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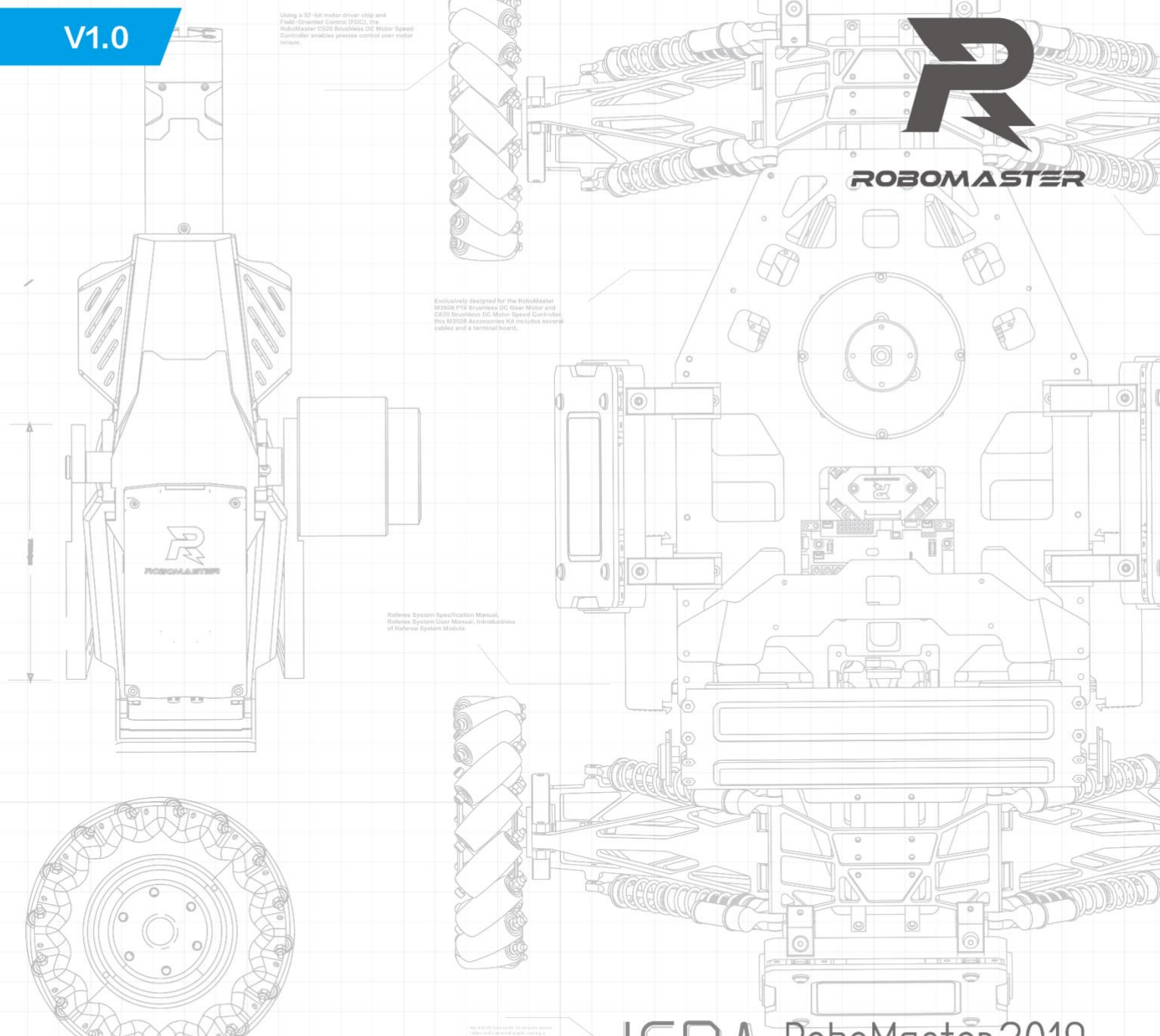


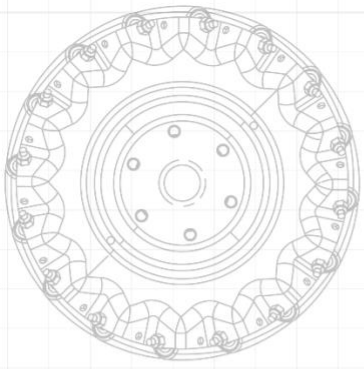
ROBOMASTER

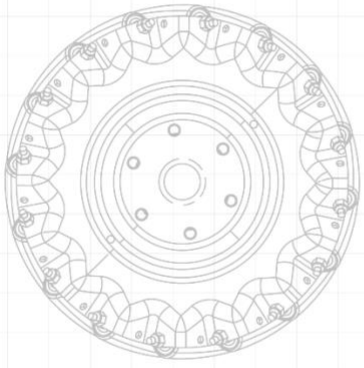
ICRA RoboMaster 2019
AI CHALLENGE

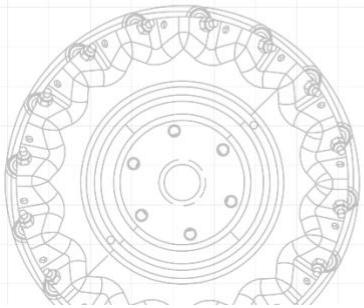
# AI ROBOT USER MANUAL

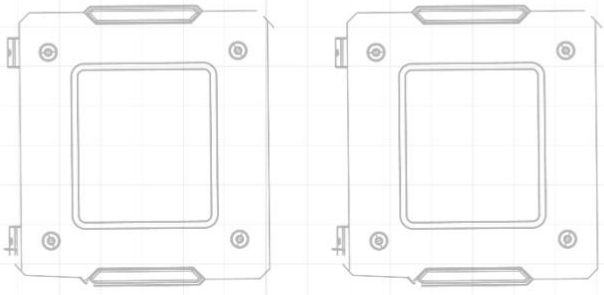
The *RoboMaster* Organizing Committee

January 10, 2019









# Using This Manual

**Legend**

⊘ Warning ⚠ Important Hints and Tips 🕮 Reference

**Convention**

ICRA 2019 DJI RoboMaster™ AI Challenge AI Robot does not include the RoboMaster UWB Positioning System Module, sensors like LiDAR or computing devices like Manifold 2. To use such devices, please configure them separately. In addition, the DR16 Receiver in the remote controller kit has been installed near the Development Board Type A of the Robot's Chassis Module and thus is not provided separately.

**Read Before First Use**

Read the following documents before using the RoboMaster™ AI Robot:

1. ICRA 2019 DJI RoboMaster AI Challenge AI Robot In the Box
2. ICRA 2019 DJI RoboMaster AI Challenge AI Robot User Manual
3. DJI MATRICE 100 Intelligent Flight Battery Safety Guidelines

Meanwhile, RoboMaster has put instructions for various accessories (including motor and ESC) used in the ICRA 2019 DJI RoboMaster AI Challenge AI Robot into an archive named "ICRA 2019 DJI RoboMaster AI Challenge AI Robot Information Kit" for reference.

Check all of the included parts listed in the ICRA 2019 DJI RoboMaster AI Challenge AI Robot In the Box document. Prepare for first use by reviewing this User Manual. For more documents for developer, please refer to the "ICRA 2019 DJI RoboMaster AI Challenge AI Robot Information Kit". Read the DJI MATRICE 100 Intelligent Flight Battery Safety Guidelines before use. For more technical instruction, visit https://robomaster.com to download relevant documentation or contact RoboMaster.

# Disclaimer and Warning

Thank you for purchasing the ICRA 2019 DJI RoboMaster™ AI Challenge AI Robot. Please read this disclaimer carefully before using this product. By using this product, you hereby signify that you have read and agreed to this disclaimer. Install and use this product in strict accordance with the User Manual. SZ DJI TECHNOLOGY CO., LTD. (hereinafter referred to as "DJI") and its affiliated companies assume no liability for damage(s) or injuries incurred directly or indirectly from using, installing or modifying this product improperly, including but not limited to using non-designated accessories. DJI™ and RoboMaster™ are trademarks or registered trademarks of DJI and its affiliates. Names of products, brands, etc. appearing in this document are trademarks or registered trademarks of their respective owner companies. This product, the manual, and the software and driver that are compatible with the Referee System (RoboMaster Client, RoboMaster Assistant, RoboMaster Server and DJI WIN driver) are copyrighted by DJI with all rights reserved. No parts of this product or document shall be modified, reproduced or transmitted in any form without the prior written consent or authorization of DJI. DJI reserves the right to final interpretation of this document and all its related documents. All contents are subjected to the latest version of the manual.

# Product Usage Precautions

The fast-moving chassis, the rotating friction wheel and the projectiles it fires can cause serious damage and injury. Use with caution at all times.

1. DO NOT allow AI Robot to come into contact with any kind of liquid since it is not waterproof.
2. Before use, AI Robot must enter and pass the internal initialization procedure when powered on.
3. AI Robot that moves at high speed must be used in a wide and empty space. DO NOT hit AI Robot against hard objects like wall at full speed.
4. DO NOT fire projectiles towards people. After adjusting the speed of launch, it is best to fire at a box with cushioning materials such as cloth bag.
5. Turn off the friction wheel motor when projectile launching finishes, when AI Robot is not in use for a long time, or when there is someone staying in front of the barrel.
6. Counter-shooting must be carried out in an enclosed area with a two-meter high fence and while a skilled operator is present.
7. Empty projectiles in the Projectile Depot after each use.
8. Remove the battery and store it in accordance with the storage method described in the DJI MATRICE 100 Intelligent Flight Battery Safety Guidelines when AI Robot is not in use for a long time.
9. Use standard Intelligent Flight Battery (model: TB47D or TB48D).
10. Tighten each screw correctly. Since the blue glue used in screws is a disposable thread locker, when repeatedly disassembling and assembling a robot, apply appropriate thread locker.
11. Fasten the two DOF of the gimbal and the four driving wheels of the chassis, remove the battery and empty the Projectile Depot during transportation.

If you have any problems you cannot resolve, please contact RoboMaster.

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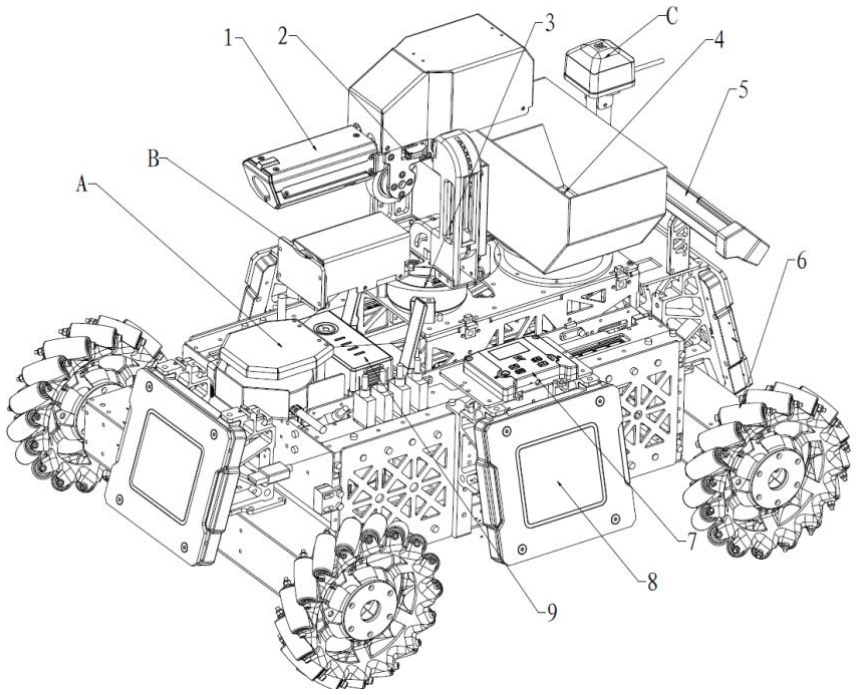
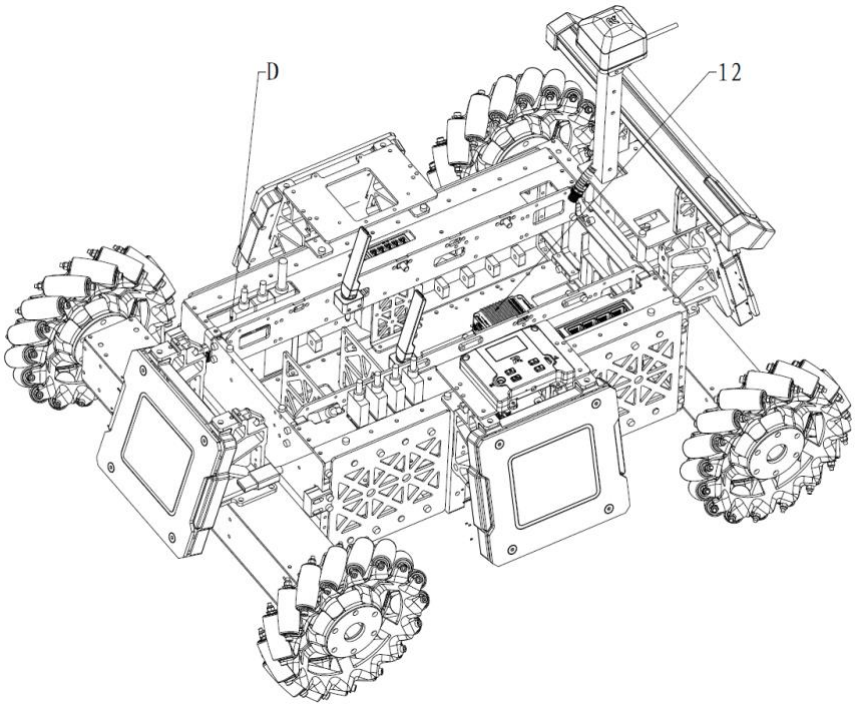
# 1. Introduction

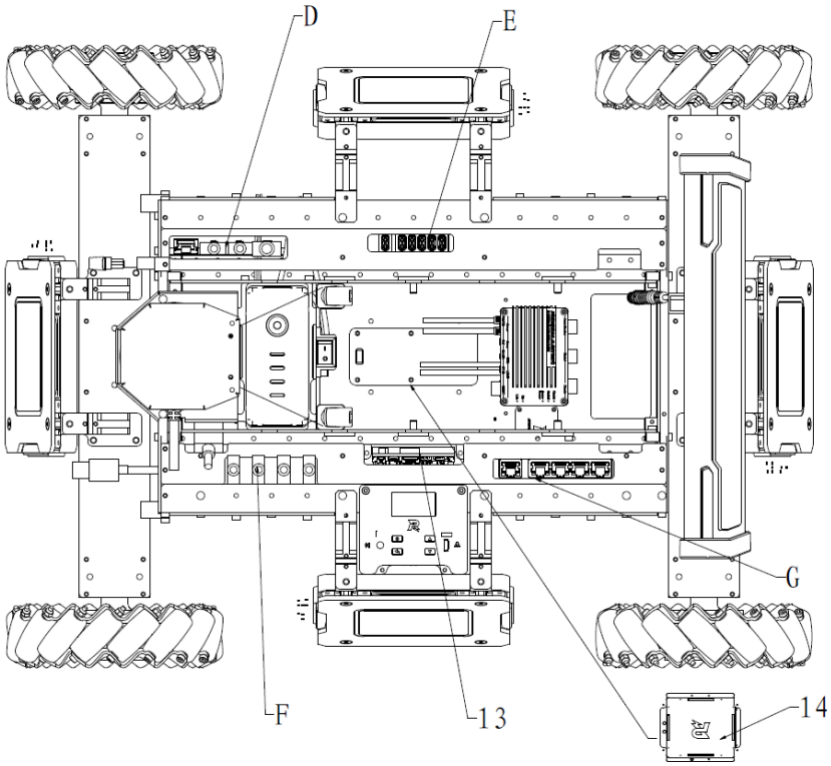
ICRA 2019 DJI RoboMaster AI Challenge AI Robot (hereinafter referred to as "Robot") consists of chassis, two-axis gimbal, Launching Mechanism, Referee System and intelligent battery. Mecanum wheels are used in the chassis for omnidirectional motion. The two-axis gimbal can complete two-DOF rotation, enhancing the flexibility and resistance of the robot. The Launching Mechanism can fire RoboMaster 17 mm standard projectiles. The Referee System has built-in sensors to detect the damage value of the robot. When the robot's HP drops to 0, the Referee System automatically cuts off the power and simulates the robot's death. Multiple Robots can have a shooting competition in a specific area. The Robot is open to all hardware debugging interfaces except the Referee System, and users are free to create a unique and fully automatic robot.

# 2. Introduction and Usage of Hardware Module

## 2.1 Introduction to Overall Hardware Feature






1. Referee System - Speed Monitor Module
2. Launching Mechanism
3. Two-Axis Gimbal
4. Supply System
5. Referee System - Light Indicator Module
6. Propulsion Module
7. Referee System - Main Controller Module
8. Referee System - Armor
9. Battery

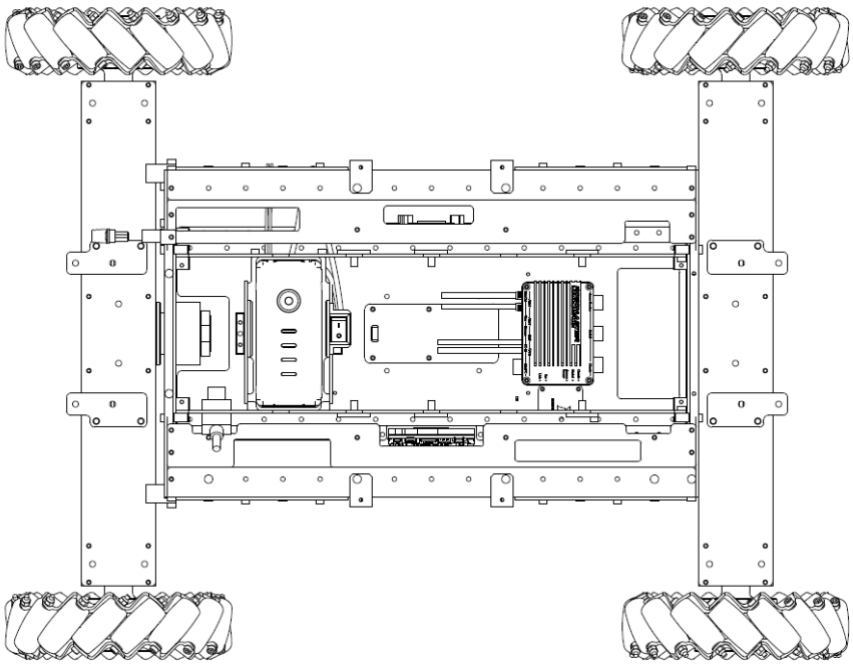
| | | |
|---|---|---|
| 10. Referee System - RFID Module | 11. Referee System - Power Management Module | 12. Referee System - Power Module |
| 13. Development Board Type-A | 14. Referee System - RFID | - |

The following modules are not included in the sales list:

| | | |
|---|---|---|
| A. LiDAR | B. Camera | C. Tag for UWB Locating System |
| D. Manifold 2 | E. Manifold 2 - USB HUB | F. Manifold 2-Power HUB |
| G. Manifold 2 - Gigabit Switch | - | - |

## 2.2 Chassis

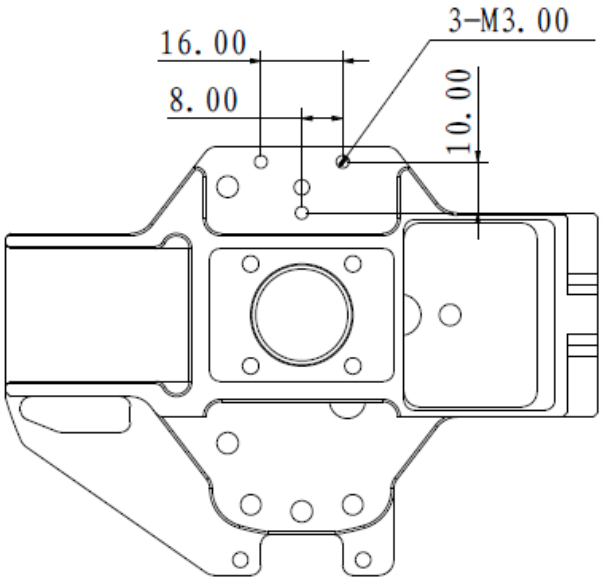
The chassis is a motion platform based on omnidirectional Mecanum wheels, which enables many motion modes including forward, traverse, skew, rotation and combinations of these.



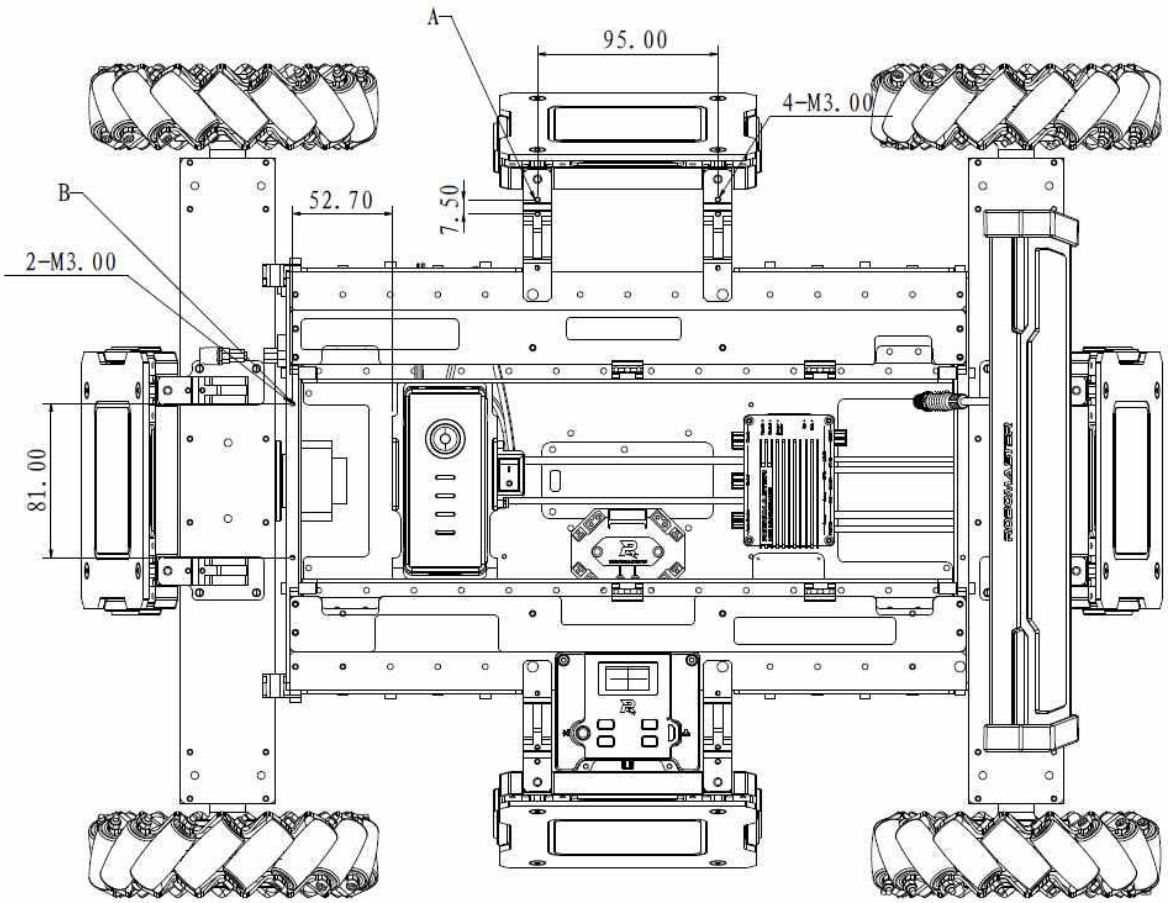
Robot uses the RoboMaster 3508 Gear Motor for four-wheel driving and integrates the C620 ESC into the Propulsion Module. For motor's ESC technical specifications, please refer to the RoboMaster 3508 Gear Motor User Manual and the RoboMaster C620 Brushless DC Motor Speed Controller User Manual in the Information Kit.

## 2.3 Sensor Installation

Mounting hole for the sensor holder is reserved on the Yaw axis of the gimbal. You can design the mounting bracket based on the dimensions of mounting hole shown below.




Mounting hole for the sensor holder is reserved on both the side (above the armor plate) and front of the chassis. You can design the bracket based on the dimensions of mounting hole shown below.

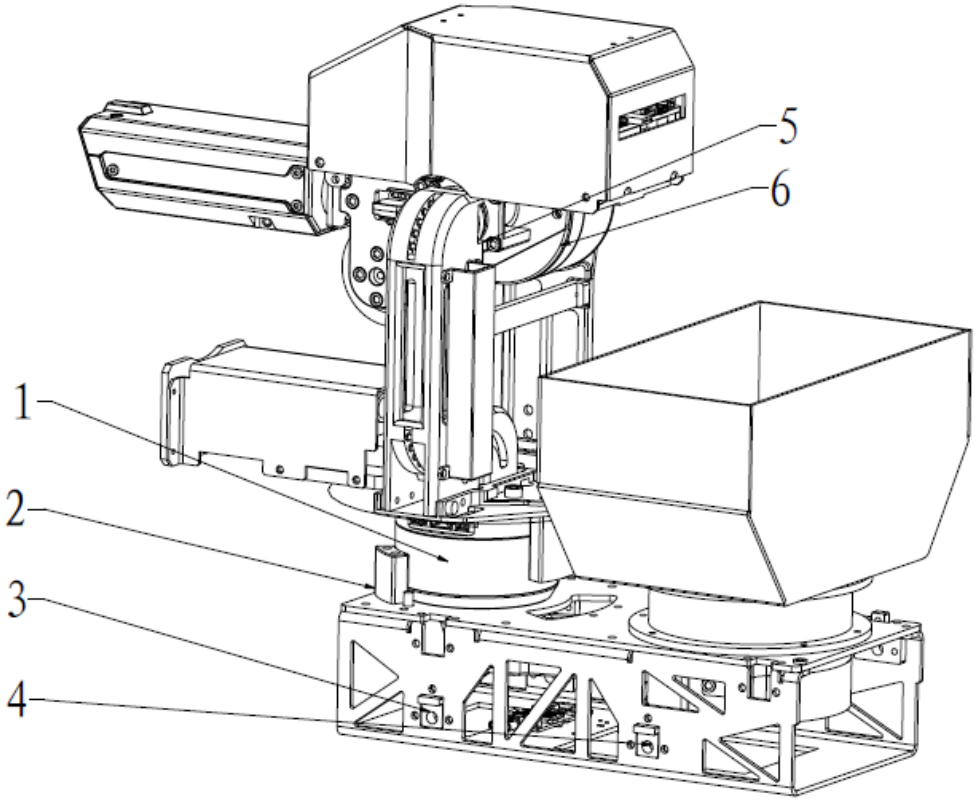



A. Mounting hole for side sensor mounting bracket

B. Mounting hole for front sensor mounting bracket

## 2.4 Two-Axis Gimbal

A two-axis gimbal is installed between the chassis and the Launching Mechanism. The pitching direction is the Pitch axis and the yaw direction is the Yaw axis. Pitch axis motion range: -23° to +23° (mechanical limit angle); Yaw axis motion range: ±92.5° (mechanical limit angle). The two-axis gimbal uses mechanical limits to control the motion range, as shown in the figure below:




1. Yaw-axis Motor
2. Yaw-axis Limit
3. Gimbal Chassis Connection Fixture
4. Gimbal Chassis Connection Fixture
5. Pitch-axis Limit
6. Pitch-axis Motor

**Note**: Separate the gimbal from the chassis by removing the four outer parts of the gimbal connection fixture.

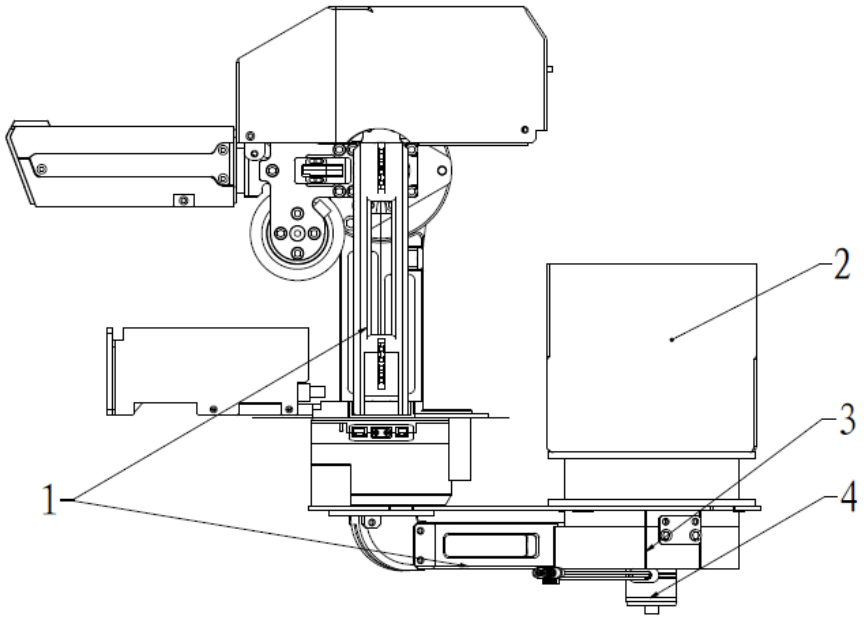
There are three connection cables between the gimbal and the chassis. The XT30 power cable is connected to the Gimbal XT30 interface of the Referee System - Power Management Module. The 4-pin CAN2 cable is connected to the CAN2 interface of the Development Board Type-A on the chassis. The aerial line is connected to the aerial line interface of the Referee System - Power Management Module.

The gimbal is driven by a DC power supply. The driving motor is RoboMaster GM6020 Brushless DC Gear Motor and the ESC is integrated in the rear of the motor. For more technical specifications of the motor and ESC, please refer to the RoboMaster GM6020 Motor User Guide in the Information Kit.

## 2.5 Projectile Supplying System

Robot supplies projectiles from its lower part. The Projectile Depot is separated from the Launching

Mechanism, increasing the flexibility of the Launching Mechanism and the amount of projectile load. The projectile load is over 200 projectiles, which fully meets the needs of the competition. After the initial loading, you must wait for the Loading Mechanism to fill the Projectile Pipeline so that projectiles can be fired from the barrel.

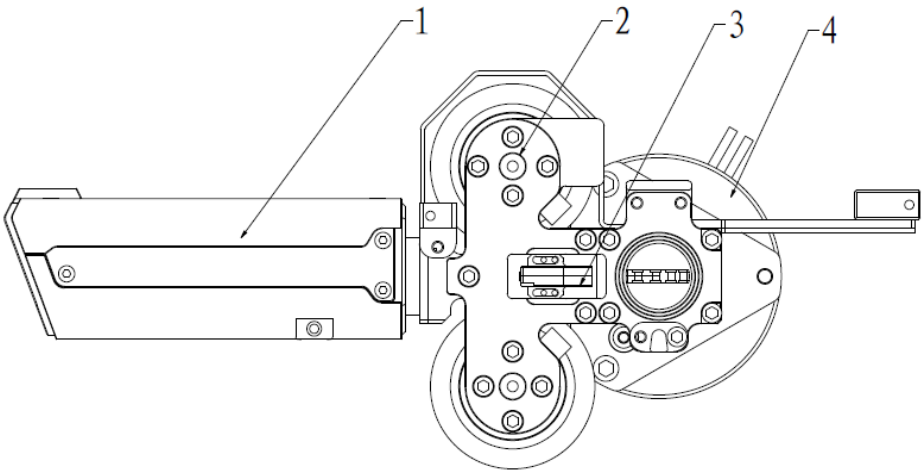



1. Projectile Pipeline 2. Projectile Depot 3. Loading Mechanism 4. Loading Motor

The loading motor is a combination of RoboMaster M2006 P36 Brushless DC Gear Motor and RoboMaster C610 Brushless DC Motor Speed Controller. For more technical specifications of the motor and ESC, please refer to the RoboMaster M2006 P36 Brushless DC Gear Motor User Guide and the RoboMaster C610 Brushless DC Motor Speed Controller User Guide in the Information Kit.

## 2.6 Launching Mechanism

The Launching Mechanism works by using the rotation friction ball. The friction wheel is driven by two reverse-rotating DC brushless motors. Projectile is subjected to the squeezing friction of the two rotating friction wheels to obtain the kinetic energy for launching.




| | | | |
|---|---|---|---|
| 1. Referee System - Speed Monitor Module | 2. Snail Motor and Friction Wheel | 3. Loading Preset Switch | 4. Pitch-axis Motor |

DO NOT point the barrel at people or animals during firing to prevent damage caused by high-speed projectiles and lasers (if any).

The friction wheel driving motor is DJI Snail 2305 Racing Motor with the Snail 430-R Racing ESC. For more technical specifications of the motor and ESC, please refer to the DJI Snail Racing Propulsion System User Manual in the Information Kit.

## 2.7 Referee System

The Referee System is an electronic penalty system integrating computation, communication and control and used for robotic competitions. The Referee System includes the onboard terminal installed on the robot and the server and client software installed on the PC. The onboard terminal includes the Main Controller Module, Power Management Module, Armor Module, Speed Monitor Module and RFID Interaction Module. This system can detect the damage of robot and the speed and frequency of launch. The server and client software record the real-time status of all robots, automatically determine the outcome of the competition according to the competition rules and send control order to robot to complete corresponding operations.

**The server (RoboMaster Server)** is the service center of the whole Referee System. It collects data from all robots, Battlefield Components and the client side during the competition, visually presents these data to referees and automatically determine the competition outcome.

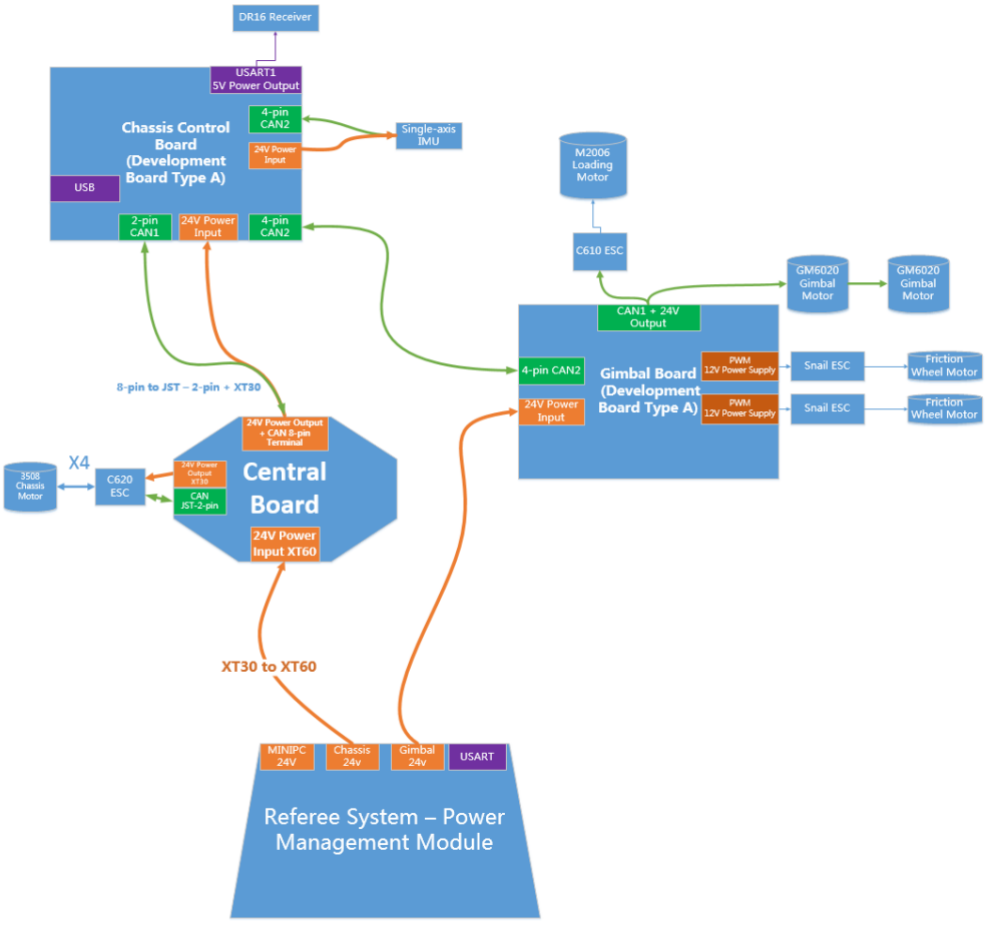
For specifications of Referee System, please refer to the ICRA 2019 DJI RoboMaster AI Challenge Referee System Specification Manual. For client installation, server setup and more details about Referee System, please refer to the RoboMaster 2019 Referee System User Manual.

To download the Referee System installation package (version 2019), visit:
https://www.robomaster.com/zh-CN/products/components/judge?index=1&position=58
To download the documents relevant to the Referee System, visit:
https://www.robomaster.com/en-US/resource/download

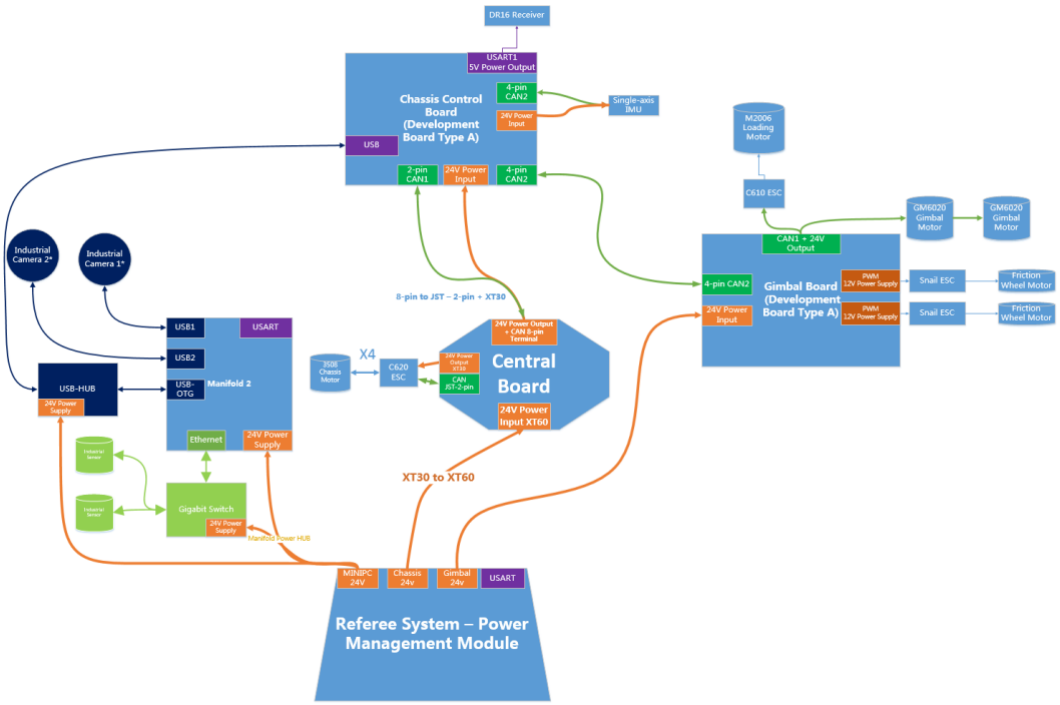
⚠
- The Speed Monitor Module is subject to the relevant information stated in ICRA 2019 DJI RoboMaster AI Challenge Referee System Specification Manual.
- The server installation package will be released on the RoboMaster official website in early March 2019 at https://www.robomaster.com/zh-CN/resource/download. Please stay tuned.

## 2.8 Hardware Circuit System

The hardware circuit system uses Robot CAN bus for communication. The resource allocation of the main control board and the overall circuit topology diagram are as follows:




**Note:** Below is the wiring scheme of the official test prototype.



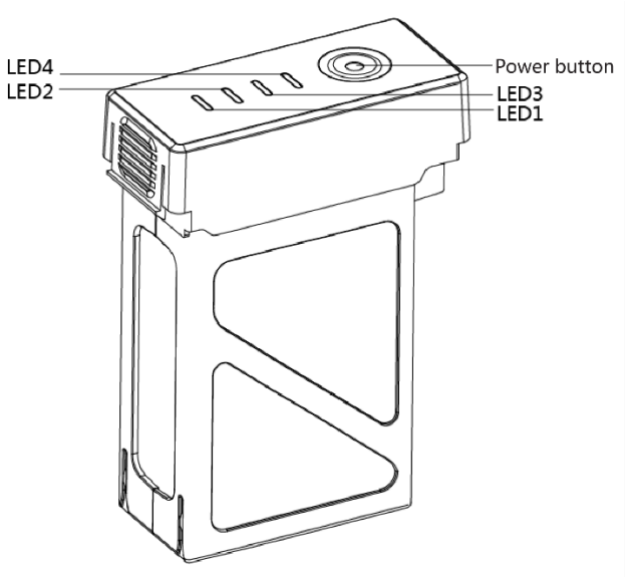

The RoboMaster Main Controller Development Board is an open-source main controller board designed for RoboMaster robots. It meets the control need of the entire robot and provides an open interface for customizing robot system and developing other functions. For more technical information of RoboMaster Development Board, please refer to the RoboMaster Main Controller Development Board User Guide in the Information Kit or download it from RoboMaster website https://robomaster.com.

# 3. Software System

To download documents related to the software system of Robot, visit:
https://github.com/RoboMaster/RoboRTS-Firmware;
https://github.com/RoboMaster/RoboRTS.

# 4. Intelligent Flight Battery

The Intelligent Flight battery (model: TB48D or TB47D) is used by DJI MATRICE 100. It has a capacity of 5700 mAh (for TB48D) or 4500 mAh (for TB47D), voltage of 22.2V and built-in smart charge-discharge function. It can only be charged with an appropriate RoboMaster approved charger. Read the DJI MATRICE 100 Intelligent Flight Battery Safety Guidelines before use.




## 4.1 Powering On/Off

**Powering On:** Press the Power Button once, then press again and hold for 2 seconds to power on. The Battery Level Indicators will display the current battery level.
**Powering Off:** Press the Power Button once, then press again and hold for 2 seconds to power off.

## 4.2 Checking the Battery Level

The Battery Level Indicator shows how much battery capacity is remaining. When the battery is powered off, press the Power Button once. The Battery Level Indicator will light up to display the current battery level. See the table below for details.

---

The Battery Level Indicator will show the current battery level during charging and discharging. Its LEDs can exhibit the following behavior.

LED is on.

LED is blinking.

LED is off.

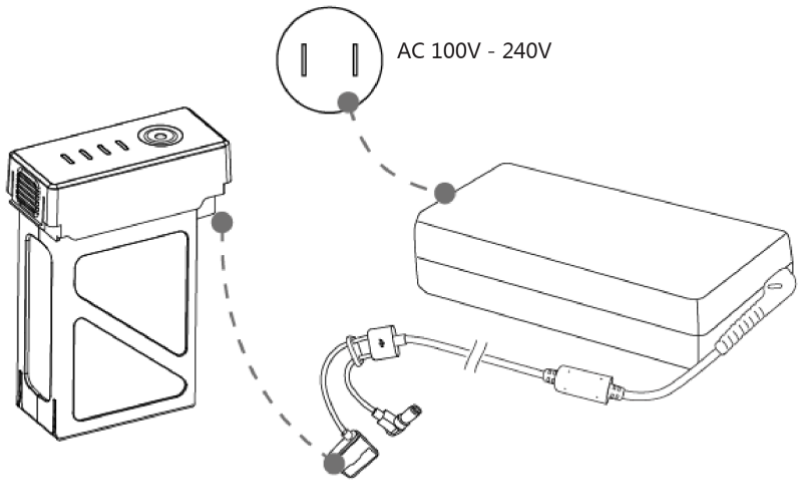
---

| Battery Level Indicator | | | | |
|---|---|---|---|---|
| **LED1** | **LED2** | **LED3** | **LED4** | **Battery Level** |
| | | | | 87.5%~100% |
| | | | | 75%~87.5% |
| | | | | 62.5%~75% |
| | | | | 50%~62.5% |
| | | | | 37.5%~50% |
| | | | | 25%~37.5% |
| | | | | 12.5%~25% |
| | | | | 0%~12.5% |
| | | | | = 0% |

## 4.3 Charging the Intelligent Flight Battery

The Intelligent Flight Battery must be fully charged before first-time use.

1. Connect the battery charger to a suitable power supply (100-240V, 50/60 Hz).
2. Open the protection cap and connect the Intelligent Flight Battery to the battery charger. If the battery level is above 95%, turn on the battery before charging.
3. The Battery Level Indicator will display the current battery level during charging.
4. The Intelligent Flight Battery is fully charged when Battery Level Indicators are all off. Disconnect the Intelligent Flight Battery from the battery charger.




Charging Time: approx. 1.5 hours

⚠
- It can only be charged with an appropriate RoboMaster official approved charger (model: A14-100P1A).
- Air cool the Intelligent Flight Battery after each use. Allow its temperature to drop to room temperature before charging.
- The charging temperature range is 0 to 40°C. The battery management system will stop the battery from charging when the battery cell temperature is out of range.

## 4.4 Charging Protection LED Display

The table below describes the battery protection mechanisms and their corresponding LED patterns.

| **Battery Level Indicator While Charging** | | | | | |
|---|---|---|---|---|---|
| **LED1** | **LED2** | **LED3** | **LED4** | **Indicators Pattern** | **Battery Protection Item** |
| ○ | ✳ | ○ | ○ | LED2 blinks twice per second | Overcurrent detected |
| ○ | ✳ | ○ | ○ | LED2 blinks three times per second | Short circuit detected |
| ○ | ○ | ✳ | ○ | LED3 blinks twice per second | Overcharge detected |
| ○ | ○ | ✳ | ○ | LED3 blinks three times per second | Charger overvoltage detected |
| ○ | ○ | ○ | ✳ | LED4 blinks twice per second | Charging temperature is too low (<0℃) |
| ○ | ○ | ○ | ✳ | LED4 blinks three times per second | Charging temperature is too high (>40℃) |

After any of the above protection issues are resolved, press the power button to turn off the Battery Level Indicator. Unplug the Intelligent Flight Battery from the battery charger and plug it back in to resume charging. Note that you do not need to unplug and plug the battery charger in the event of a room temperature error; the battery charger will resume charging when the temperature falls within the normal range.

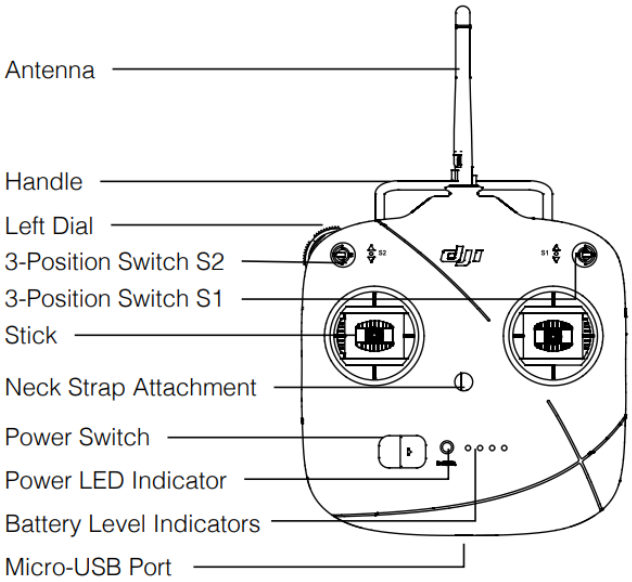
# 5. Remote Controller Kit

## 5.1 Overview

The kit includes a remote controller and a receiver. The receiver is mounted near the Development Board Type A of Robot's chassis. The link between the DT7 remote controller and the DR16 receiver has already been established.

## 5.2 Remote Controller

Robot uses the DJI Flight Remote Controller DT7. The DT7 remote controller is a wireless communication device that uses the 2.4 GHz frequency band. It is only compatible with the DR16 receiver. It has a built-in LiPo battery, can continually run for about 12 hours and its communication distance is up to 1,000 meters in an open area (you can control Robot to complete various actions on the ground with a distance of up to 100 meters).




### 5.2.1 Powering On/Off the Remote Controller

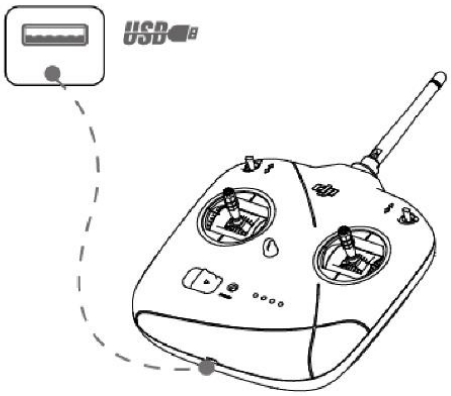
**Powering On:**

1. Toggle the Switch S1 to the uppermost position and ensure both sticks are at the mid-point position.
2. Toggle the Power Switch to the right to power on the remote controller.
3. The Power LED Indicator will turn solid green and the buzzer emit a "beep" sound to indicate that the remote controller has been powered on.

**Powering Off:** Push the Power Switch to the left to power off the remote controller.

### 5.2.2 Charging the Remote Controller

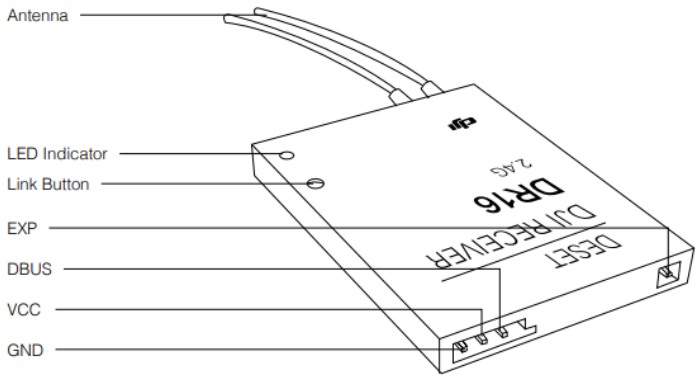
Charge the remote controller's battery by using the included micro-USB cable (1.5 A Charging Current). The Power LED Indicator is solid red and the Battery Level Indicator blinks green when charging. If fully charged, both the Power LED Indicator and Battery Level Indicator are solid green.



Charging Time: approx. 2.5 hours

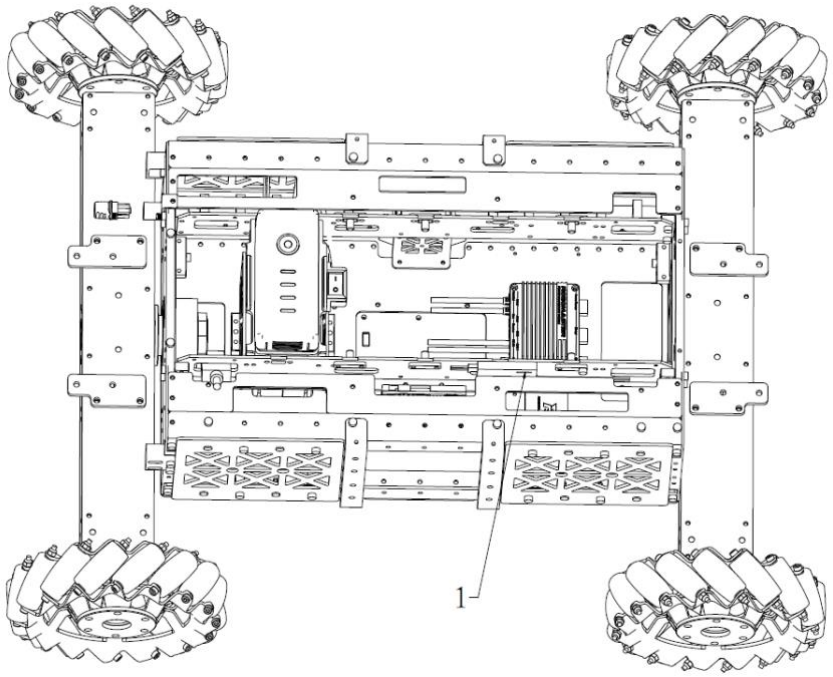
## 5.3 Receiver

The DR16 Receiver is a 16-channel receiver that uses the 2.4 GHz frequency band. It is compatible with the DT7 remote controller.



## Linking the Remote Controller and Receiver

The receiver is mounted near the Development Board Type A of Robot's chassis (as shown below). The remote controller is linked to the DR16 receiver by default . Follow these steps to link the remote controller with the receiver:




1. Link Hole

1. Locate the Link Hole on the right of the Development Board Type A on the chassis, within which there is the Link Button of the receiver.
2. Power on Robot and ensure that the receiver is powered up. If there are no other powered-on controllers nearby, the Power LED Indicator of the receiver is solid red.
3. Power on the remote controller and bring it close to the receiver until the Power LED Indicator of the receiver blinks green.
4. Press and hold the Link Button for two seconds. The Power LED Indicator of the receiver blinks red during linking.
5. Release the Link Button. The Power LED Indicator of the receiver displays solid green once the remote controller successfully links to the receiver.

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Ensure the remote controller is close to the receiver and there are no other powered-on remote controller nearby during linking.

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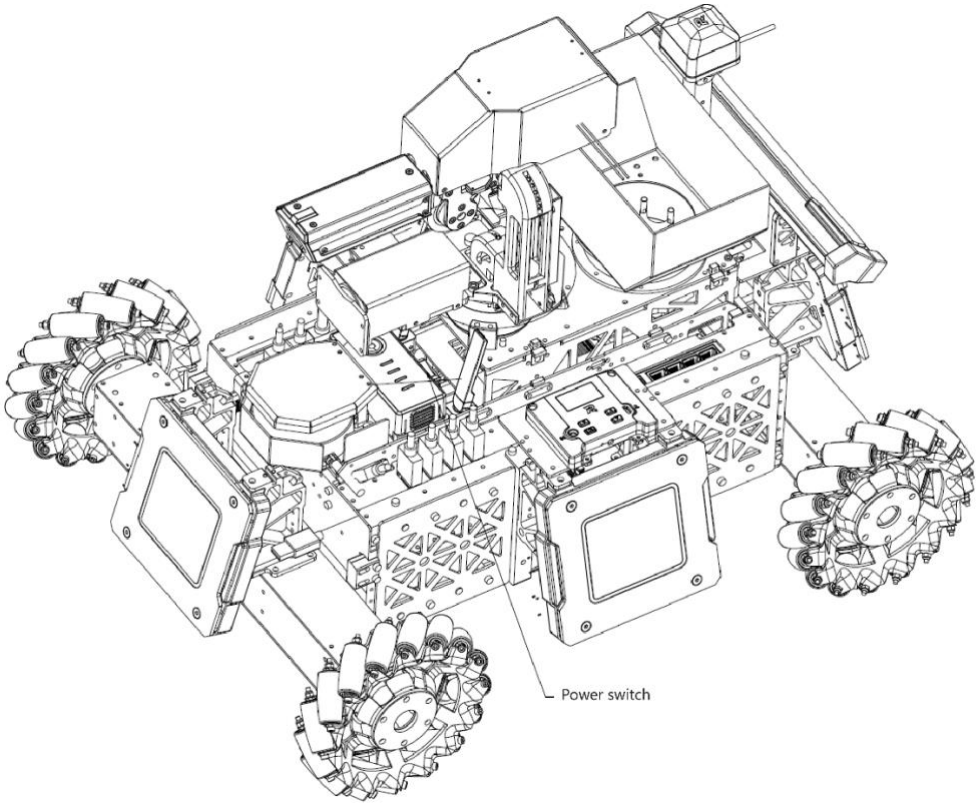
For the communication protocol between the DT47 remote controller and the DR16 receiver, please refer to the RoboMaster Robot Remote Controller (Receiver) User Manual in the Information Kit.

# 6. Powering On and Operating the Robot

## 6.1 Installing and Removing the Battery

The battery rack is in the middle of Robot chassis and in front of the gimbal. Vertically install the battery into the battery rack when use the robot. The following figure shows the installing position:




## 6.2 Powering On/Off the Robot

After installing the battery to the battery rack, power on the Intelligent Flight Battery and turn on the Power Switch of Robot (as shown above). The Power Switch is between the battery rack and the rear armor and fixed on the battery rack. After powering on, Robot will have an initialization, during which the HP displayed on the Light Indicator of the Main Controller Module of the Referee System gradually increases from 0% to 90%. If it passes the initialization, the HP increases to 100%. The remote controller is unavailable during the initialization.

## 6.3 Operation Mode

Robot supports two user operation modes:

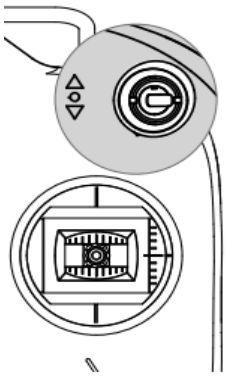
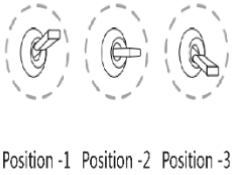
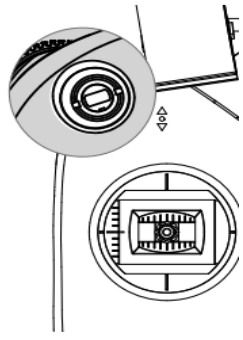
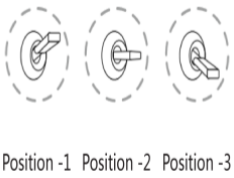
1. **Manual**: Operate Robot with the remote controller. This mode is simple, convenient, ready to use upon power-on and most suitable for demonstration and debugging.

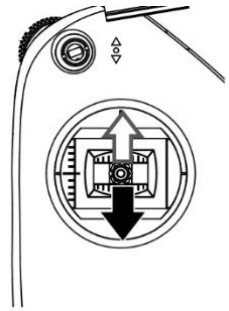
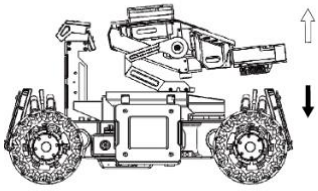
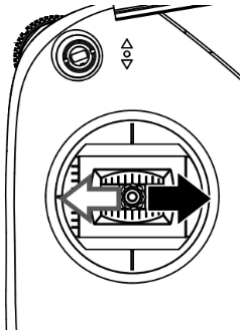
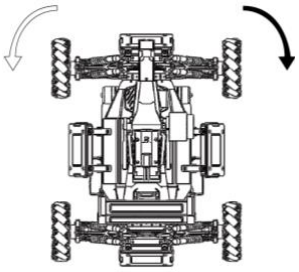
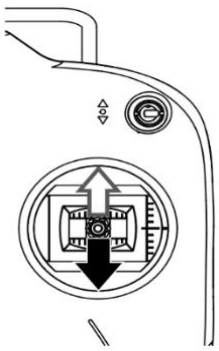
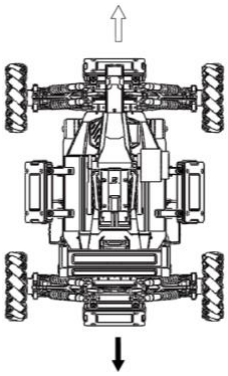
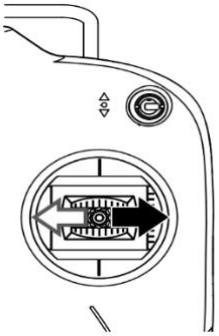
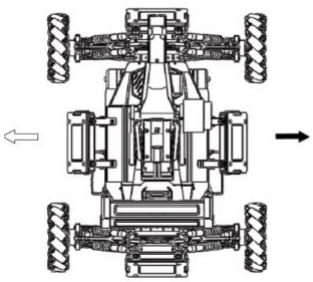
2. **Automatic**: The onboard PC receives data and operates Robot through the interaction with USB HUB and Development Board Type A.

Select either mode accordingly and toggle the Switch S1 on the remote controller.

## Operating the Remote Controller

Power on the remote controller to operate Robot. When the remote controller is powered off, Robot is locked. Methods for performing different functions are as follows:

| Remote Controller | Robot | Function |
|---|---|---|
|  |  | Switch S1 is a mode control switch. When S1 is in Position-3, it is in the automatic operation mode. When S1 is in Position-1 or Position-2, it is in the manual operation mode. Posiiton-1 means the chassis rotates along with the Yaw-axis of the gimbal. Posiiton-2 means the Yaw-axis of the gimbal rotates along with the chassis. |
|  |  | Switch S2 changes the control state through the stick. When toggle S2 from Position-2 to Position-1, the friction wheel of the Launching Mechanism is enabled or disabled.<br>When the friction wheel is enabled, if you toggle S2 from Position-2 to Position-3 and quickly back to Position-2, Robot will launch a projectile. When S2 stays in Position-3, Robot will continuously launch projectiles.<br>Remote controller can be used in any mode. |

| Remote Controller | Robot | Function |
| --- | --- | --- |
|  |  | Push the stick up to tilt the gimbal up (+), and down to tilt the gimbal down (-).<br>The rotation range of gimbal is -20° to +20°. |
|  |  | Use S1 to decide whether the chassis rotates along with the Yaw-axis of the gimbal or the Yaw-axis of the gimbal rotates along with the chassis.<br>Push the stick left to rotate the gimbal counter-clockwise and right to rotate the gimbal clockwise.<br>The more the stick is pushed away from the center position, the faster the robot will rotate. |
|  |  | Push the stick up to move forward and down to move backwards;<br>The more the stick is pushed away from the center position, the faster the robot will move. |
|  |  | Push the stick left to move left and right to move right.<br>The more the stick is pushed away from the center position, the faster the robot will move. |

The above operation methods are officially defined and can be customized by users.

# Appendix

## Specifications

| | |
|---|---|
| **Structure** | |
| Overall Dimensions | 600 * 450 * 460 mm |
| Weight (with battery) | 16.6 kg |
| **Performance** | |
| Maximum Forward Velocity | 3 m/s |
| Maximum Translational Velocity | 2 m/s |
| Gimbal Pitch-axis Rotation Range | -20° to 20° |
| Gimbal Yaw-axis Rotation Range | -90° to 90° |
| Projectile Frequency of Launch | 10 projectiles/second |
| Projectile Speed of Launch (barrel) | 25 m/s |
| Projectile Load | 200 |
| **Propulsion System** | |
| Chassis Power Motor Model | RoboMaster M3508 P19 Brushless DC Gear Motor |
| Gimbal Power Motor Model | RoboMaster GM6020 Gimbal Motor |
| Launch Power Motor Model | DJI Snail 2305 Racing Motor |
| Launch Power Motor ESC | DJI Snail 430-R Racing ESC |
| Load Power Motor Model | RoboMaster 2006 P36 Brushless Gear Motor |
| Load Power Motor ESC | RoboMaster C610 Brushless Motor ESC |
| **Battery** | |

| | |
|---|---|
| Model | TB47D |
| Type | LiPo 6S |
| Voltage | 22.8 V |
| Capacity | 5700 mAh for TB48D, 4500 mAh for TB47D |
| **Remote Controller** | |
| Model | DT7 |
| Operating Frequency | 2.4 GHz |
| Communication Distance | 1,000 m |
| Power Supply | Built-in lithium battery |
| Charging Port | Micro USB |
| Battery Capacity | 2600 mAh |
| **Charger** | |
| Model | A14-100P1A |
| Input | 100-240 V, 50-60 Hz |
| Output | 26.3 V |
| **Projectile** | |
| Model | RoboMaster 17mm Standard Projectile |
| Color | White |
| Size | 17 mm |
| Weight | 3.4 g |

## Parts List (Incomplete)

| Module Name | Component Name | Quantity |
|---|---|---|
| Robot Chassis | RoboMaster M3508 P19 Brushless DC Gear Motor | 4 |
| | RoboMaster Mecanum Wheel (left) | 2 |
| | RoboMaster Mecanum Wheel (right) | 2 |
| | RoboMaster Main Controller Development Board | 1 |
| Two-axis Gimbal and Launching Mechanism | RoboMaster M2006 P36 Brushless DC Gear Motor | 1 |
| | RoboMaster C610 Brushless Motor ESC | 1 |
| | RoboMaster GM6020 Brushless Motor (with ESC) | 2 |
| | RoboMaster Main Controller Development Board | 1 |
| | DJI Snail 2305 Racing Motor | 2 |
| | DJI Snail 430-R Racing ESC | 2 |
| Robomaster Referee System | Armor Module | 4 |
| | Main Controller Module | 1 |
| | Speed Monitor Module | 1 |
| | RFID Interaction Module | 1 |
| | RFID Interaction Card | 2 |
| | Power Management Module | 1 |
| Remote Controller | Remote Controller | 1 |
| | Remote Control Receiver | 1 |
| Battery | Intelligent Flight Battery | 1 |

| Module Name | Component Name | Quantity |
| --- | --- | --- |
| | Charger (with charging cable) | 1 |

**E-mail**: robomaster@dji.com
**Forum**: bbs.robomaster.com
**Website**: www.robomaster.com
**Tel**: +86 (0)755 36383255 (GTC+8, 10:00AM–7:00PM, Monday to Friday)
**Address**: Room 202, Floor 2, Integrated Circuit Design & Application Industrial Park, No. 1089, Chaguang Road, Xili County, Nanshan District, Shenzhen City, Guangdong Province, China