon dioxide, and sand.
- The use of open flames is strictly prohibited in the robot's operating environment.

1. 4 Operation Requirements

- Provide training to operators on the use, safety, and maintenance of robots. Ensure operators comply with operating procedures, safety regulations, and have the ability to assess potential hazards in the work to be performed.
- It is prohibited to operate the robot by untrained personnel. If the robot is used without permission, the operating company and the operator shall be fully responsible, not the manufacturer.
- Operation of the robot by unauthorized personnel is prohibited.
- To ensure safety, all personnel entering the venue are required to wear safety protective equipment such as helmets, safety shoes, reflective vests, and safety gloves.
- Operators must strictly abide by this manual and various electrical safety regulations of the country and area of use.
- The robot operates automatically and there are no operators directly on the product.

- Operators on site are required to wear personal protective equipment (PPE) to minimize the harm caused by the noise generated by the robot during operation.
- It is strictly forbidden to operate the robot when your hands or feet are covered with water, oil or other slippery substances.
- During operation, no personnel are allowed to enter the working area of the robot. Entering the running route of a robot and walking towards a moving robot may result in collisions and crushing by the robot.
- Before starting the robot, make sure there are no obstacles in the robot's operating area.
- Heart failure patients who require pacemakers or defibrillators are not allowed to enter this area as the electromagnetic field in this area may cause pacemakers or defibrillators to malfunction.
- When the robot is running, the indicator light will flash according to the operating status. It is strictly forbidden to stare at the indicator light for a long time.
- If the robot comes into contact with any liquid: first turn off the power, remove as much liquid as possible, and do not restore power until the robot is dry.
- It is strictly forbidden to place your hands under the turntable of a latent robot or in the middle of the rollers of a roller robot.
- When a manual cart is required to transfer latent and mobile robots, both hands should be placed on the rear panel, and not on the turntable or in the gap between the turntable and the body to prevent hands from being pinched.
- It is strictly forbidden to walk, stand or sit on the forks of the forklift robot.
- When a robot stops working, do not assume that it has completed its work, as the robot is likely waiting for the next task.
- It is strictly forbidden to lean on the robot.
- Please do not press the operation buttons randomly.

1.5 Machine Inspection

- Before using the robot, first conduct a corresponding inspection on the robot to ensure that all parts of the robot are normal and not damaged.
- Only robots that have been maintained as required can be used. It is strictly forbidden to use faulty robots for operations. Before starting the robot, make sure that there is no one in the robot's working area and operating route.
- The robot has the following built-in safety devices to ensure its safe operation. If there is any defect or failure, the machine must be shut down immediately or not put into operation.

Emergency stop button: When the robot malfunctions and needs to be stopped urgently, you can manually press the button and the robot will stop immediately.

Bumper strip: When an obstacle collides with the robot's pneumatic bumper strip, the robot will stop and alarm.

Obstacle avoidance sensor: The obstacle avoidance sensor will scan the operating environment, and

when an obstacle is detected, it will control the robot to slow down or stop to avoid a collision between the robot and the obstacle.

- When setting the robot speed, acceleration, deceleration, and rotation speed, please do not exceed the recommended values.

1. 6 Load Requirements

- It is strictly prohibited to use the robot to transport people or animals.
- It is strictly prohibited to use a robot to carry, drag or fork another robot.
- The cargo to be transported by the robot must be structurally stable and must be placed evenly and symmetrically on the robot.
- It is strictly prohibited to load eccentric cargo.
- It is strictly prohibited to transport cargo whose dimensions exceed the carrying capacity of the robot.
- It is prohibited to transport cargo that exceeds the rated load of the robot. (The rated load information can be found on the robot body nameplate. The placement of cargo on the forklift robot must comply with the load curve diagram.) Overloading will affect the robot's braking distance and stability.
- Ensure the combined weight of the robot and cargo does not exceed the load-bearing capacity of the floor.
- Before the robot enters the elevator, it must ensure that the elevator can withstand all weight (the robot's own weight, the load weight and the operator's weight).

1. 7 Parking Requirements

- When planning a project, it is necessary to design a robot storage area to park robots that are temporarily not in use.
- It is prohibited to park the robot on a slope and leave it unattended.
- It is prohibited to park the robot in front of emergency exits, fire extinguishers, etc.
- When the robot needs to be parked somewhere temporarily, warning signs need to be placed in front and behind the robot, and it should be moved as soon as possible.

1. 8 Battery Requirements

- Only use the original charging station to charge the robot.
- It is prohibited to replace battery cells and BMS without permission.
- Batteries require regular maintenance.
- Good ventilation should be maintained during charging and fireworks are strictly prohibited.

- When checking the battery, you should wear protective glasses and gloves. If the battery leaks and the liquid splashes onto the skin or eyes, rinse with clean water as soon as possible and seek medical attention immediately.
- Do not squeeze or disassemble the battery. If the battery is damaged, it may cause it to overheat, burn or explode.
- Do not get batteries wet.
- When a battery catches fire, use a foam fire extinguisher, dry powder fire extinguisher or fire sand to put out the fire. It is strictly prohibited to use water to extinguish the fire.
- Batteries should be transported and stored in a half-charged condition (more than 50% of the battery's nominal capacity).
- If the robot needs to be stored for a long time, charge it every 3 months.
- The maximum number of charging cycles for the robot battery is 1500~2000 times, and the battery must be replaced before the end of its service life.
- Batteries are classified as toxic and hazardous waste and scrapped batteries must be disposed of in accordance with applicable national laws, regulations and standards.
- A dedicated charging area should be set up for the robot and personnel are strictly prohibited from entering to prevent the robot from being injured when entering the charging area to charge.

1.9 Repair and Maintenance

- Arrange professional maintenance personnel to perform regular maintenance on the robot according to the robot maintenance manual and maintenance inspection list.
- During project planning, maintenance areas must be divided. Robot maintenance can only be performed in the maintenance area, and maintenance in the working area is strictly prohibited.
- The power must be turned off before maintenance on robot, and maintenance with power on is strictly prohibited.
- For operations that require suspending the robot, such as replacing casters, batteries, and ground code cameras (scanning terminals, camera components), the robot must be placed on a work vehicle and it is strictly prohibited to leave it suspended in the air without support.
- Robots are large and heavy equipment. It is strictly prohibited to move or overturn robots manually.
- When maintaining the robot's rotating parts, such as drive components, electric lifting mechanisms, and slewing mechanisms, it is strictly prohibited to wear gloves to prevent the gloves from getting stuck in the parts.
- When repairing parts other than rotating parts, maintenance personnel must wear work gloves to prevent injuries from certain sharp parts or the sharp edges of the robot itself.
- Product manuals, identification plates, mechanical structures, electronic systems and software must not be modified without the manufacturer's consent, and third-party installation parts must not be used, otherwise the warranty will be void.

- The manufacturer is not responsible for personal injury or property damage caused by replacement or modified parts.

1. 10 Elevator/Lift Requirements

- After the landing door and car door are closed, the gap between the door leaves and between the door leaves and the door pillars, as well as between the passenger and cargo elevators, cannot exceed 10mm. The horizontal distance between the car door and the closed landing door, or the passage distance between each door during the entire normal operation period, must not exceed 0.12m.
- The horizontal distance between the car sill and the landing door sill shall not be greater than 35mm.
- Arrange professional maintenance personnel to regularly repair and maintain elevators/lifts in accordance with the maintenance requirements of elevators/lifts.
- According to the on-site environment, set up a safe area for on-duty personnel to perform duties. This area cannot be on the robot's operating route.
- It is prohibited to transport people in elevators/lifts that transport robots.
- Precautions for meeting an elevator/lift malfunctioning:
 1. First, you need to pause the robot through the robot control platform, monitoring client, or by pressing the emergency stop button.
 2. In the robot remote control platform, disable all access routes to elevators/lifts.
 3. Place warning signs at the elevator/lift door to prohibit non-professional maintenance personnel from entering.
 4. Notify the monitoring center to monitor the elevator/lift status.
 5. Arrange engineering personnel to the machine room to turn on the manual mode of the elevator/lift, and place warning signs at the door of the machine room to prohibit non-professional maintenance personnel from entering.
- The engineer manually adjusts the elevator to the level floor. If the robot is in the elevator, push the robot out manually or use a forklift to push the robot out and clear all equipment in the elevator before proceeding to the next maintenance step.

1. 11 Safety Devices

If any defect or malfunction of the safety device is detected, the machine must be shut down immediately or not put into operation.

The robot has the following built-in safety devices to ensure its safe operation in the intended environment.

- Emergency stop button: When the robot malfunctions and needs to be stopped urgently, you can manually press the button and the robot will stop immediately.
- Bumper strip: When an obstacle collides with the robot's pneumatic bumper strip, the robot will stop and alarm.

- Obstacle avoidance sensor: The obstacle avoidance sensor will scan the operating environment, and when an obstacle is detected, it will control the robot to slow down or stop to avoid a collision between the robot and the obstacle.

2 Product Overview

2.1 Product Introduction

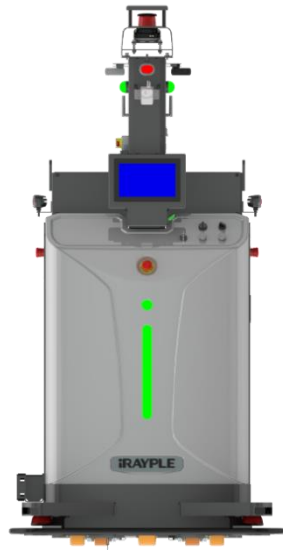
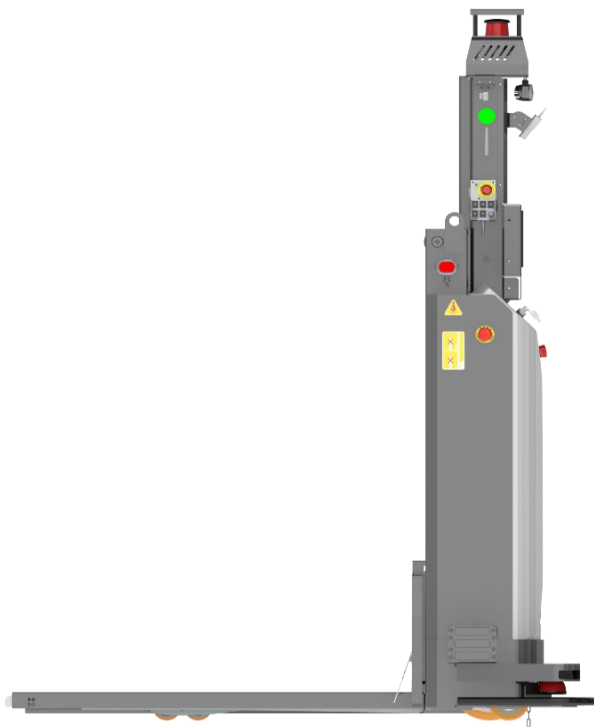
RTA-F140-L-H100-620CE-EU2-1500 Forklift F140 The rated load of the forklift is 1000kg, be able to carry and lift(maximum 1meter), adopts laser SLAM navigation and single steering wheel drive, and is mainly used for material handling and stacking in and out of storage, etc.

RTA-F140-L-H200-620CE-EU2-1200 Forklift F140 The rated load of the forklift is 1000kg, be able to carry and lift(maximum 1.6meters), adopts laser SLAM navigation and single steering wheel drive, and is mainly used for material handling and stacking in and out of storage, etc.

2.2 Features

The main features of the F140 stacker forklift are as follows:

- 3D Vision Positioning System: Enables autonomous pallet recognition with intelligent pose calibration for precise docking.
- Omnidirectional Steering Wheel Drive: Achieves agile operation in narrow 2100mm-wide aisles.
- Multi-Sensor Obstacle Avoidance: Combines LiDAR and vision fusion technology for 360° safety protection.
- Adaptive Arc Trajectory Planning: Supports curved path navigation with a maximum speed of 1.5m/s.
- Automotive-Grade Li-ion Battery: Features fast-charging capability and 30% improved energy efficiency.
- Five-Layer Safety Protection: Emergency stop, load-aware obstacle detection, audible/visual alarms, anti-drop sensors, and overload protection.
- 10" Industrial HMI: Real-time monitoring of operational status and parameters via touchscreen interface.
- Dual-Band Wi-Fi (802.11b/g/n/ac) + 5G Cellular Connectivity (Optional): Ensures high-speed and stable communication.



2. 3 Product Specifications

2. 3. 1 Product Parameter Table

RTA-F140-L-H200-620CE

		Item	Symbol	Unit	Parameter
Specification	1.1	Manufacturer			HuaRay
	1.2	Model			RTA-F140-L-H200-620CE
	1.3	Powered by (Electric/Diesel/Gasoline/Natural Gas/Manual)			Electric
	1.4	Operation Mode (Manual/Walkie/Stand-On/Sit-Down/AGV/Order Picker)			AGV
	1.5	Rated Load Capacity	Q	kg	1500
	1.6	Load Center Distance	c	mm	600
	1.7	Front Overhang	x	mm	647
	1.8	Wheelbase	y	mm	876
Weight & Wheel	2.1	Curb Weight (Incl. Battery)		kg	As per Nameplate
	2.2	Axle Load (Loaded): Drive/Support Side		kg	
	2.3	Axle Load (Unloaded): Drive/Support Side		kg	
	3.1	Tire Type (Solid Rubber/Elastomer/Pneumatic/Polyurethane)			Polyurethane
	3.2	Drive Wheel Dimension		mm	$\Phi 230 \times 75$
	3.3	Load Wheel Dimension		mm	$\Phi 80 \times 54$
	3.4	Stabilizer Wheel Dimension		mm	$\Phi 115 \times 55$
Basic Dimensions	3.5	Wheel Quantity (Drive Wheels $\times$ / Load Wheels)			1 $\times$ -2/4
	3.6	Track Width: Support Side	b11	mm	440
	3.7	Track Width: Drive Side	b10	mm	538
	4.1	Overall Height	h1	mm	2210
	4.2	Lift Height	h3	mm	1000
	4.3	Mast Extended Height	h4	mm	2530
	4.4	Fork Lowered Height	h5	mm	85
	4.5	Overall Length	L1	mm	1751
	4.6	Fork Face to Front Edge	L2	mm	540
	4.7	Overall Width	b1	mm	1067
	4.8	Fork Dimension	s/e/l	mm	60/180/1150

	4.9	Fork Spread	b5	mm	620
Performance	4.10	Min. Ground Clearance	m1	mm	30.5
	4.11	Min. Aisle Width for 90° Stacking	Ast	mm	1902+200
	4.12	Min. Turning Radius	Wa	mm	1267
	5.1	Travel Speed: Loaded/Unloaded		km/h	5/6
	5.2	Lift Speed: Loaded/Unloaded		mm/s	115/150
	5.3	Lowering Speed: Loaded/Unloaded		mm/s	160/125

2. 3. 2 Product Dimensional Drawing

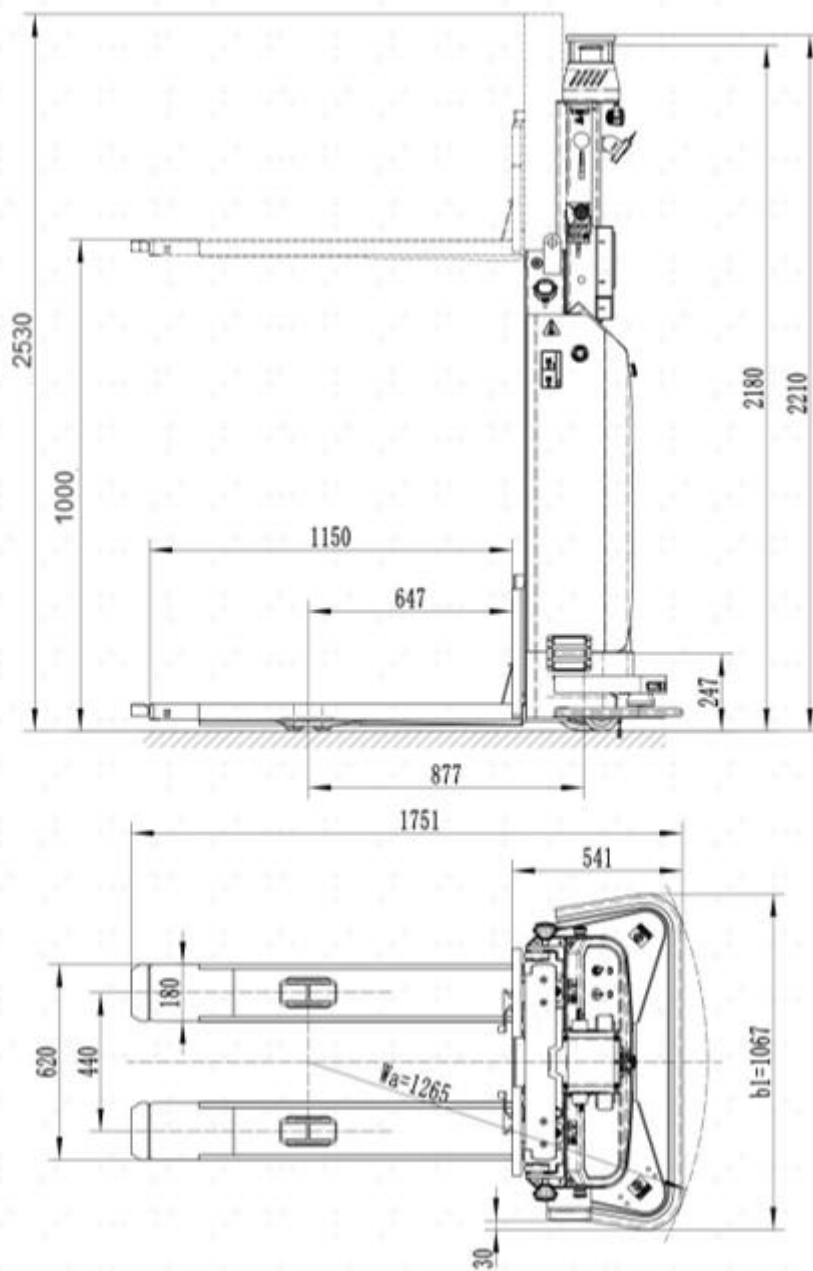
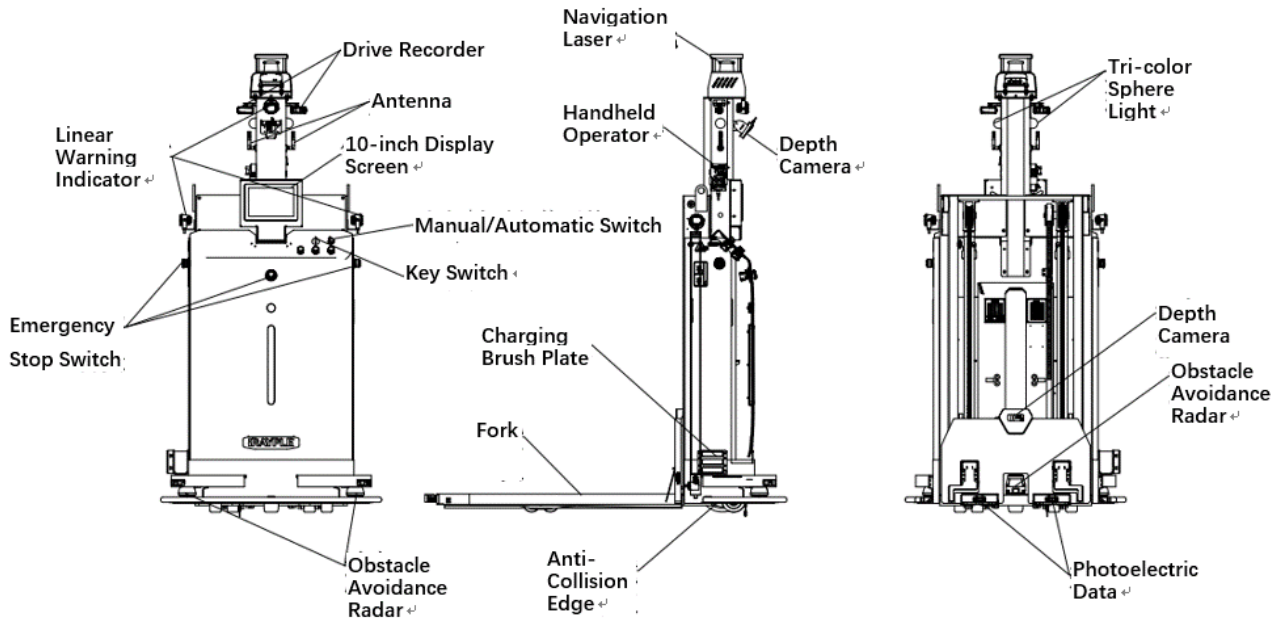


Figure 2-1 Equipment Dimension Drawing(unit: mm)

2. 3. 3 Overall View



 LASER RADIATION

Number	Name	Description
1	Navigation Laser	Real-time positioning and obstacle avoidance
2	Linear Warning Indicator	<p>Equipment Status Indicator</p> <ul style="list-style-type: none"> ● Green Light <ul style="list-style-type: none"> ◇ <i>Operating status</i>: Solid light indicates normal operation. ◇ <i>Charging status</i>: Solid light indicates charging in progress. ● Yellow Light <ul style="list-style-type: none"> ◇ <i>Flashing</i>: Indicates the device is in sleep mode. ◇ <i>Solid light</i>: Indicates the device is idle/standby. ● Red Light <p><i>Equipment fault</i>: Solid or flashing light indicates one of the following anomalies:</p> <ul style="list-style-type: none"> ◇ Network signal anomaly ◇ Equipment malfunction ◇ Low battery or hibernation due to insufficient power ◇ Obstruction detected <p> <i>Low-battery charging</i>: Red light flashes.</p>
3	Power Knob	Power switch of the electrical control box

Number	Name	Description
4	Manual/Automatic	Used to switch automatic/manual mode of F140 forklift equipment
5	Confirm Key	Press the confirm key to complete the manual intervention.
6	Emergency Stop Button	<ul style="list-style-type: none"> Press this button to stop the mechanical device of the equipment from operating Rotate to pop up this button and the device has released the emergency stop
7	Key Switch	Control the on and off of the vehicle's main power supply
8	Handheld Operator Interface	Used to connect handheld operator
9	Charging Brush Plate	Used for charging
10	Obstacle Avoidance Laser	Detect obstacles in the travelling path
11	Anti-Collision Edge	When a collision force is detected, report and stop the vehicle.

3 Operating Instructions

The use of the F140 forklift is divided into implementation and operation maintenance. This chapter explains the basic operational steps for implementation and operation maintenance. The F140 stacker forklift requires professional personnel to deploy and implement it upon arrival. After implementation, it can operate according to the established process.

3. 1 Equipment Start-up and Emergency Stop

Before using the vehicle, please ensure that daily inspections have been performed.



DANGER

- After the robot is turned on, the operator should leave the robot's working area to prevent the obstacle avoidance sensor from detecting interference and causing robot abnormalities.
- Clear obstacles on the operating site to ensure that the robot's working path is unobstructed.

Equipment Start-up: Turn on the emergency stop button and rotate the side key switch clockwise to power on the battery. Operate the equipment after it is fully turned on. Pay attention to the status of the automatic knob. If you want it to operate automatically, turn it to the automatic position.



CAUTION

After pausing the robot, it will not accept any tasks from the robot control system.

Equipment Pause: The robot can be paused by the following operations.

Release the robot's on/off button.

Press the robot's emergency stop button.

Log in to the monitoring client and pause the robot.

Equipment Shutdown: Turn off the key switch.

Manual Operation: Connect the handheld operator to the socket, rotate the manual/auto switch to the manual position, and the handheld controller's indicator light will illuminate, indicating that manual operation is now available. For detailed operating steps, please refer to Section 3.2 Manual Operation.

3. 2 Manual Operation

After the equipment arrives at the site, first remove the packaging and place the equipment on the ground.

The forklift F140 is equipped with two lifting rings; please use a crane or other lifting equipment to hoist the forklift F140 from the wooden pallet and lower it to the ground. Ensure that the wheels are on a flat surface, and then manually drive the forklift F140 to the designated area.

After powering on the equipment, rotate the switch to manual mode, and you can remotely operate the equipment using the handheld controller.

In case of an emergency stop, press the emergency stop button on the vehicle.

If the vehicle needs to be parked for an extended period, lower the forks to the lowest position and turn off the battery key switch.

3. 3 Implementation

The formal implementation operation is divided into several steps including equipment network configuration, map scanning, map editing, and platform configuration.

For specific operation steps, please refer to the training course and training materials "Implementation Manual".

3. 3. 1 Map Scanning and Editing

Laser maps are constructed through mapping tools and remote control equipment.

After the map scanning is completed, the map needs to be processed, including marking points, drawing lines, and editing, to obtain the final map.

Once the map is completed, proceed with platform configuration. Use the RCS client to configure tasks. For detailed steps, please refer to the implementation training materials and the "RCS&ICS Configuration Document."

3. 4 Charging

The power source of the stacker forklift F140 is a lithium iron phosphate (LiFePO₄) battery. It can be charged using the matching charging station or a portable handheld charger.

3. 4. 1 Automatic Charging

The automatic charging pile charges the F140 forklift through RCS unified scheduling. The charging pile features a retractable side charging design.

After the automatic charging pile is configured, the F140 forklift can be dispatched by RCS to charge



autonomously.

4 Introduction to Forklift Components

4. 1 Status Indicator Light and Blue Light

Table 4-1 Status Description

Indicator Lights	Status	Description
Blue Light	Solid Blue Light	The robot is powered on.
Status Indicator Light	Solid Yellow Light	Indicates that the device is idle.
	Yellow Light Flashing	Indicates that the device is in sleep mode
	Solid Green Light	Operating status: Solid light indicates normal operation. Charging status: Solid light indicates charging in progress.
	Solid Red Light	Equipment fault: indicates one of the following anomalies: ◇ Network signal anomaly

		◇ Equipment malfunction ◇ Low battery or hibernation due to insufficient power ◇ Obstruction detected
	Red Light Flashing	Low-battery charging: Red light flashes.

In addition to indicating the status, the indicator light also functions as a turn signal. When the robot turns, the status indicator light on that side will flash.

4. 2 LCD Screen Menu Instructions

The main function of the LCD screen is to display the robot's current motion status information, task information, alarm information, obstacle avoidance data, and map configuration information.

4. 2. 1 Home Page Information

The real-time task information on the home page contains three parts:

- Status Bar: Home Page, Real-time Information, Operation Control, System Information
- Top of Page: Time, Signal Strength, Battery Power, Manua/Automatic Status, Operating Status, Network Status;
- Bottom of Page: Device Address, Battery Level





Figure 4-1 Home Page Interface

4. 2. 2 Real-time Information

You can view the current system information, platform tasks and status, etc.



Figure 4-2 Real-time Information Interface

System Maintenance & Platform Alarm Information: You can view the current operating time and related maintenance information.



Figure 4-3 Maintenance Information Interface



Figure 4-4 Device Abnormality Interface

Recent Abnormality&Safety Status: You can view recent device abnormalities and safety status

4. 2. 3 Operation and Control

Enter the device control interface to control the lifting and lowering of the current device as well as the volume control.

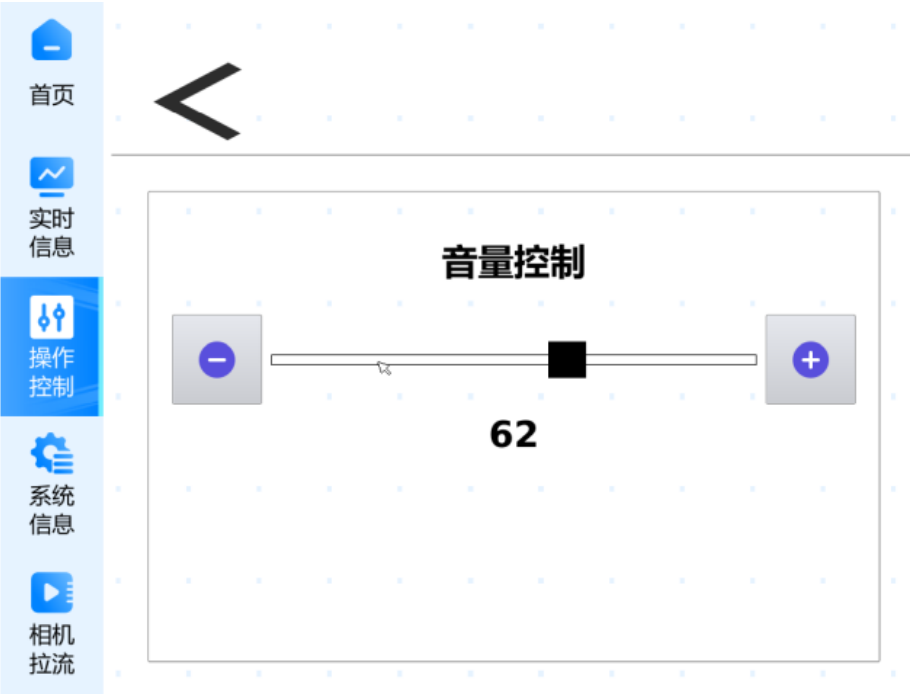


Figure 4-7 Volume Control Interface

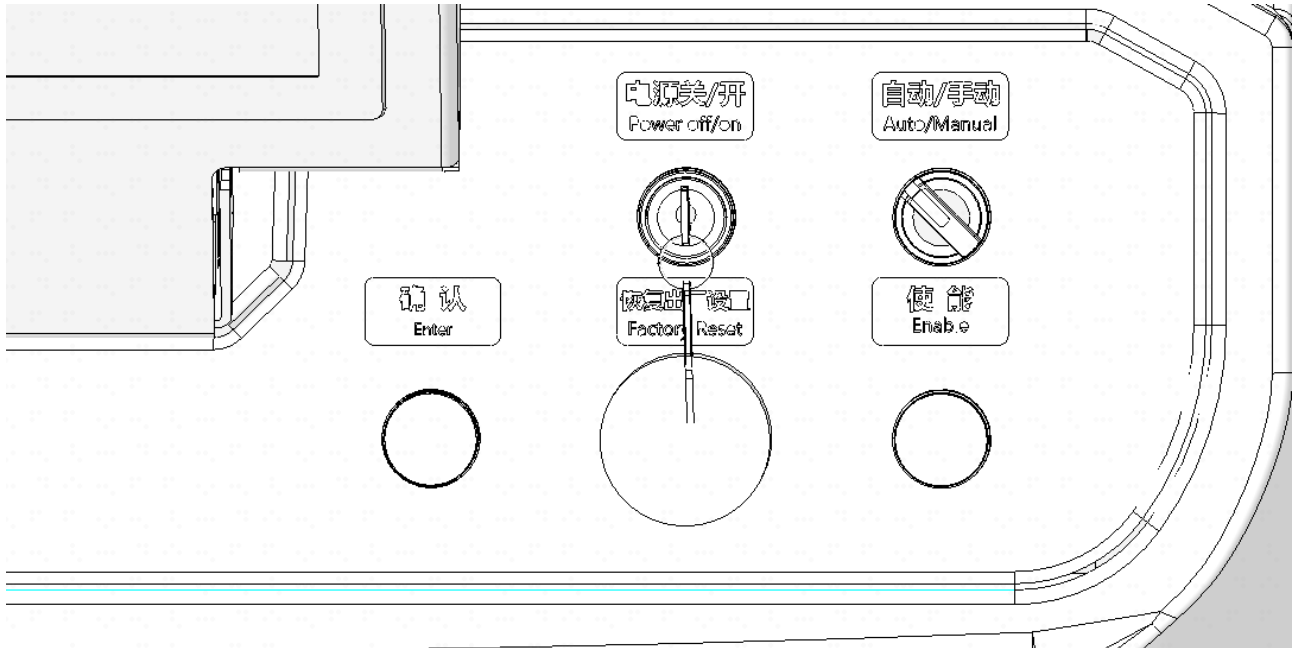
4. 2. 4 System Information

Enter the system information interface to query various software version information and device models.



Figure 4-10 Version Information

4. 3 Power Switch



NOTE

- Do not power off the robot while it is in motion.
- Turn the power switch to "Power on" to turn on the robot. After startup, you need to press the "Factory Reset" so that the robot can operate normally
- Turn the power switch to "Power off" to cut off the power to the robot.

4. 4 Emergency Stop Button

- When the robot has an abnormality, press the emergency stop button, and then the robot will stop, issuing a voice alarm "Emergency stop button signal detected, please pull out the emergency stop button to restore", at this time, the red indicator light is solid.
- Pull out the emergency stop button and press the "Factory Reset", then the robot can resume the task and the red indicator light will go out.

4. 5 Lifting&Lowering Button

When you need to manually control the fork, first rotate the knob to "Manual" mode, then press the "Lifting/Lowering" button until the fork reaches the desired height, then releases.

4. 6 Auto/Manual Mode Knob

- Automatic Mode (A): The robot is in automatic mode by default. In this mode, the robot control system can be remotely controlled.
- Manual Mode (M): In this mode, the fork can be lifted/lowered manually and the robot can be transferred manually, but it will no longer receive platform tasks.

4. 7 Confirm Button

- When the robot's abnormal situation has been handled and it needs to resume work, in addition to pulling out the emergency stop button, you also need to press the "Confirm" button to resume normal operation.
- When the robot walks out of the topological point, the LCD screen displays "Task Abnormal". Press the "Factory Reset" and the robot will resume normal.
- After startup, the LCD screen displays "Task Abnormal" and a voice prompt appears "Vehicle Task Abnormal". You need to press the "Factory Reset" before the robot can operate normally.

4. 8 Navigation Laser Sensor

Navigation laser sensors mainly have the following purposes:

- Mapping: Scanning environmental information and collecting data for creating maps.
- Positioning: Determine the robot's position in the map based on the scanned environment information.

4. 9 Safety Laser Sensors

4. 9. 1 Purpose

The obstacle avoidance laser sensor is mainly used for obstacle avoidance: scanning the operating environment, and when an obstacle is detected, controlling the robot to slow down or stop to avoid a collision between the robot and the obstacle.

4. 9. 2 Protected Areas

- The top of the robot is equipped with a navigation laser;
- The left and right sides of the robot are equipped with laser obstacle avoidance sensors;

- The front and back of the robot are equipped with 3D cameras
- The fork tip is equipped with obstacle avoidance laser and infrared photoelectric.

4. 9. 3 Protected Area Settings

The range of the protected area can be planned in the robot control system. When the set protected area is larger than the capability of the sensor itself, the protected area is invalid.

4. 10 Collision Mechanism

4. 10. 1 Anti-Collision Edge

The robot is equipped with anti-collision edges to protect the robot. When the anti-collision edge collides with an obstacle, the robot will stop and alarm.

After the anti-collision edge is triggered, you need to press the emergency stop button and remove the obstacle. Then pull out the emergency stop button and press the “Factory Reset” before the robot can resume normal.

4. 10. 2 Mechanical Anti-Collision Mechanism of Fork

When the fork collides with an obstacle, the fork's mechanical anti-collision mechanism will protect the robot.

After the fork's mechanical anti-collision mechanism is triggered, you need to press the emergency stop button and remove the obstacle. Then pull out the emergency stop button and press the “Factory Reset” before the robot can return to normal.

4. 11 Pallet Position Detection Module

Used to detect whether the pallet is in the appropriate position. When the pallet is detected to be in the wrong position, the robot will alarm and manual intervention is required to place the pallet correctly.

5 Alarm Description

Alarm types are classified into level one and level two according to severity. For detailed alarm description, please see Table 5-1.

Table 5-1 Alarm Description

Alarm Type	Sub-alarm Type	Description
Level 1 Alarm	Drive Wheel Driver Initialization Failed	When an alarm is triggered, the red indicator flashes, the device stops running, and the alarm information is reported to the platform, waiting for manual intervention and maintenance.
	Drive Wheel Driver Communication Lost/Failed	
	Driver Stalled	
	Drive Wheel Motor Undervoltage	
	Drive Wheel Motor Overvoltage	
	Driving Wheel Motor Overcurrent	
	Drive Wheel Motor Overload	
	Drive Wheel Motor Overspeed	
	Drive Wheel Motor Overheating	
	Drive Wheel Motor Encoder Error	
Level 2 Alarm	Obstacle Detected	When an alarm is triggered, the red indicator flashes, and the alarm information is reported to the platform. The device will not process it by default.
	Emergency Braking Activated	
	Charging Malfunction	
	Network Disconnected	
	Pallet Docking Failed	
	LIDAR Malfunction	When an alarm is triggered, the red indicator flashes, and the device stops running. The device system automatically reports the alarm information to the platform and requires manual intervention.
	Collision Detected	
	Motor Not Initialized	

NOTE

After manual intervention, you need to press the device's "Confirm" button to confirm and end the operation.

6 Obstacle Avoidance Instructions

The following is the default obstacle avoidance configuration on the device. The actual obstacle avoidance configuration shall be based on the real scenario.

- The front end of the device uses lasers and visual sensors to perform safety monitoring within a certain range. If an obstacle approaches from a distance, it will automatically slow down. The device will move slowly in the slow-moving area (indicated by the yellow area) and stop moving in the stop area (indicated by the red area).

Figure 6-1 Schematic Diagram of F140 Forklift Straight forward to Exits Pallet Area and Obstacle Avoidance Stop
Schematic Diagram of Obstacle Avoidance Slow Movement and Parking when F140 Forklift Pallet
Docking

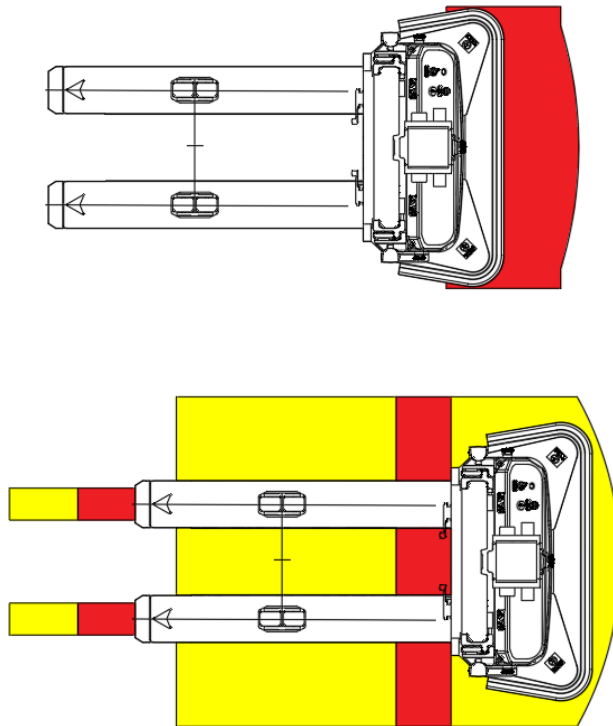


Figure 6-2 Schematic Diagram of the Sensing Area of the F140 Forklift Vision Camera

The diagram shows the obstacle avoidance range during no-load operation. Under loaded conditions, the shelving blocks the rear TOF sensor, preventing effective detection.

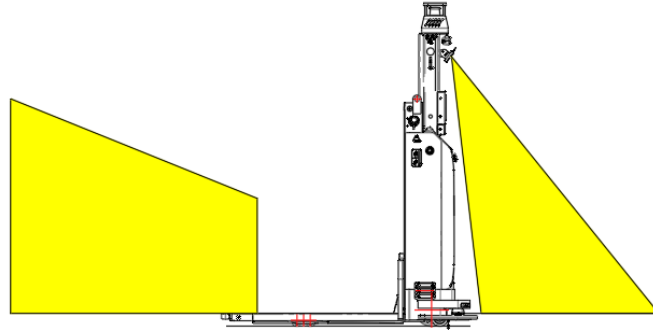


Figure 6-3 Schematic Diagram of the F140 Forklift's Front and Rear Arc Obstacle Avoidance When Turning Right

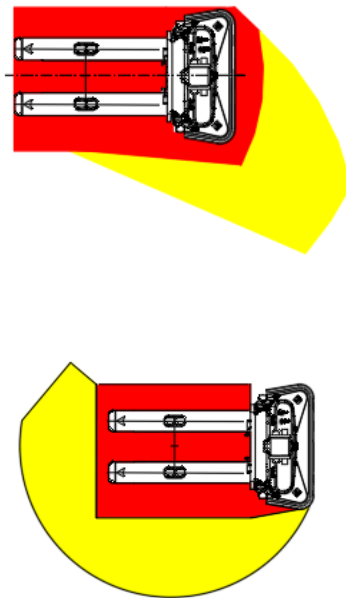
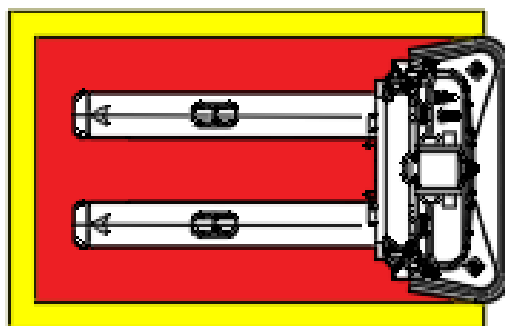


Figure 6-4 Schematic Diagram of the F140 Forklift Reverse Obstacle Avoidance



Appendix 1 Frequently Asked Questions

Hardware Related Issues

1. Common Problems and Solutions for the Drive System

(1) Vehicle Sway When Starting to Move

Troubleshooting Steps:

- Check if the chain is loose and whether the tension on the left and right sides is uneven;
Solution: Tighten the chain. The chain should have some elasticity when pressed.
- Check if the front casters are damaged, including whether the caster axle is broken or stuck;
Solution: Replace the casters.
- Check if the caster is tilted or misaligned, whether the casters are debonded or the rubber is displaced;
Solution: Replace the casters.
- Check if the drive wheels have detached rubber, shifted rubber, or uneven wear on the left and right sides;
Solution: Replace the drive wheels;
- Check if there is any unbalanced loading;
Solution: Cargo should be stacked evenly;

(2) Abnormal Noise During Movement

Troubleshooting Steps:

- If the noise is regular: Check if the casters or drive wheels are damaged, if foreign objects are stuck in the tire tread or wrapped around the axle, or if the tire tread is worn;
Solution:
 - 1) If foreign objects are stuck or wrapped around the axle, remove them.;
 - 2) If the tire tread is worn (more than 50% of the polyurethane thickness is worn), replace the wheel.
- If the noise is regular or irregular: Check if the sprockets and chain are severely worn, misaligned, or if foreign objects are wrapped around them:
Solution:
 - 1) If the sprockets and chain are severely worn, replace them;
 - 2) If the sprockets and chain are misaligned, adjust the motor mounting bracket to eliminate the misalignment;
 - 3) If foreign objects are wrapped around, remove them;
- If the noise is irregular: Check if screws are loose or if foreign objects have fallen inside the vehicle body;
Solution:
 - 1) If screws are loose, re-tighten them.;
 - 2) If foreign objects have fallen inside the vehicle body, remove them.;

(3) Abnormal Noise from the Drive Motor/Reducer.

Solution: Replace the motor/reducer

2. Common Problems and Solutions in Hydraulic Systems

- Pump Station Oil Leak/Seepage: Oil leakage/seepage at the pump station's P-port or oil tank;check

whether the oil pipe, adapter and sealing gasket here are damaged;

Solution: Replace damaged parts.

- Oil Tank Leak/Seepage: Check if the oil tank is damaged;

Solution: Replace the oil tank;

- Cylinder Oil Leak/Seepage: Check for damage to the cylinder's inlet adapter, sealing gasket, or oil pipe;

Solution: Replace damaged parts.

- Cylinder Descending under Load: Check the oil cylinder and find oil seeping out of the breathing hole, which indicates that the internal seal of the oil cylinder is damaged; the normal life of the oil cylinder is 20w times;

Solution: Replace the oil cylinder;

Check the oil cylinder and find that there is no oil leakage from the breathing hole, which indicates that the solenoid valve of the pump station is not closed normally;

Solution: Replace the solenoid valve;

Illustration:

- 1) The hydraulic oil should be replaced once every six months for the first time and once a year thereafter;
- 2) The sealing gasket should be replaced every 1-2 years;
- 3) The oil pipe should be replaced every 2 years.

3. Common Energy System Problems and Solutions

- Automatic Charging Failure;

Solution: Check wiring connections and reorganize/fix the cabling.;

- Successful docking but no discharge; check contact integrity with a multimeter;

Solution: If poor contact is detected, replace the contacts.

- Foreign objects on vehicle or charging pile contacts;

Solution: Remove foreign objects.

- Charging pile malfunction: contacts fail to extend or extend without discharge;

Solution:

- 1) Check for foreign objects blocking the extension mechanism and remove them;
- 2) If the battery does not discharge when extended, check the charger;

4. Common Sensor Issues and Solutions

- Loose connections, non-illumination, or network disconnection in blue lights, tricolor lights, or antennas;

For loose connections: Check for loose screws;

Solution: Re-tighten the screws;

For non-illumination or network disconnection: Inspect power supply lines and component integrity;

Solution: 1. Replace faulty components;

2. Reorganize wiring if line issues exist.;

- Navigation laser issues: tilt, power loss, network disconnection, positioning failure, or visible structural damage;

Solution:

- 1) For tilt: Adjust the laser mounting base to restore horizontal alignment.;
- 2) For power/network issues: Inspect and repair wiring;

- Obstacle-avoidance laser issues: tilt, power loss, network disconnection, close-range false detection, or visible structural damage:

Solution:

- 1) For tilt: Adjust the laser mounting base;
 - 2) For power/network issues: Inspect wiring;
 - 3) For close-range false detection: Clean foreign objects from the laser surface or adjust its angle if reflecting on the vehicle body;
 - 4) Replace components with visible structural damage;
- Front/Rear Depth Camera Issues: tilt, power loss, network disconnection, close-range false detection, or visible structural damage;

Solution:

- 1) For tilt: Adjust the camera mounting base;
 - 2) For power/network issues: Inspect wiring;
 - 3) For close-range false detection: Clean foreign objects or adjust camera angle;
 - 4) Replace damaged components.
- Pallet Positioning Mechanism; the baffle cannot rebound normally and the baffle is severely deformed;

Solution:

- 1) Check whether there is any foreign object stuck and remove it;
 - 2) Check for spring damage and replace the spring;
 - 3) Find out what causes the serious deformation, whether it is man-made or accidental, and replace the baffle;
 - 4) Frequent damage will be reported to R&D and the baffle will be replaced;
- Positioning Sensor Malfunction: the sensor bracket is damaged and needs to be replaced;

Solution: Check whether the positioning sensor can be triggered normally. You can use a screwdriver to pry it open to see if the sensor light is on;

- 1) Lights up, adjust the distance between sensor and baffle;
- 2) If it doesn't light up, check the circuit and replace the sensor;
- (1) There are problems with the upper and lower limits and the structure cannot reach the lower limit;

Solution:

- 1) Check whether there are any foreign objects blocking the fork from descending and remove them;
- 2) Check whether the fork has reached the lowest point and increase lubrication on the fork's moving structure;
- 3) Adjust the lower limit position;
- (2) There are problems with the upper and lower limits and the structure cannot reach the lower limit;

Solution:

- 3) Check whether there are any foreign objects blocking the fork from descending and remove them;
- 4) Check whether the fork has reached the lowest point and increase lubrication on the fork's moving structure;
- 5) Adjust the lower limit position;
- (3) There is a problem with the upper and lower limits, and the sensor fails.

Solution: Check whether the in-place sensor can be triggered normally. You can use a screwdriver to pry it open to see if the in-place sensor light is on;

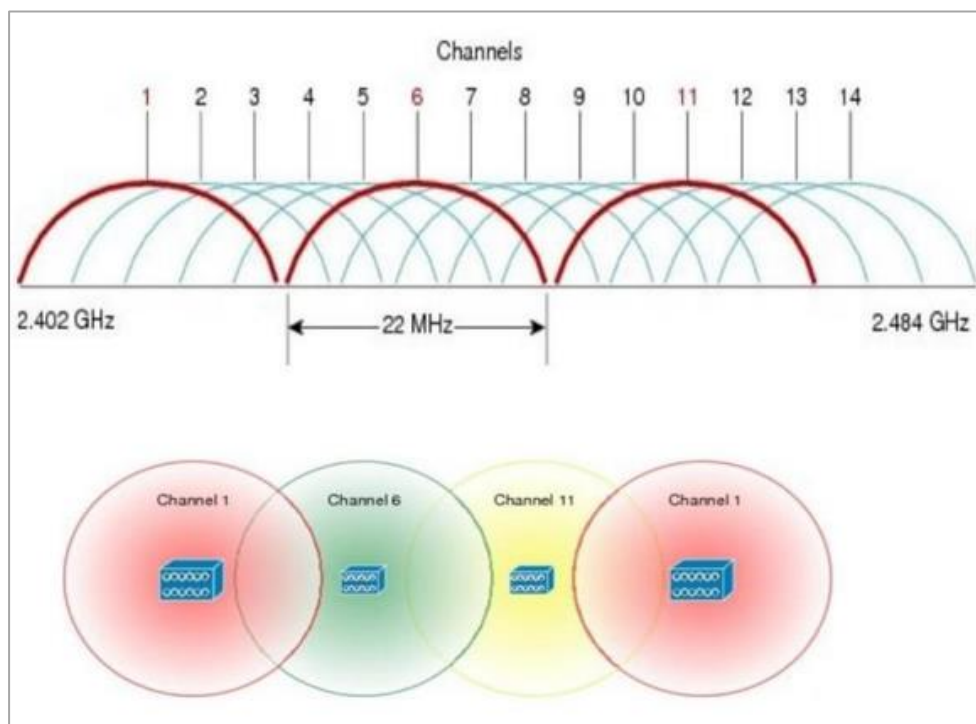
- 1) Lights up, adjust the distance between sensor and baffle;

- 2) If it doesn't light up, check the circuit and replace the sensor;
- The anti-collision edge is damaged. Pressing the device recovery button still fails to restore the device and still displays the collision status. It is judged that the anti-collision edge is damaged.
If broken, replace;
 - Forklift gear photoelectric switch does not light up
Solution:
 - 1) Check if the circuit is loose and rearrange it;
 - 2) If the optoelectronic device itself is damaged, please replace it;
- ① Whether the platform lock grid can be planned normally, etc.

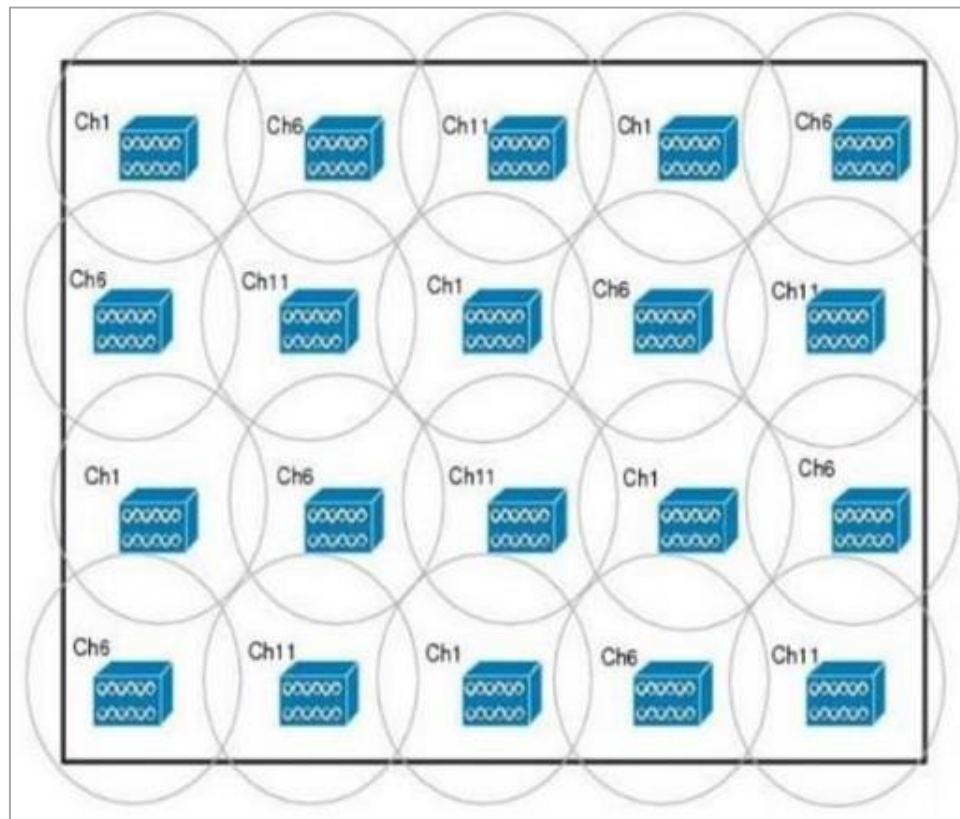
Appendix 2 Wireless Network Requirements

Appendix 2.1 Key Points for Wireless AP Point Layout

- The AP can be ceiling mounted or wall mounted. When wall mounted, the AP is recommended to be tilted 7~9° and the height is recommended to be between 3~5 meters.
- The quantity of APs must be appropriate and sufficient. Too many APs may easily cause interference between APs. You can refer to the following evaluation: when the AP transmission power is 20 dBm, the AP covers an area with a radius of 15 meters in the scenario with metal shelf task; the AP covers an area with a radius of 20 meters in the scenario without metal shelf task.
- The AP model (especially omnidirectional and directional) determines its coverage and installation.
- The configuration of adjacent AP channels need to be staggered, and the channels must be fixed: 2.4G Frequency Band use 1, 6, 11 Channels; 5.8G Frequency Band use 149, 153, 157, 161, 165 Channels. The following image is a Channel diagram of the 2.4G Frequency Band. 5.8G can refer to 2.4G deployment, except that the Channels are different, and other deployment principles are the same.

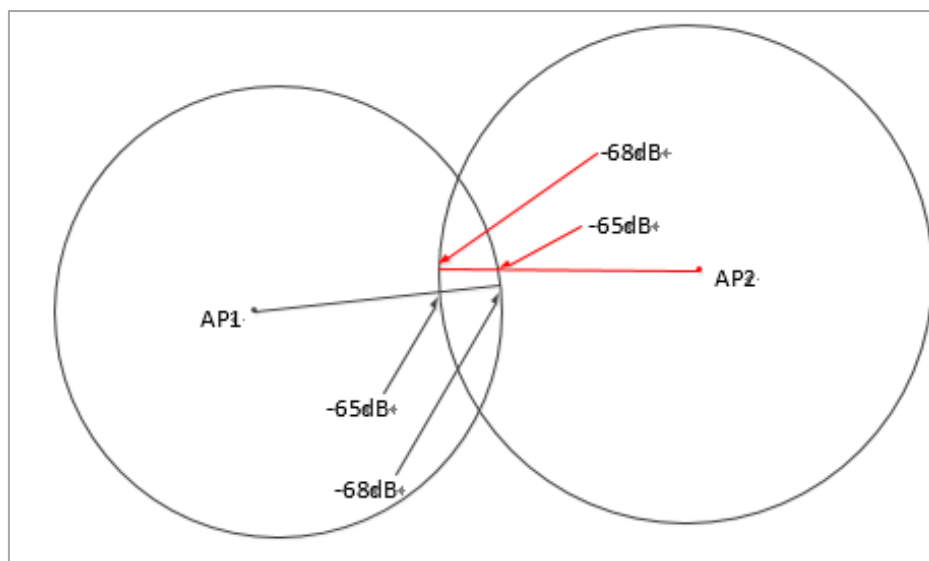


Appendix Figure 2-1 2.4G Frequency Band Channel Diagram



Appendix Figure 2-2 Covering Schematic Diagram

- Wireless signals have poor wall penetration performance, so AP layout must fully consider physical isolation such as walls. Warehouses are usually firewalls, and there will be a cliff-like break in signal strength. It is recommended to consider adding APs at these locations, such as deploying an AP near the firewall door.
- The determination of the signal overlap range of adjacent APs is the key to the AP layout, which is determined by the roaming handover strategy of the STA, the matching threshold between the AP and the STA, the maximum moving speed of the STA and the handover time supported by the AP/AC, subject to the actual measurement. It is recommended to ensure that each AP has a -65dB strength overlay area in the AP and AP signal strength overlay area. As shown in the image:



Appendix Figure 3-3 AP and AP Signal Strength Coverage Overlap Area

Appendix 2.2 Configuration Requirements for Wireless Network

- As an industrial production network, the robot needs to have exclusive Frequency Band and independent use of 2.4G or 5.8G. At the same time, to ensure the uniqueness of the robot's IP address, it is recommended to use mac address binding to manage the robot to prevent illegal users from using the wireless network of the robot.
- Turn off the smart antenna and other functions to ensure that the AP's transmission power and channel are fixed. Provide a stable and predictable spectrum distribution of radio field strength (automatic channel separation and power automatic adjustment functions cannot be enabled).
- The channel bandwidth of 2.4G and 5.8G needs to be configured to 20 M to ensure stable communication.

Appendix 2.3 Network Signal Strength Requirements

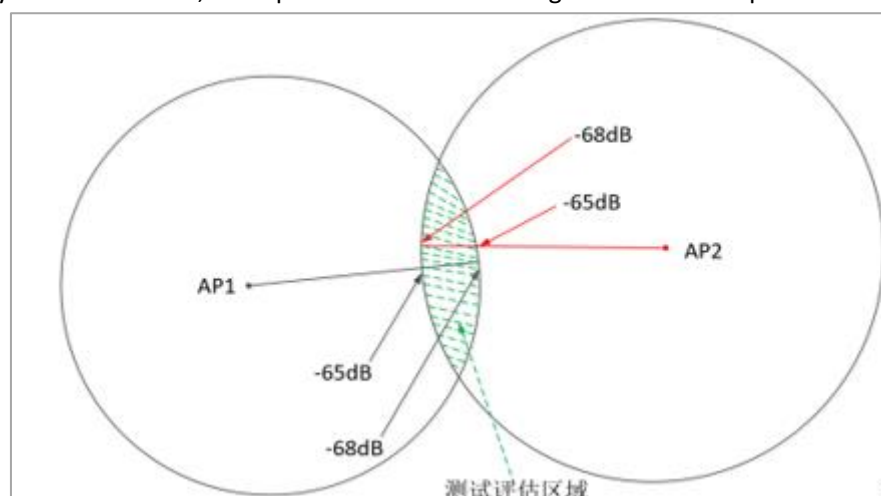
Signal strength requirements in different areas:

- In the main activity area (such as entry and exit, queuing area), the signal strength is greater than -55dB, and the delay of Packet Internet Groper (PING) 1500Byte packet is less than 100ms.
- In the non-core business area of the warehouse and non-robot cluster area (such as the edge of the warehouse, non-arterial road), the signal strength coverage is between -68dB and -65dB.
- In the fringe area, under -65dB Signal Strength, the delay of Packet Internet Groper (PING) 1500Byte packet is less than 200ms.

NOTE

The strength is determined by actual testing of the robot's own WIFI module.

- Simple proposal for evaluating the wireless environment on site: test the robot's automatic roaming function in the test area in the image below, first connect to a specific AP1 where the AP signal strength is around -65dB, move at a speed of 800mm/s, Packet Internet Groper (PING) 1500Byte packet, delay less than 200ms, and uplink and downlink rate greater than or equal to 2Mbit.



Appendix Figure 4-4 Test Evaluation Area

- When the robot is roaming between APs, the number of lost Roaming Packet Internet Groper (PING) packets is less than 2 each time, the switch time would be controlled within 100ms. To ensure a stable

wireless network environment, it is recommended to use a dual AC Backup deployment method.

Appendix 3 Legal Statement

Trademark Notice

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Appendix 4 Cybersecurity Recommendations

Essential Measures to Ensure Basic Cybersecurity of the Equipment:

1. Use Strong Passwords

Please follow the recommendations below when setting passwords:

- The password length must be at least 8 characters.
- Include at least two types of characters, such as uppercase letters, lowercase letters, numbers, and symbols.
- Do not include the account name or its reverse.
- Avoid using sequential characters, such as "123" or "abc".
- Avoid using repeated characters, such as "111" or "aaa".

2. Update Firmware and Client Software Promptly

- According to industry standards, firmware for devices (e.g., NVRs, DVRs, and IP cameras) should be updated to the latest version to ensure the latest features and security. For devices connected to the public network, it is recommended to enable the automatic online update detection feature to promptly receive firmware update notifications from the manufacturer.
- It is recommended to download and use the latest version of the client software.

Additional Recommendations to Enhance Equipment Cybersecurity:

1. Physical Protection

It is recommended to physically protect the equipment (especially storage devices) by placing them in dedicated server rooms or cabinets, and implementing access control and key management to prevent unauthorized personnel from physically tampering with the hardware or connecting external devices (e.g., USB drives, serial ports).

2. Change Passwords Regularly

It is recommended to change passwords periodically to reduce the risk of being guessed or cracked.

3. Set and Update Password Reset Information Promptly

The equipment supports the password reset function. To reduce the risk of this function being exploited by attackers, please promptly set up password reset information, including a reserved phone number/email and security questions. If there are any changes to this information, update it immediately. When setting security questions, avoid using easily guessable answers.

4. Enable Account Locking

The account locking feature is enabled by default. It is recommended to keep it enabled to protect account security. After multiple failed password attempts by an attacker, the corresponding account and source IP will be locked.

5. Change Default Ports for HTTP and Other Services

It is recommended to change the default ports for HTTP and other services to any port between 1024 and 65535 to reduce the risk of attackers guessing the service ports.

6. Enable HTTPS

It is recommended to enable HTTPS to access web services through a secure channel.

7. Enable Whitelist

It is recommended to enable the whitelist function. Once enabled, only IP addresses listed in the whitelist will be allowed to access the device. Therefore, ensure that your computer's IP address and the IP addresses of associated devices are added to the whitelist.

8. MAC Address Binding

It is recommended to bind the IP address of the gateway device to its MAC address on the device to reduce the risk of ARP spoofing.

9. Properly Assign Accounts and Permissions

Based on business and management needs, create new users as required and assign them the minimum necessary permissions.

10. Disable Non-Essential Services and Use Secure Modes

- If not required, it is recommended to disable functions such as SNMP, SMTP, and UPnP to reduce the risk exposure of the device.
- If required, it is strongly recommended to use secure modes, including but not limited to:
 - ◇ SNMP: Use SNMP v3 and set complex encryption and authentication passwords.
 - ◇ SMTP: Use TLS to connect to the email server.
 - ◇ FTP: Use SFTP and set a complex password.
 - ◇ AP hotspot: Use WPA2-PSK encryption mode and set a complex password.

11. Encrypted Audio and Video Transmission

If your audio and video data contains important or sensitive content, it is recommended to enable encrypted transmission to reduce the risk of data interception during transmission.

12. Connect Devices Using PoE

If the device supports PoE (Power over Ethernet), it is recommended to use PoE for connection, which isolates the camera from other networks.

13. Security Auditing

- Check Online Users: Periodically check online users to identify any unauthorized logins.
- Review Device Logs: By reviewing logs, you can obtain information about IP addresses attempting to log in and key operations performed by logged-in users.

14. Network Logs

Due to the limited storage capacity of the device, log storage is restricted. If you need to retain logs for an extended period, it is recommended to enable the network log function to ensure critical logs are synchronized to a network log server for easier issue tracing.

15. Building a Secure Network Environment

To better ensure the security of the device and reduce network security risks, it is recommended to:

- Disable the router's port mapping function to prevent external networks from directly accessing services on devices within the internal network.
- Segment and isolate the network based on actual needs: If there is no communication requirement between two subnets, use VLANs, network gateways, or other methods to achieve network isolation.
- Establish an 802.1x access authentication system to reduce the risk of unauthorized terminals

accessing the private network.

- Enable IP/MAC address filtering on the device to restrict the range of hosts allowed to access the device.