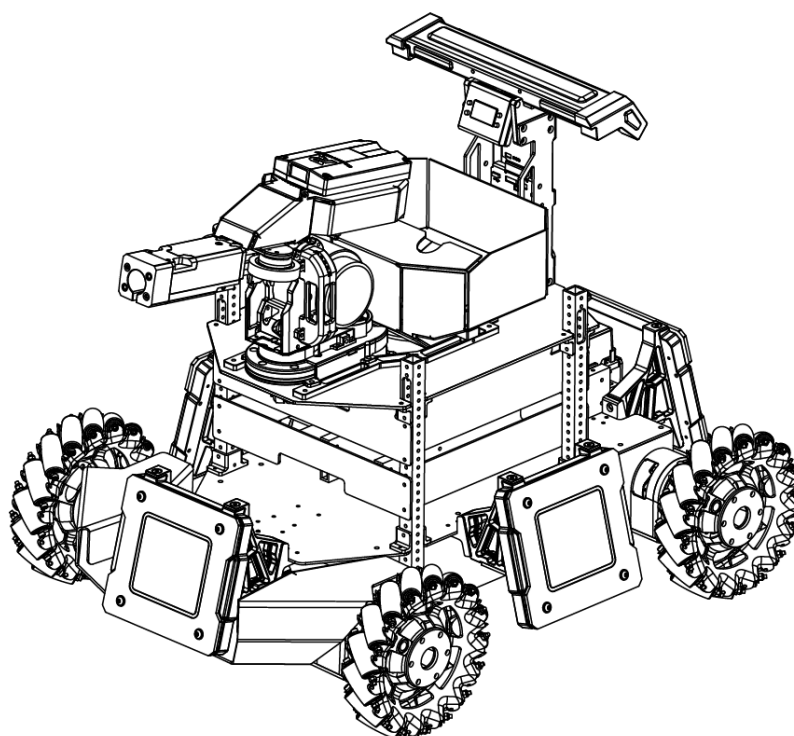


# ICRA 2018 DJI RoboMaster AI Robot

## User Manual

V1.0 2018.03



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# Using this manual

## Legends

 Warning    Important    Hints and Tips    Reference

## Agreement

ICRA 2018 DJI RoboMaster™ AI Robot does not include RoboMaster UWB positioning module and laser radar. If you require these components, please purchase them separately. Additionally, the DR16 receiver is installed on lower part of the AI Robot's launching mechanism and will not be provided separately.

## Recommended

RoboMaster provides the following documentation:

1. *ICRA 2018 DJI RoboMaster Items List for AI Robots*
2. *ICRA 2018 DJI RoboMaster AI Robot User Manual*
3. *DJI Matrice 100 Intelligent Flight Battery Safety Guidelines*

RoboMaster also provides a compressed file (*ICRA 2018 DJI RoboMaster AI Robot Supplementary Materials*) containing the instructions for the various components (including the motor, ESC, etc.) used on AI Robots.

We recommend users first to verify that all the items listed in the *ICRA 2018 DJI RoboMaster Items List for AI Robots* are in place. Then, read through the *ICRA 2018 DJI RoboMaster AI Robot User Manual* to gain an understanding of the entire usage process. If you require further developer materials, please check the contents of the *ICRA 2018 DJI RoboMaster AI Robot Supplementary Materials* compressed file. Before using the M100 intelligent flight battery, please carefully read through the *DJI Matrice 100 Intelligent Flight Battery Safety Guidelines*. If you require further technical instructions, please log in to <https://robomaster.com> and download the relevant materials or contact RoboMaster.

## Warnings & Disclaimers

Thank you for using the ICRA 2018 DJI RoboMaster AI Robot. Before use, please carefully read through the warnings and disclaimers contained in this section. By using the product, you are considered have understood and accepted the warnings and disclaimers contained herein. Please strictly follow the manual, product description, and the relevant laws and regulations, policies, and guidelines when assembling and using the product. When using the product, the user bears full responsibility for his or her own actions and all consequences arising therefrom. DJI™ will not be liable for any loss caused by improper usage, assembly, or modification of the user.

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DJI reserves the right of final interpretation of the disclaimers contained herein.

## Precautions

The chassis, friction wheel, and launched projectiles move at rapid speeds and may damage assets or cause bodily harm. Ensure that safety measures are taken during use.

Please pay careful attention to the “Important” items contained in the manual.

1. AI Robots are not waterproof. Avoid getting it wet or exposing it to any liquids.
2. Once turned on, an AI Robot will perform a self-test. It can then be operated if the self-test is passed.
3. When engaging in high speed maneuvers, ensure that the AI Robot is in a wide open environment free of people and obstacles. Do not crash it into large and hard objects, such as walls, at full speed.
4. Do not fire projectiles at people. After adjusting projectile speeds, the best testing environment firing projectiles a cloth bag or other shock absorbing materials.
5. When not in use or when there are people around, ensure the friction wheels are turned of to prevent misfiring.
6. When engaging in robot battles, the battle must be carried out in an area completely enclosed by a 2 m tall fence and in the presence of a skilled operator.
7. After each use, be sure to empty the projectile in the cartridge, to prevent misfires.
8. When no using the robot for an extended period, remove the battery and store it according to the storage method described in the *DJI Matrice 100 Intelligent Flight Battery Safety Guidelines*.
9. Be sure to use the standard battery (model: tb47d/tb48d).
10. When assembling and disassembling the robot, tighten screws by applying an appropriate amount force. The blue colored glue used on the screws is screw glue. After repeated disassembly, use a proper amount of screw glue to fix the screws.
11. When transporting the robot, fix the servo and the four wheels of the chassis in place, remove the battery, empty the projectile cartridge.

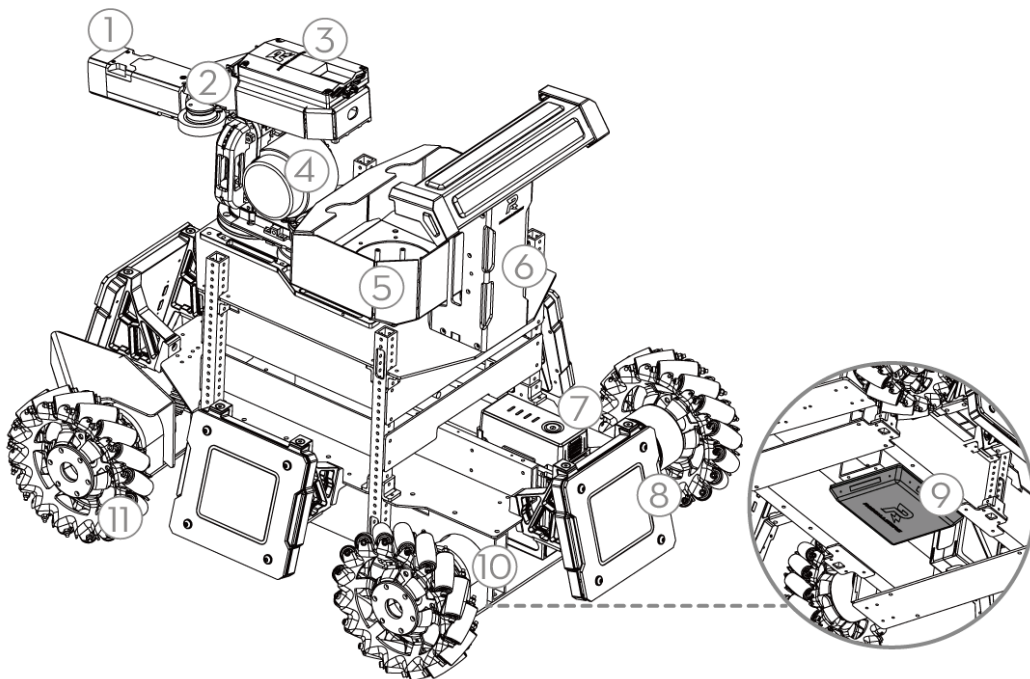
For any unresolved problems during use, please contact RoboMaster for assistance.

## Introduction

The ICRA 2018 DJI RoboMaster AI Robot ("AI Robot" or "robot") consists of a chassis, 2-axis servo, launching mechanism, referee system, and intelligent battery. The chassis uses Mecanum wheels to achieve multi-directional movement. The robot's 2-axis servo is capable of panning and tilting, enhancing the robot's dexterity and the combat capability. The launching mechanism launches RoboMaster 17mm projectiles. The referee system features built-in sensors that evaluates the amount of damage taken by the robot. When the robot's HP reaches 0, the referee system automatically cuts off the power supply, deactivating the robot. Multiple AI Robots can engage in battles in specialized battle fields. All hardware debugging interfaces of AI Robots are open except the referee system. You can use it to create a unique robot automation schemes.

## Hardware Modules Introduction

### Complete Overview of Hardware Functions

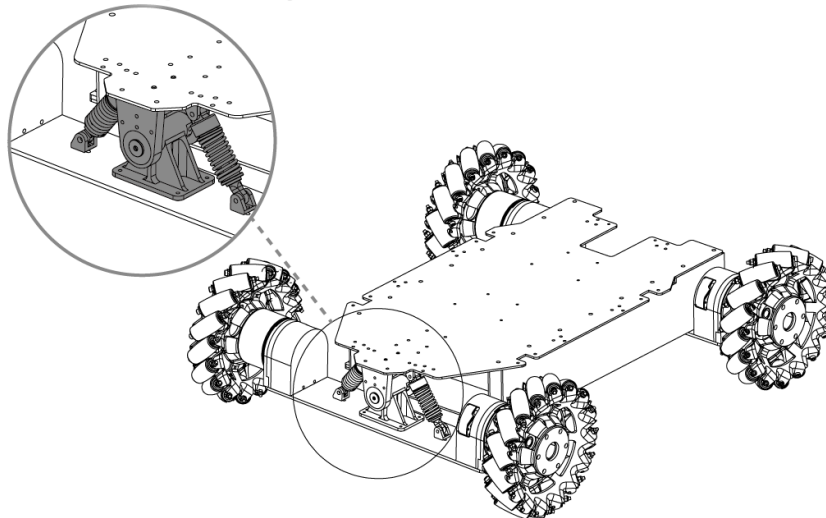


- |   |   |
|---|---|
| 1. Referee System - Speed Measurement Module                  | 7. Intelligent Battery                      |
| 2. Launching Mechanism  | 8. Referee System - Armor Module            |
| 3. Referee System - Camera Transmission Module (transmit-end) | 9. Referee System - RFID Interaction Module |
| 4. 2-Axis Servo   | 10. Chassis Motor                           |
| 5. Projectile Feeding System                                  | 11. Mecanum Wheels                          |
| 6. Referee System - Main Control Module                       |   |

## Chassis

The chassis of AI Robots features Mecanum wheels, which allows it to move in multiple directions, including forwards, sideways, diagonally, and rotate in place. The chassis is equipped with a front-wheel joint suspension system, which enables it to move within standard competition venues.

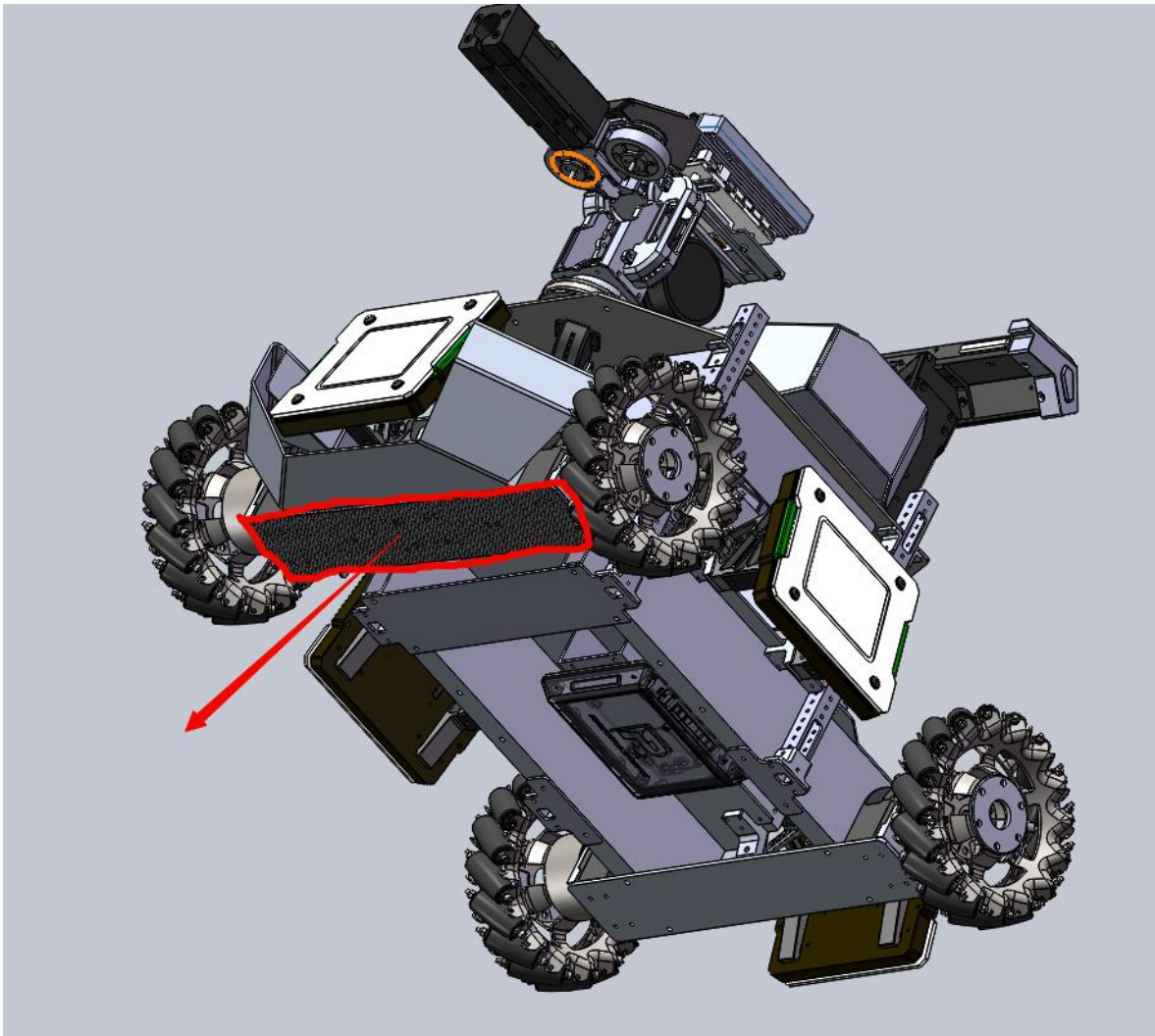
**Joint suspension system**



With the Robomaster EC60 Brushless Motor for four-wheel drive, the ESC is integrated into the tail of the motor. For the technical specifications of the ESC, please refer to the *Robomaster EC60 Brushless Motor User Manual*.

**Reminder :**





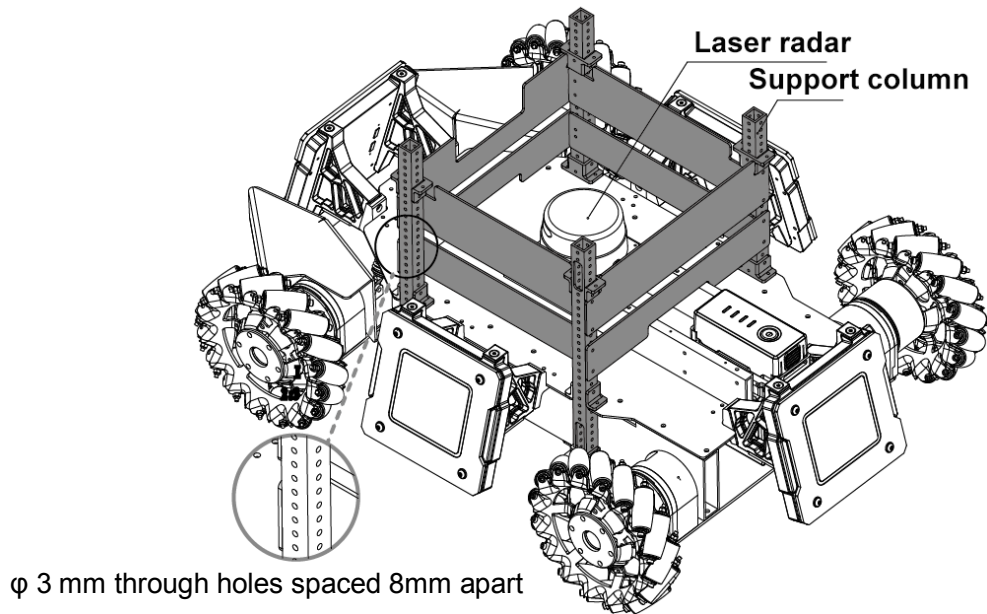
Change the parts as shown in the figure to a 5mm thick carbon fiber plate, or attach an identical plate onto the current design, can increase the rigidity of the front bridge and effectively mitigate the infantry front bridge shaking problem.

A [DXF drawing of the plate](#) is in the attachment.

## Customization

Upper layer functional modules (2-axis servo and projectile feeding system) are attached to the chassis by four support columns. The center area is reserved for sensor installation, for example, you can install the laser radar in this area. The support columns are aluminum alloy pipes that measure 15 mm x 1.5 mm x 2 mm and features  $\varnothing$  3 mm through holes spaced 8mm apart. You can adjust the height of the boards and install other sensors as needed.

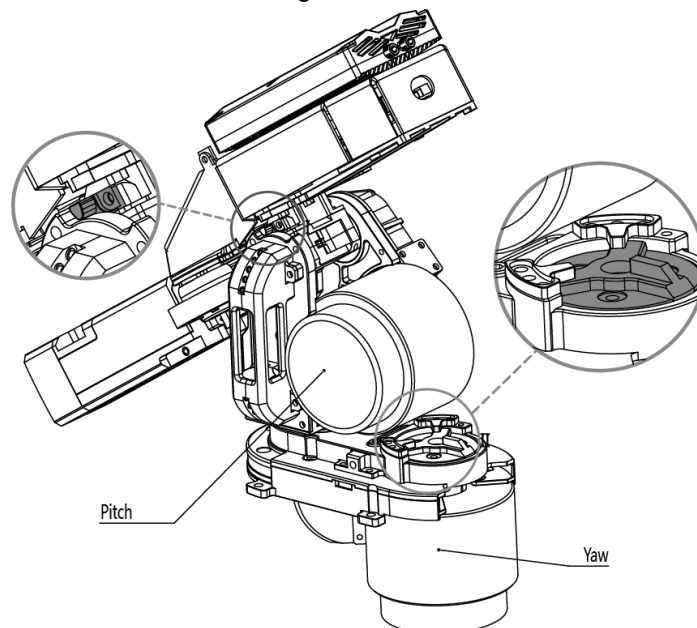




- Install the C610 ESC on the backside of the board between the support column and the servo, and ensure that the Set button faces downward. When making modifications, be sure not to press the Set button on the ESC to avoid resetting the ID. If the ID is reset, refer to the *RoboMaster C610 Brushless Motor Speed Controller Manual* to restore the ID.
- The 8-pin line, which connects the servo to the chassis, passes through the rear left support column. Ensure not to damage the 8-pin line when making modifications.

## 2-Axis Servo

A 2-axis servo is installed between the chassis and the launching mechanism. The pitch axis controls the tilt motion and the yaw axis controls the pan motion. Pitch range:  $-38^{\circ}$  to  $+24^{\circ}$ , yaw range:  $\pm 110^{\circ}$ . The 2-axis servo adopts mechanical limit switches to control the range of motion, as shown in the following figure:

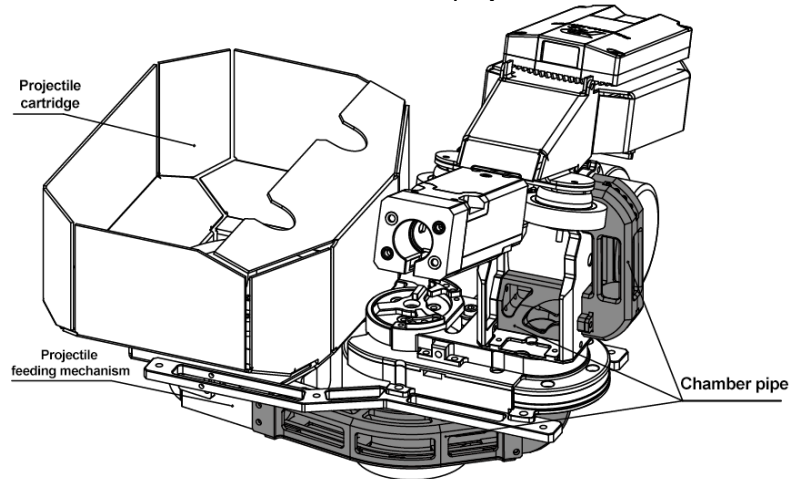


The servo is driven by a synchronous belt connected to the RoboMaster 6623 Brushless DC Motor with an integrated ESC at the tail of the motor. For the technical specifications of the motor and ESC, please refer to

the *RoboMaster 6623 ESC User Manual* and the *RoboMaster 6623 Brushless Motor User Manual*.

## Projectile Feeding System

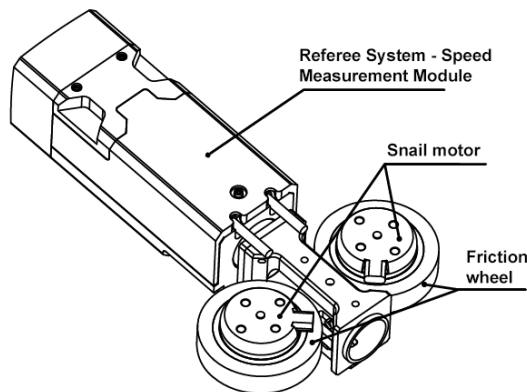
The projectile feeding system of AI Robots is located lower part of the robot. The cartridge and launching mechanism are separated to increase the flexibility of the launching mechanism and the capacity of the cartridge. The cartridge can hold over 200 projectiles, fully meeting competition needs. After loading the cartridge, wait for the feeding wheel fill the chamber. Once the chamber is full, projectiles can be launched through the barrel.



Projectile loading is driven by the RoboMaster M2006 P36 DC Brushless DC Gear Motor with the RoboMaster C610 Brushless Motor Speed Controller. For the technical specifications of the motor and ESC, please refer to the *RoboMaster M2006 P36 Brushless DC Gear Motor User Manual* and the *RoboMaster C610 Brushless Motor Speed Controller User Manual*.

## Launching Mechanism

The launching mechanism launches projectiles using the friction wheel. The friction wheels are driven by two brushless DC motors rotating in opposite directions. When spinning, projectiles receive kinetic energy when they are squeezed passed the two rotating friction wheels and are launched out the barrel.



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⊘ Do not aim the barrel at people or animals to avoid injuries caused by misfired projectiles or the laser (if installed).

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The friction wheels are driven by the DJI Snail 2305 Racing Motor with the Snail 430-R Racing ESC. For the technical specifications of the motor and ESC, please refer to the *DJI Snail Racing Propulsion System User Manual*.

## Referee System

The referee system is an electronic penalty system that integrates computing, communication, and control used in robot competitions. The referee system consists of a robot mounted terminal and a server and client software installed on a physical PC. The on-board terminal includes the main control module, armor module, speed measurement module, RFID interaction module, camera transmission module, and positioning module (if installed). The modules form a system that can assess the damage taken by the robot over the course of battle, detect the velocity and frequency of projectiles, and transmit the robot's first person view to the client. The server and client software checks the robot's status in real time and automatically determines the outcome of the battle according to competition rules. The server and client software is also responsible for sending control commands to the robot to complete the corresponding operation.

**The server (RoboMaster Server)** is the service center of the referee system. During the competition, it collects data from all robots, battlefield mechanisms, and the clients, and presents it to the referee in a visualized manner, and automatically handles the results logic of the competition.

**The client (RoboMaster client)** provides the player with a first person view from the robot. A data collection card is installed on the PC that connects to a private server or the competition server. From the first person view, you can check the robots data uploaded by the referee system, including the current HP of the robot, real-time projectile launch speeds and launch rate, battlefield map, real-time power output of the chassis, teammate information, etc.

For guidelines on the usage of the referee system, please refer to the *ICRA 2018 DJI RoboMaster AI Challenge Referee System Specification Manual*. For client installation, server setup, and other details of the referee system, refer to the *RoboMaster 2018 Referee System User Manual*.

To download the latest version of the Referee System installation package, please visit the following link:

<https://www.robomaster.com/zh-CN/products/components/referee>

For materials related to the referee system, please visit the following link:

<https://www.robomaster.com/en-US/resource/pages/834?type=announcementSub>



- Information regarding the speed measurement module can be found in the *ICRA 2018 DJI RoboMaster AI Challenge Referee System Specification Manual*.

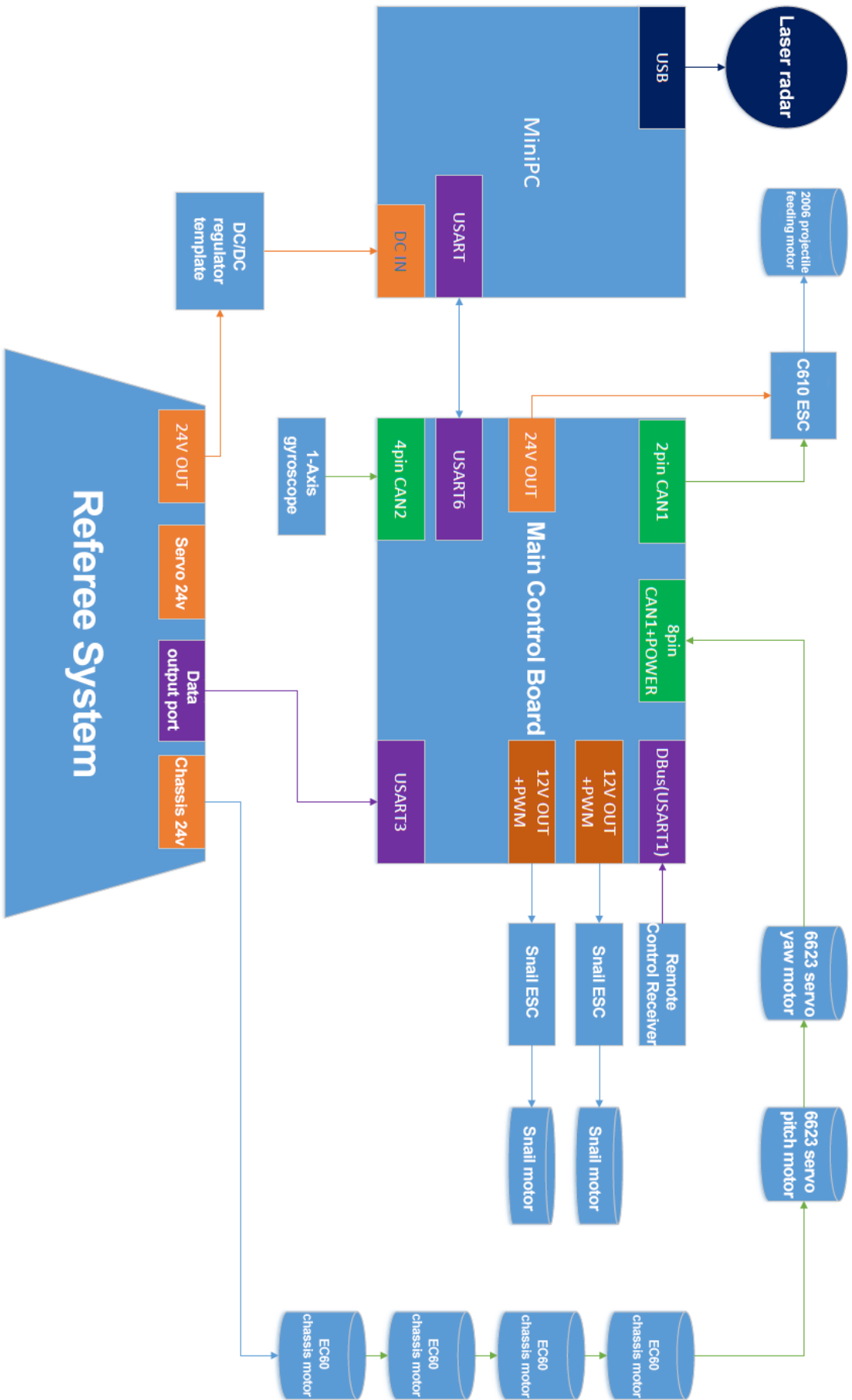
The client and server installation packages will be released on the RoboMaster website in early March:

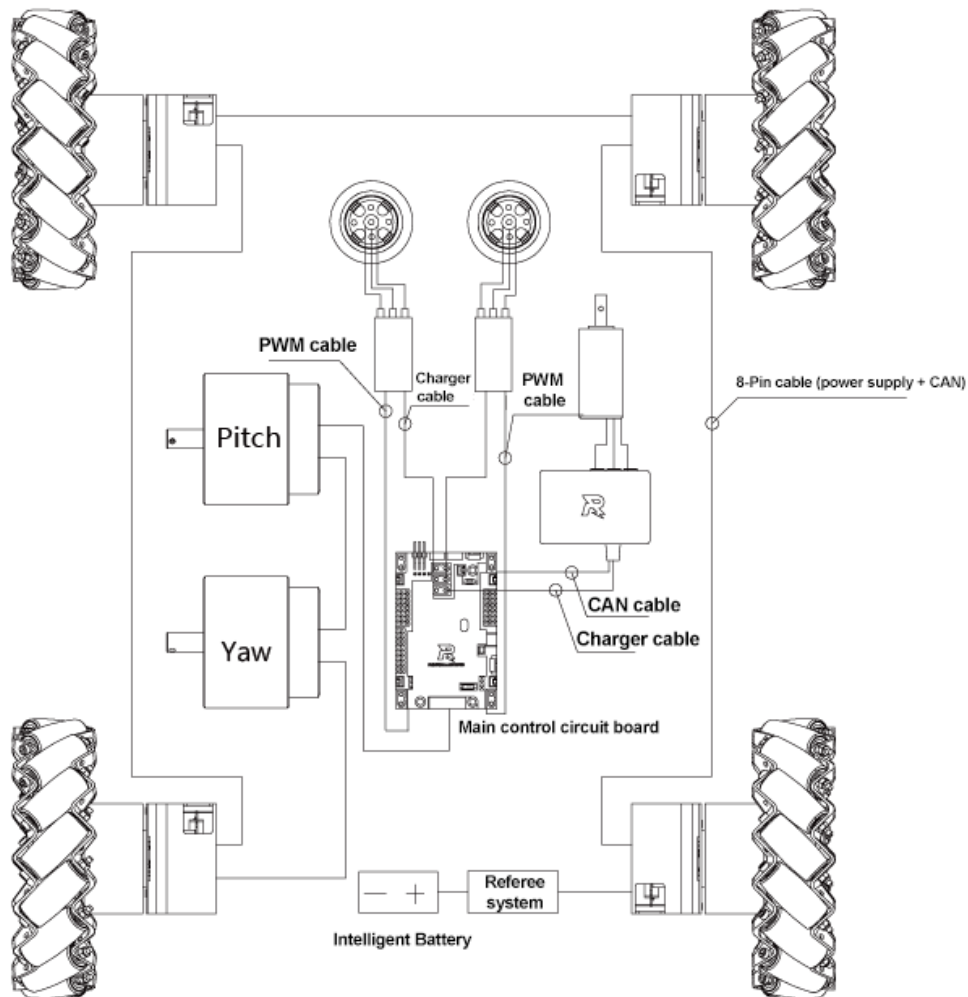
<https://www.robomaster.com/zh-CN/products/components/referee>

- . Please look out for release notifications.
- 

## Hardware Circuit System

The robot's hardware circuit system uses standard CAN bus communications. Main control board resource allocation and circuit topology diagram are as follows:





The RoboMaster Main Control Board is an open source control board specially designed for RoboMaster robots. It enables control of the entire robot and provides an open interface to help you customize and develop new functions. For detailed technical information on the RoboMaster Main Control Board, please see the [RoboMaster Main Control Board User Manual](#).

**Connector Specification:**

Teams are recommended to purchase corresponding cables according to the following connector specification. The pinout of the referee system can be found in the RoboMaster Referee System User Manual (<https://www.robomaster.com/en-US/resource/pages/834?type=announcementSub>), and the pinout for infantry robot MCU can be found in [RoboMaster Main Control Board User Manual](#).

1. Referee system firmware update connector/port: SM04B-GHS-TB (JST 4pin)
2. Referee system and MCU communication:
  - 2.1. Referee system side connector: SM04B-GHS-TB (JST 4pin)
  - 2.2. MCU side connector corresponds to USART3 on the above diagram. The connector is: MOLEX 53261-0571
3. MCU and the miniPC communication port is USART6 on the above diagram. The connector is: SM04B-GHS-TB (JST 4pin)
4. MCU program download port is the SWD connector on the above diagram. The connector is: MOLEX 53261-047

## Software System

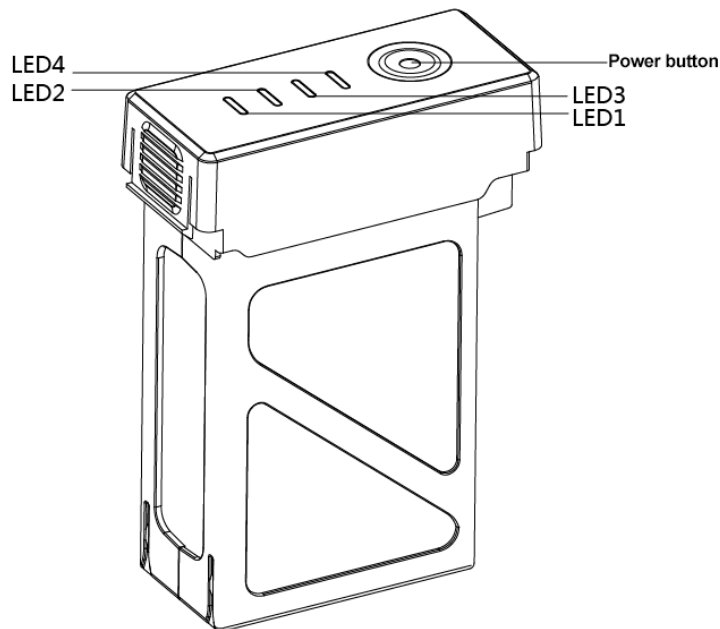
For information on the software system of AI Robots, please visit the following link:

<https://github.com/RoboMaster/RoboRTS-Firmware>

<https://github.com/RoboMaster/RoboRTS>

## Intelligent Battery

The battery of AI Robots (tb48d/tb47d) is the same intelligent battery that is used in the DJI Matrice 100 aircraft. The tb48d model has a capacity of 5700 mAh and the tb47d model has a 4500 mAh capacity. Both models are 22.2 V and feature charge-discharge management. The battery uses high-energy cells and features an advanced battery management system to provide the robot with ample power. Charge the battery only with the official charger provided by RoboMaster. Before using the M100 intelligent flight battery, please carefully read through the *DJI Matrice 100 Intelligent Flight Battery Safety Guidelines*.



















## Turning On/Off

Short press the battery button once and then press and hold the battery button for 2 seconds to turn the battery on or off. When the battery is on, the battery level indicator indicates the battery's charge, and the battery level indicators are off when the battery is turned off.

## Checking the Charge

When the battery is turned off, short press the power button once, to view the charge.

	The battery level indicator shows the battery's charge when it is charging or discharging as follows:	
	 The LED indicator is on	 The LED indicator is blinking
	 The LED indicator is off	

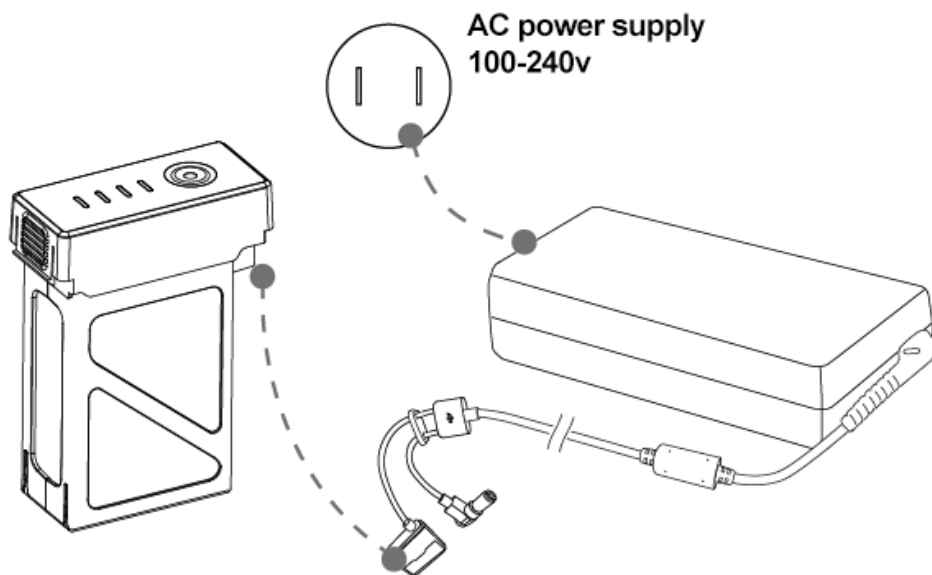
Battery level indicator				
LED1	LED2	LED3	LED4	Battery charge
				87.5%~100%
				75%~87.5%
				62.5%~75%

				50%~62.5%
				37.5%~50%
				25%~37.5%
				12.5%~25%
				0%~12.5%
				= 0%

## Charging

Before using the battery for the first time, ensure that it is fully charged.

1. Connect the charger to AC adapter (100-240 v, 50/60 hz; use a power converter if necessary).
2. Connect the battery to the charger when the battery is turned on or off. If the current battery charge is higher than 95%, you need to turn on the battery to charge it further.
3. The battery level indicator will flash when the battery is charging and will indicate charge.
4. When the battery level indicator is completely off, the battery is fully charged. Remove the battery and charger.



**To achieve a full charge using the standard charger requires approximately 1.5 hours**



























- The designated charger is the A14-100P1A. Only use the designated charger from RoboMaster to charge the battery.
- The battery's temperature is high after use. Wait for the battery to cool down to room temperature before charging.
- The best temperature range for charging the battery is between 0 °C to 40 °C. If the temperature of the cells is not within this range, the battery management system will prohibit charging.

## Charge Protection Indicator

Battery level indicators will indicate when battery protection has been triggered due to a charge exception.



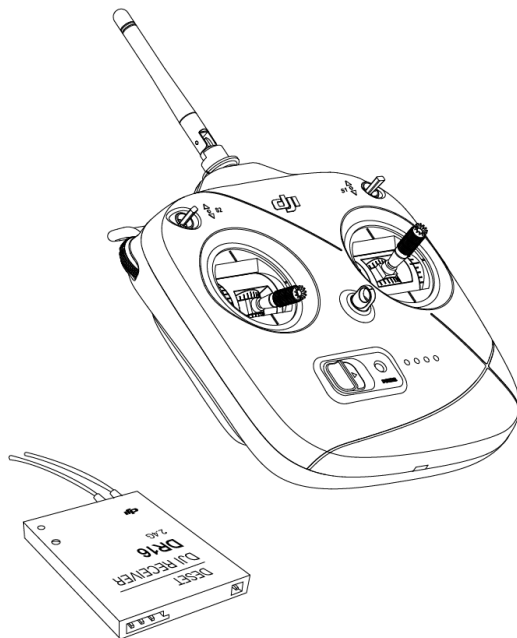
Battery level indicators					
LED1	LED2	LED3	LED4	Behavior	Exception
				LED 2 blinks twice each second	The electric current is too high
				LED 2 blinks three times each second	Short circuit
				LED 3 blinks twice each second	Overcharging has caused the battery voltage to be too high
				LED 3 blinks three times each second	Charger voltage is too high
				LED 4 blinks twice each second	The battery's temperature is too low for charging
				LED 4 blinks three times each second	The battery's temperature is too high for charging

After you discover the cause of the exception (the current is too large, short circuit, overcharge, charger voltage too high), press the battery button to clear indicators, unplug and replug the charger, and resume charging. If the battery's temperature is beyond the acceptable range for charging, it will automatically resume charging when the temperature returns to normal.

# Remote Control Kit

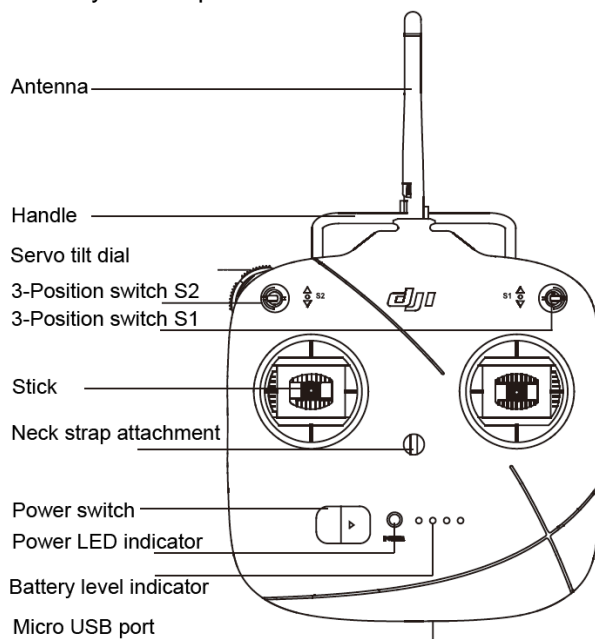
## Kit Overview

The kit includes a remote control and a receiver that is mounted below the launching mechanism of the AI Robot. The frequency configuration of the remote control and receiver have already been completed.



## Remote Control

The AI Robot's remote control is the DJI DT7. DT7 is a radio communication device that operates in the 2.4GHz band. The device can only be used with the DR16 receiver. In an open outdoor environment, the maximum range of DT7 is 1000 m (you can control AI Robots on the ground from a maximum distance of 100 m). It has a built-in lithium battery with a battery life of up to 12 hours.

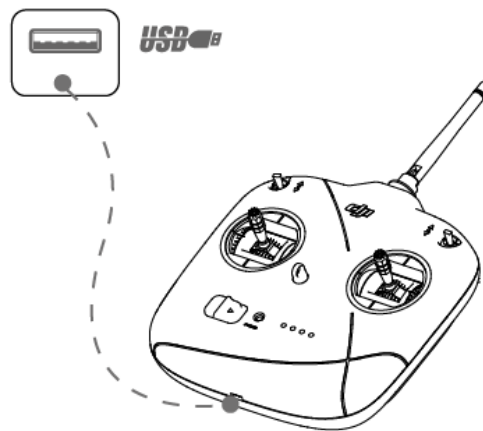


## Turning On/Off

1. Toggle the S1 switch to the top setting and confirm that the two rockers are in neutral position.
2. Toggle the power switch to the right to turn on the remote. Slide the power switch to the left to turn off the remote.
3. When the remote control is turned on, the power LED indicator is green and the buzzer beeps.

## Charging

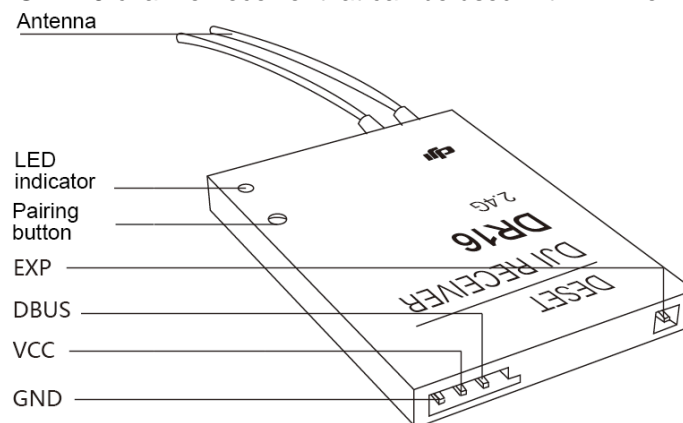
To charge the DT7, use the micro USB cable to connect the USB charger with the parameter adjustment interface at the lower end of the device. When charging, the power indicator is solid red and the battery level indicator is blinking green. When the charge is complete, the power LED indicator and the battery level indicator are both solid green.

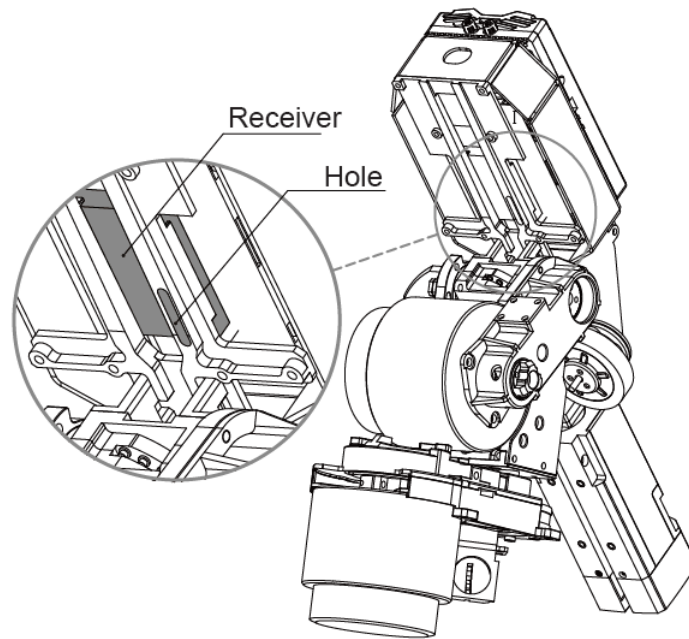


To achieve a full charge via USB requires approximately 2.5 hours  
(1.5 A charger)

## Receiver

The DR16 Receiver is a 2.4 GHz 16-channel receiver that can be used with DT7 remote control.





## Pairing the Remote Control and Receiver

The receiver is installed below the launching mechanism of the robot (above). Before leaving the factory, the frequency of the remote control and receiver have already been paired and can be used out of box. To pair the remote control and receiver, follow the steps below:

1. The pairing button for the receiver is located in a hole under the main control board on the launching mechanism.
2. Open the AI Robot and ensure that the receiver is being powered. If there are no nearby remote controls, the receiver indicator will be solid red.
3. Turn on the remote control to be paired with the receiver. At this time, the receiver indicator will blink green.
4. Press the receiver pairing button for 2 seconds, and the receiver indicator will blink red while pairing.
5. Release the pairing button to complete pairing. At this time, the receiver indicator is solid green.



Keep the distance between the remote control and the receiver as close as possible and ensure that there are no other remote controls in the vicinity.

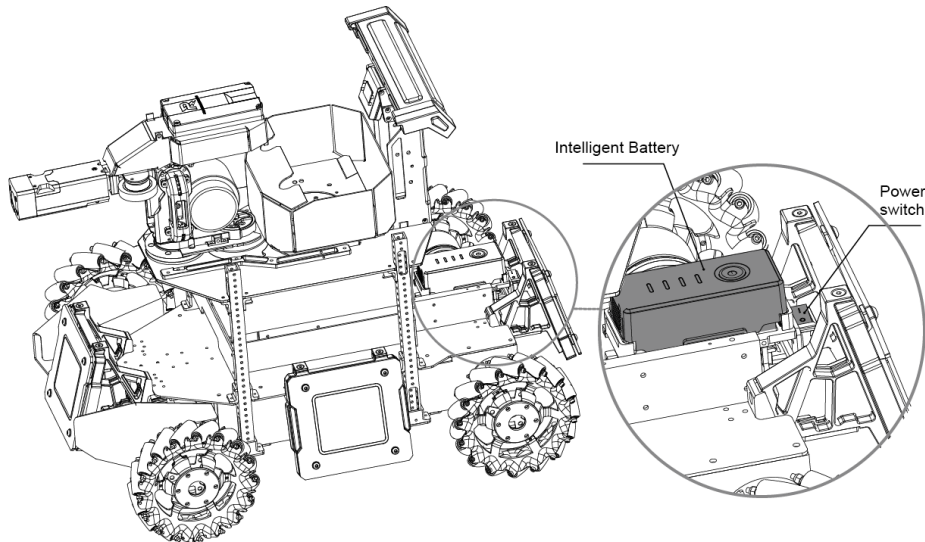
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For the communication protocol between the DT47 remote control and DR16 receiver, please refer to the *RoboMaster Robot Remote Control (Receiver) User Manual*.

# Powering On and Controlling the Robot

## Battery Installation/Removal

The battery rack is located in front of the AI Robot's rear armor plate. During use, install the battery vertically in the battery rack. Battery rack location:



## Powering On/Off

After the battery is installed into the battery rack, turn on the intelligent battery and the press the power switch of the AI Robot (as shown above). The power switch is located between the battery rack and rear armor plate and is fixed on the battery rack. After the AI Robot is powered on, it will perform a self-test, during which the referee system will increase the HP on the main control display from 0 to 90%. Once the self-test successfully completes, the HP on the main control display will be at 100%. During the self-test, remote control operations are invalid.

## Control Modes

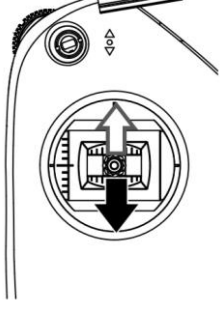
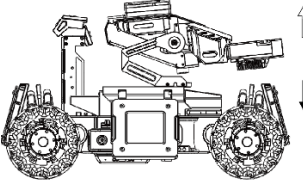
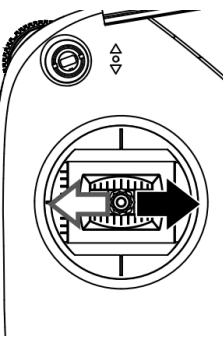
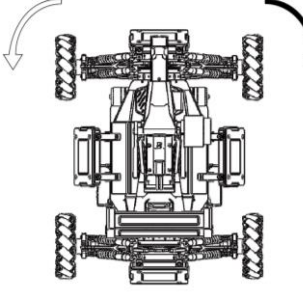
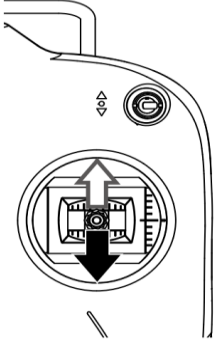
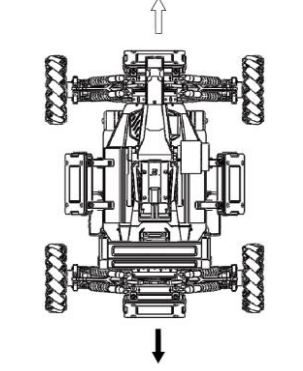

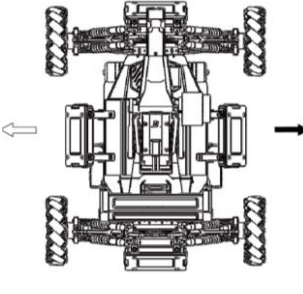
Mecanum wheels enable AI Robots to move in any direction. In fixed servo control mode, the chassis and servo move in unison. AI Robots have two control modes:

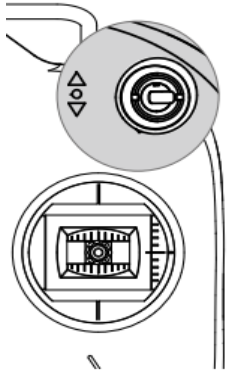

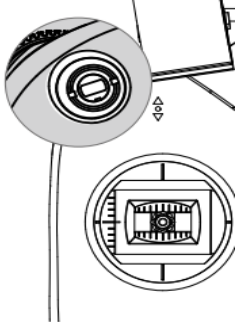

1. Remote control only: Simple and convenient, ready to use, suitable for demonstration and debugging.
2. Remote control + PC: Controlling the robot based on the first person view from the robot on the PC screen, which is suitable for competition.

Select the control mode by toggling the S2 switch on the remote control. The remote control can be used in any control mode.

## Controlling with Remote Control

Turn on the remote control and set the S1 switch on the top right side of the remote control to -1 (up) and the S2 switch to -2 (center) to control the robot via remote control. Each function is implemented as follows:

Remote Control	Robot	Control
		<p>Moving the stick up tilts the robot's head up (+); moving the stick down tilts the robot's head down (-); Servo pan range: <math>-38^{\circ}</math>~<math>24^{\circ}</math></p>
		<p>Moving the stick left rotates the servo and chassis counterclockwise Moving the stick right rotates the servo and chassis clockwise When the stick is in neutral position, the robot does not move</p>
		<p>Moving the stick up moves the robot forward Moving the stick down moves the robot backwards When the stick is in neutral position, the robot does not move</p>
		<p>Moving the stick left makes the robot strafe left Moving the stick right makes the robot strafe right When the stick is in neutral position, the robot does not move</p>

	 <p>Position -1 Position -2 Position -3</p>	<p>S1 switch is the software switch button: When S1 is toggled to -1, the robot's servo and chassis are powered on. When S1 is toggled to -2 or -3, the robot's servo and chassis are powered off*. The referee system is always powered on.</p>
	 <p>Position -1 Position -2 Position -3</p>	<p>When S2 is toggled from -2 to -1, the launching mechanism's friction wheels start to spin. Once the friction wheels are spinning, toggling S2 from -2 to -3 and then quickly back to -2 will launch a projectile. If S2 stays on -3, the robot continuously launches projectiles. When S2 is toggled to -2, the robot can be controlled via the PC.</p>

When the miniPC/TX1/TX2 is not connected to the MCU, both tap positions on S1 will power-off chassis and gimbal motors. Otherwise, the robot will operate under automatic mode. Check the Operation Instructions on GitHub (<https://github.com/RoboMaster/RoboRTS-Firmware>) for more details.

## Controlling with Remote Control + PC

Connect the parameter adjustment port at the lower part of the remote control to the USB port of a computer using a Micro USB cable and dial the switch in the upper-left corner of the remote control to 2 (medium). Launch RoboMaster\_Client from the PC and you will have a first person view from the robot. Now, you can control the AI Robot via keyboard and mouse. For details about RoboMaster\_Client, see the "Referee System" section of this manual.

Controls:

Keyboard	W	Move forwards
	S	Move backwards
	A	Strafe left
	D	Strafe right
	E	Tactical evasive maneuver
	Shift+W、 A、 S、 D	Move quickly
	Ctrl+W、 A、 S、 D	Move slowly
	Q	Turn on the friction wheel
	Shift+Q	Turn off the friction wheel
Mouse	Pan left	Rotate the servo and chassis counterclockwise
	Pan right	Rotate the servo and chassis clockwise
	Zoom in	Tilt servo up (+)
	Pan right	Tilt servo down (-)
	Single left click	Launch projectiles (single shot)
	Hold the left mouse button (2 seconds)	Launch projectiles (rapid fire)

The above default controls may be customized according to your requirements.

## Appendix

### Specifications

<b>Structure</b>	
Dimensions	650 × 450 × 460 mm
Weight (with battery)	16.6 Kg
<b>Performance</b>	
Maximum Forward Velocity	3 m/s
Maximum Transverse Velocity	2 m/s
Servo Pitch Range	-38° ~ 24°
Servo Yaw Range	-110° ~ 110°
Projectile Launch Frequency	10 shots/s
Projectile Launch Speed	25 m/s
Projectile Capacity	200
<b>Drive System</b>	
Chassis Motor Model	RoboMaster EC60 Brushless Motor
Servo Motor Model	RoboMaster 6623 Servo Motor
Launch Motor Model	DJI Snail 2305 Racing Motor
Launcher Motor ESC	DJI Snail 430-R Racing ESC
Loader Motor Model	RoboMaster M2006 P36 Brushless DC Gear Motor
Loader Motor ESC	RoboMaster C610 Brushless Motor Speed Controller
<b>Battery</b>	
Model	TB48D/TB47D
Type	LiPo 6S
Voltage	22.8 V
Capacity	TB48D:5700 mAh/TB47D:4500mAh
<b>Remote Control</b>	
Model	DT7
Working Frequency	2.4 GHz
Communication Range	1000 m
Power Supply Mode	Built-in Lithium Battery
Interface	Micro USB
Batter Capacity	2600 mAh
<b>Charger</b>	
Model	A14-100P1A
Input	100-240 V 50-60 Hz
Output	26.3 V
<b>Projectile</b>	
Model	RoboMaster 17 mm Projectile
Color	White



Size	17 mm
Weight	2.5g

## Parts List

Module	Part	Amount
Chassis	RoboMaster EC60 Brushless Motor-01	1
	RoboMaster EC60 Brushless Motor-02	1
	RoboMaster EC60 Brushless Motor-03	1
	RoboMaster EC60 Brushless Motor-04	1
	RoboMaster Mecanum Wheel (left)	2
	RoboMaster Mecanum Wheel (right)	2
2-Axis Servo and Launching Mechanism	RoboMaster M2006 P36 Brushless DC Gear Motor	1
	RoboMaster C610 Brushless Motor Speed Controller	1
	RoboMaster 6623 Brushless Motor (with speed controller)	2
	RoboMaster Main Control Board	1
	DJI Snail 2305 Racing Motor	2
	DJI Snail 430-R Racing ESC	2
Referee system	Armor Module	4
	Main Control Module	1
	Speed Measurement Module	1
	Camera Transmission Module (transmit-end)	1
	RFID Interaction Module	1
	RFID Interaction Card	2
	Camera Transmission Module (receive-end)	1
Remote Control	Remote Control	1
	Remote Control Receiver	1
Battery	Intelligent Battery	1
	Charger (wired)	1



## Contact Us

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