

V1.0

Using a 32-bit motor driver chip and Field-Oriented Control (FOC), the RoboMaster C20 Brushless DC Motor Speed Controller enables precise control over motor torque.



ROBOMASTER

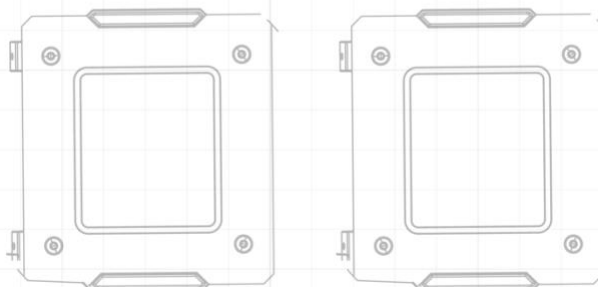
Exclusively designed for the RoboMaster M308 P18 Brushless DC Gear Motor and C20 Brushless DC Motor Speed Controller, the M308 Accessories Kit includes several cables and a terminal board.

Refer to System Specification Manual, RoboMaster User Manual, Introduction of RoboMaster Module.

All M308 Accessories Kit include several cables and terminal board, please refer to the accessories kit.

# ICRA RoboMaster 2019 AI CHALLENGE **RULES MANUAL**

The RoboMaster Organizing Committee  
December, 2018



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# Revision Log

<b>Date</b>	<b>Version</b>	<b>Record</b>
12/10/2018	1.0	First Release

**The RoboMaster Organizing Committee reserves the right to revise and interpret the rules manual.**

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# Groups and Organizations

## **Hosts:**

IEEE RAS International Conference on Robotics and Automation 2019  
(ICRA 2019)

SZ DJI Technology Co., Ltd.  
(DJI, Dà-Jiāng Innovations)

## **Organizer:**

RoboMaster Organizing Committee

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# Foreword

Robotics is currently one of the most mainstream cutting-edge technologies in the world.

Robots are not only the key supporting equipment for advanced manufacturing, but also an important carrier for improving human lifestyle. Whether it is an industrial robot applied in a manufacturing environment or a service robot applied in a non-manufacturing environment, its R&D and industrial application are important standards for measuring a country's technological innovation and high-end manufacturing development.

Since 2015, DJI has launched the RoboMaster Robotics Competition, hoping to cultivate a group of talented engineers and scientists. In this competition, the teams need to develop a group of ground robots and aerial robots to fire projectiles on the battlefield and fight each other. The data interaction of the robots is monitored by a special referee system. The referee system converts damage inflicted by projectiles into dynamic changes in HP, and finally presents it to the audience on a game-like viewing page. The competitive mode of modern robots is constantly evolving.

In recent years, deep learning technology has also been brought up in numerous fields, reshaping the frontiers of computer vision and other areas of artificial intelligence research. In robot research, deep neural network (DNN)-based reinforcement learning enables robots to make decisions autonomously. As well-known games such as Go, Warcraft, and StarCraft are used as research platforms, the potential for the application of robotic autonomous decision-making in our daily life is unlimited.

As an emerging robotics academic platform, RoboMaster Organizing Committee launched the ICRA RoboMaster AI Challenge, which enables global enthusiasts to research deep neural network (DNN)-based robotics. Research results are expected to be applied in industries such as field rescue, driverless vehicles, and automatic logistics to benefit our lives.

All participants should abide by the rules and the relevant documents of the competition. Principal specifications documents for the ICRA 2019 RoboMaster AI Challenge (hereinafter referred to as the "AI Challenge") are the ICRA 2019 RoboMaster AI Challenge Rules Manual, the ICRA 2019 RoboMaster AI Challenge Robot Specification Manual, the ICRA 2019 RoboMaster AI Challenge Referee System Specification Manual, and the ICRA 2019 RoboMaster AI Challenge Participant's Manual (all documents are subject to the latest version officially released by the RoboMaster Organizing Committee).

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In the document ICRA 2019 RoboMaster AI Challenge Rules Manual, all the rules laid out should be taken at face value. Participants should not misinterpret the content in this manual nor refer to information from rules manuals of previous or other competitions.



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# Objectives

## **Create a Broad Influence**

The competition draws attention to the robotics industry through its creative battle rounds, professional research standards, and innovative event schedules.

## **Promote the Development of Practical Teaching**

This competition is designed to promote and develop practical teaching methods combined with cutting-edge technologies together with the higher education institutions that enter the competition. By developing the skills and talent pool of the teaching staff who work in the robotics field and building practical teaching centers and open labs for intelligent technologies, we encourage undergraduate students, graduate students, and Ph.D. students to combine their researches with robotics projects. By carrying out robotics experiments and tests through these robot competitions, we provide opportunities for students to apply their scientific research theories to practice. In this way, we hope to cultivate a group of outstanding scientists and engineers to apply research results to real life.

## **Increase Social Engagement**

During the competitions, various activities related to the competitions will be held combined with local characteristics of the host venues. We will also cooperate closely with enterprises in the industry to integrate resources and provide a variety of interactive experiences and the most cutting-edge technologies for the public to feast on in the most straight-forward way.

## **Summarize Academic Achievements**

In addition to the competing process itself, this event also focuses on bringing together academic and technological achievements within the robotics field. We encourage participating team members to share their latest achievements in robotics research and development, thus promoting in-depth exchanges of researches and ideas.

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# Chapter One – Introduction to the Competition

## 1.1 Overview

From developing robotic automation and artificial intelligence technology to promoting the application of robot technology in field rescue, driverless vehicles, automatic logistics and other related scenarios, we strive to make robots better serve our lives. The RoboMaster Organizing Committee will organize the ICRA 2019 RoboMaster AI Challenge (hereinafter referred to as the "AI Challenge") in May 2019.

This year, a standard robot platform will be provided by the competition. This standard platform is equipped with standard interfaces for features such as firing projectiles and attack detection. The teams entering the AI Challenge will be required to develop their own algorithms and cooperate with the equipped sensors and computing devices to enable robots to make independent decisions, move, and fire.

In the AI Challenge, each team needs to prepare one or two robots to perform fully automatic firing battles with the opposing team on a 5m × 8m competition area. During each round, a robot reduces its opponent's HP by recognizing and firing projectiles to hit the opponent's armor. At the end of each round, the team with the highest total damage output by the robots wins the round.

In order to examine the superiority and stability of a robot's algorithm, each short-listed team needs to complete the group stage and the knockout stage. Teams will be ranked based on their final scores, and be awarded with corresponding certificates and bonuses.

Compared to the ICRA 2018 RoboMaster AI Challenge, this year's rules removed the bonus zone located in the center of the competition area where attacks were enhanced. Strategies for projectile preloading have been changed as well. Projectile supply tasks based on computer vision tags and automatic planning have been added to the Challenge. The starting zones for the red team and the blue team have been expanded to two for each. Two defense bonus zones for the red team and the blue team have been added. The distribution of obstacles in the competition area has also been changed to expand the moving area for the robots.

## 1.2 Competition Schedule

The RoboMaster Organizing Committee is entitled to make reasonable changes in the schedule, competition system, and other areas. The specific implementation plan shall be subject to the latest information published by the Organizing Committee through official channels before the competition.

Competition Schedule		Date	Platform	Notes
<b>Registration Period</b>		December 20, 2018 to January 18, 2019	Log in to <a href="http://www.robomaster.com/en-US">www.robomaster.com/en-US</a> and select the registration system to register.	Successful registration allows participants to obtain a discount on the purchase of materials.
<b>Material Purchasing</b>	Batch One	December 10, 2018 to January 10, 2019	Offline purchasing	Purchase materials according to the material purchase announcement published on the official RoboMaster website.
	Batch Two	February 11, 2019 to April 18, 2019	Offline purchasing	
<b>Technical Assessment</b>	Technical Proposal	December 10, 2018 to January 22, 2019	By registering and obtaining registration numbers, teams can use their captains' accounts to log in to the competition registration system to submit for technical assessment.	<ol style="list-style-type: none"> <li>Optional.</li> <li>Teams with excellent Technical Proposals can receive robots or robot purchasing coupons sponsored by the Organizing Committee.</li> </ol>
	Technical Report	February 11, 2019 to March 25, 2019		<ol style="list-style-type: none"> <li>Required.</li> <li>Only teams with passed technical reports are eligible to enter the AI Challenge.</li> </ol>
<b>Announcement of Entry List</b>		April 5, 2019	Competing teams will be announced on the official RoboMaster website and other platforms.	The final competing teams may receive funding subsidies from the Organizing Committee.
<b>Competition Days</b>	Registration Day and Practice Matches	May 20, 2019	Montreal, Canada	-
	Official Competition	May 20, 2019 to May 22, 2019		Includes the group stage and the knockout stage.

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Note: The time for the competition days is UTC-5 standard, and for other schedules it is UTC+8 (Beijing time) standard.

## 1.3 Eligibility

### 1.3.1 Basic Rules for Entering the AI Challenge

1. Only undergraduate students, graduate students and doctoral degree candidates registered before May 2019 are eligible to sign up for the Challenge.
2. Each team must have a captain. During the preparation period, team captains will serve as the official point of contact.
3. Each team must have six to twelve team members. Each member's responsibility must be marked at the time of registration.
4. Multiple teams from the same school are allowed to register.
5. The team name must be in the format of "school name + team custom name + team".
  - A. The first part is the school name of the team. Abbreviations are allowed.
  - B. The second part is the custom name of the team. The total length of the custom team name should not exceed 16 characters (one Chinese character counts as two characters; one English letter counts as one character). The team name should showcase the team's proactive attitude and their pursuit for excellency.
  - C. Multiple teams from the same school are not allowed to have the same team name.
6. Each contestant is allowed to join only one team.

### 1.3.2 Description of the Responsibilities in the AI Challenge

#### Captain:

- A. The Captain's responsibilities include: dividing team member responsibilities, planning, as well as strategy development and adjustment.
- B. During the competition, captains are required to attend pre-match meetings, confirm each match result on behalf of their teams, participate in the appeal process, and process any subsequent hearings.
- C. Captains are also responsible for the continuation and development of their teams after the AI Challenge.

#### Other Team Members:

Technical Group Category	Main Responsibilities	Recommended Member Structure
Algorithm group	Program development	Five to eight people

<b>Mechanical group</b>	Mechanical structure maintenance	One to two people
<b>Embedded system group</b>	Interface call and program development	Zero to two people

Notes:

1. We recommend to assign one team member from each team to double as the OPM to plan project progress and fund allocation.
2. We recommend to have one to two supervisors or advisors on the team to provide technical guidance.

## 1.4 Prizes and Rewards

Award	Ranking	Qty.	Reward
<b>Grand Prize</b>	First Place	1	Honor certificates (for each team member) Cash bonus USD \$20,000 (pre-tax)
<b>First Prize</b>	Second Place	1	Honor certificates (for each team member) Cash bonus USD \$15,000 (pre-tax)
	Third Place	1	Honor certificates (for each team member) Cash bonus USD \$10,000 (pre-tax)
	Fourth Place	1	Honor certificates (for each team member) Cash bonus USD \$5,000 (pre-tax)
<b>Second Prize</b>	Fifth to Eighth Place	4	Honor certificates (for each team member) Cash bonus USD \$2,000 (pre-tax)
<b>Third Prize</b>	The teams that entered the AI Challenge but failed to enter the quarterfinals	Multiple	Honor certificates (for each team member)
<b>Participation Award</b>	The teams that got rank C in the Technical Report (No qualification to the competition)	Multiple	Honor certificates (for each team member)
<b>Sharpshooter Award</b>	The teams that got high average hit rate in the group stage	Multiple	Honor certificates (for each team member)

<b>Academic Incentive Award</b>	Research results related to the AI Challenge are developed into papers and published in academic journals	Multiple	Honor certificates (for each team member) Highest cash bonus USD \$10,000 (pre-tax)
<p><b>Notes:</b></p> <ol style="list-style-type: none"> <li><b>Supervisors and advisors for the winning teams will also receive the corresponding honor certificates.</b></li> <li><b>Academic awards are assessed based on factors such as journal impact factor, zoning, and the impact of international conferences. Details of the assessment will be detailed in subsequent rules.</b></li> </ol>			

## 1.5 Intellectual Property Statement

The RoboMaster Organizing Committee encourages and advocates technological innovations and an open source community. We respect the intellectual property of the teams. All rights related to the intellectual property developed during the competition are owned by individual teams. The RoboMaster Organizing Committee will not participate in the handling of intellectual property disputes among the internal members of the teams. The participating teams must properly handle all aspects of intellectual property rights among internal school members, company members and other members of the team.

While using the robots, referee system and other competition materials provided by the RoboMaster Organizing Committee, all teams shall respect the ownership of all intellectual property. Teams are also prohibited from engaging in any behavior that violates intellectual property rights, including but not limited to reverse engineering, copying or translation. Violators of the intellectual property rights of the RoboMaster Organizing Committee or the organizer will be held legally accountable as requested by the owner(s) of the intellectual property.

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# Chapter Two – Robot Technical Specifications

The AI Challenge focuses on deep neural network algorithms of robots. The participating teams must use the unified standard robot hardware platform provided by the RoboMaster Organizing Committee. Non-official robots or robots used in previous or other competitions are not allowed to be used in the competition. The participating teams need to develop sensors, computing device solutions and neural network algorithms on the robot hardware platform to register for the competition.

For purchasing, sponsorships, discounts and other information relating to the robot hardware platform, the details are subject to the announcement released on the official RoboMaster website.

All robots must follow the technical specifications defined in these instructions, otherwise they shall fail inspection and be disqualified from competition.

## 2.1 General Technical Specifications

All participating robots must meet the following general technical specifications regarding energy source, wireless, optical approaches, computer vision features, and robot numbering.

Type	Technical Specifications
Energy Source	<p>The energy source used by robots is limited to electrical power supply, and the use of gas sources, fuel oil-powered engines, explosives and hazardous chemical materials is prohibited.</p> <p><b>Power Supply:</b></p> <p>Only lithium batteries (TB47D, TB48D) with power management and short circuit protection functions produced by SZ DJI Technology Co., Ltd., which is the organizer of the competition, can be used.</p> <p><b>Notes:</b></p> <p>Explosion-proof tanks are placed at designated locations in the stadium. During the competition, if there is a safety hazard with a battery, an on-site technician will put the hazardous battery into an explosion-proof tank, and will not return it to the participating team until the safety hazard is eliminated.</p> <p><b>Penalty:</b></p> <p>Robots with batteries violating these specifications fail the pre-match inspection. Violators will be held legally liable for safety incidents caused by non-compliant batteries.</p>

Type	Technical Specifications
Wireless	<p><b>Remote Control:</b></p> <ol style="list-style-type: none"> <li>The remote controls used by the robots must be products produced by SZ DJI Technology Co., Ltd., which is the organizer of the competition.</li> <li>During the competition, each remote controller configured for a robot can only correspond to one receiver.</li> </ol> <p><b>Penalty:</b></p> <ol style="list-style-type: none"> <li>Robots equipped with other remote control products cannot pass the pre-match inspection.</li> <li>During the three-minute match, if the receiver on the robot works with 2 or more remote controls, it will be considered cheating once verified through appeals or confirmed by the chief referee, and the violator will be disqualified.</li> </ol> <p><b>Wireless Communications:</b></p> <p>In addition to the remote controls and UWB locating equipment of robots, the participating teams can also build their own Wi-Fi data links for networking communication between robots. The wireless routers used must be placed in the area specified by the Organizing Committee. Corresponding external power sources will be provided by the Organizing Committee. During the competition, both teams should use a 2.4 or 5.8 GHz Wi-Fi network, and the upper limit of bandwidth occupied by either team is 40 MHz. Due to a large audience and a large number of devices used for live broadcast during the competition, there will be many unknown Wi-Fi signal sources. The Organizing Committee does not guarantee the stability of Wi-Fi networks built by participating teams.</p> <p><b>Notes:</b></p> <ol style="list-style-type: none"> <li>In the five-minute setup period in each round, the teams can set up a wireless network by themselves. It is recommended to use a mature and fast network setup scheme.</li> <li>Computers, tablets and other devices used to receive self-built wireless network data can only be placed in the operator room, and should not be placed in other areas such as the auditorium. After the match starts, the related devices for receiving the wireless network data must not be operated. Otherwise, it will be considered cheating once identified.</li> <li>These networks can only be used for communication between robots or for testing and debugging robots during the preparation time between rounds.</li> </ol> <p><b>Penalty:</b></p> <ol style="list-style-type: none"> <li>If a team is found setting up a wireless network with an illegal band for robot communication, the team will be considered cheating once it is</li> </ol>



Type	Technical Specifications
	<p>verified through appeals or confirmed by the chief referee. The team violating the rules will be given a punitive forfeiture in all relevant matches in which the communication is conducted with an illegal robot.</p> <ol style="list-style-type: none"> <li>In the official initialization period of the competition or during a match, if a team uses wireless communications to control its robot which is on the battlefield, the team will be considered cheating. Once the violation of this rule is verified through appeals or confirmed by the chief referee, the team will be given a punitive forfeiture in all relevant matches in which illegal communications are used.</li> <li>Any team found to be deliberately using a Wi-Fi network to interfere with the referee system or normal functioning of opposing robots will be disqualified from the competition once it is verified through appeals or confirmed by the chief referee.</li> </ol>
<p><b>Optical Approach</b></p>	<p>It is forbidden to install any laser or device that emits visible light on robots.</p> <p><b>Penalty:</b> Robots that violate the rules will fail to pass the pre-match inspection.</p>
<p><b>Computer Vision Characteristics</b></p>	<p>The two sides of the referee system armor module is designed with obvious lighting effects for the development of automatic recognition algorithms. The competition area and its environment are complex, and teams should consider this when developing computer vision algorithms to better adapt to the changing illumination and other interferences from around the competition area. The RoboMaster Organizing Committee cannot guarantee that computer vision features and effects in the field will not interfere with a robot's vision system.</p> <ol style="list-style-type: none"> <li>Robotic sensors (such as LiDARs, cameras, ultrasonic sensors, etc.) should not be installed to obstruct the armor module.</li> <li>No devices (such as reflectors, mirrors, lenses, etc.) should be installed on the robot to reflect or refract light on both sides of the armor, thereby interfering with the recognition of computer vision features of the armor module.</li> <li>The area covered by the light indicator on both sides of the speed monitor module should not exceed 1/5 of the effective area of the light indicator.</li> </ol> <p><b>Penalty:</b> Robots that violate the rules will fail to pass the pre-match inspection.</p>
<p><b>Robot Numbering</b></p>	<p>In the pre-match inspection period and matches, the Organizing Committee staff will paste specified number stickers on the armor plates of participating robots. The participating robots will be marked as Red 1/Blue 1 Standard Robot and Red 2/Blue 2 Standard Robot.</p>

Type	Technical Specifications
	<p>The stickers on the robot's armor plates should be flat and free of air bubbles. Only one sticker can be attached to each piece of armor. Except for the designated number stickers provided by the Organizing Committee, similar stickers should not be attached to the armor or other structure of the robots. Other decorative stickers on the robots should not contain any prominent numbers visible.</p> <p>Schematic diagram of robot number stickers for reference: <a href="#">Appendix Five - Reference Pictures</a></p> <p><b>Penalty:</b></p> <ol style="list-style-type: none"> <li>1. Robots with stickers that fail to meet the requirements will not pass the pre-match inspection.</li> <li>2. During the official competition, all participating robots are required to paste the corresponding stickers, otherwise they will not be allowed to enter the stage to compete.</li> <li>3. During the competition, if any robot is identified with a sticker that does not meet the requirements, the team will be considered cheating, and the team will be given a punitive forfeiture in all relevant matches in which stickers do not meet the requirements.</li> </ol>
<b>Robot Paint</b>	<p>In order to make the robot as recognizable and aesthetically pleasing as possible, the teams can appropriately increase the amount of paint on the robot, but in order to ensure that it does not interfere with computer vision recognition and fairness of the competition, the RoboMaster Organizing Committee reserves the final right to interpret the judgment on the paint interfering with the competition.</p> <p><b>Penalty:</b></p> <p>Robots that do not meet the appearance requirements will not be able to pass pre-match inspection.</p>
<b>Launching Mechanism</b>	<p>The robots purchased by the participating teams include the launching mechanisms. The participating teams are prohibited from modifying the launching mechanisms.</p> <p><b>Penalty:</b></p> <p>Robots with their launching mechanisms modified will not pass the pre-match inspection.</p>

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## 2.2 Robot Technical Specifications

For the ICRA 2019 RoboMaster AI Challenge, each team needs to use the official robot platform to equip their robots with sensors and computing devices in accordance with the technical specifications to ensure the robots are fully automatic. Before each match, all participating robots must pass the pre-match inspection before they can be qualified to enter the stage. If there is serious damage to a certain robot in a match or there is a serious safety hazards such as a short circuit, the robot must be immediately powered off and be taken away from the competition area to avoid safety risks in subsequent matches. During any such situation, you must follow the orders of the chief referee.

### Notes:

During each match, each team can carry up to **2** standby robots. The standby robots must also comply with all robot specifications and pass inspection. Participants are required to declare the number of standby robots they possess during the pre-match inspection. When a **standby robot** is needed to enter the stage, the team members must promptly get a corresponding number sticker from the technicians of the organizer and attach stickers which meet the [2.1 Robot Numbering Technical Specifications](#) to the robot before the robot enters the stage. Standby robots must not replace competing robots without notifying the organizer after passing inspection.

### Penalty:

1. Before each match, if all robots of a team fail to pass the pre-match inspection, the team will be considered forfeiting its right to participate in the match and it will be ruled as punitive forfeiture.
2. If a participating team replaces or adds a standby robot with a competing robot after passing the pre-match inspection or the standby robot does not pass the pre-match inspection due to unapproved robot modification, the team will be considered to be cheating and automatically lose the match. The chief referee will judge each situation on a case-by-case basis.

### 2.2.1 Specifications of Competing Robots

A team should have one or two fully automatic robots for each match. The robot specifications are as follows:

Robot Specifications			
Item	Limit	Penalty	Notes
Initial Blood	2,000	-	-
Operating Mode	Fully Automatic	-	-
Total Power Supply Capacity (Wh)	200	Unable to pass pre-match inspection	-
Power Supply ( W ) Voltage (V)	30	Unable to pass pre-match inspection	-

Robot Specifications			
<b>Robot Chassis Power Consumption (W)</b>	No limit	-	-
<b>Launching Mechanism</b>	17 mm projectile	-	The installation of laser sight is prohibited
<b>Projectile Supply Capability</b>	Preloaded or auto receive and supply	-	-
<b>Initial Projectile Quantity</b>	Only one robot has 40 initial projectiles	-	All projectiles need to be removed in the five-minute setup period
<b>Initial Firing Speed Limit (m/s)</b>	25	HP deduction	-
<b>Barrel Heat Limit</b>	360	Refer to <a href="#">2.3.1.1 Barrel Heat</a>	-
<b>Maximum Weight (kg)</b>	20	Unable to pass pre-match inspection	Includes the battery weight, but not the weight of the referee system
<b>Maximum Initial Size (mm)</b>	600 x 600 x 500	Unable to pass pre-match inspection	<p>1. The height must not exceed 500 mm, and the orthographic projection on the ground must not exceed a 600 x 600 mm square</p> <p>2. Before the three-minute round starts, the robot size must be within the maximum initial size range</p>
<b>Maximum Expansion Size (mm)</b>	700 x 700 x 600	Robots that do not meet the size requirements will not pass the pre-match inspection	Its height should not exceed 600 mm, and its orthographic projection on the ground should not exceed a 700 mm x 700 mm square
<b>Activation Condition</b>	During the five-minute setup period, robots can be debugged in the starting zone. Projectiles can only be	For specific penalty regulations, refer to <a href="#">3.5.1 Five-Minute Setup Period</a>	-

Robot Specifications			
	<p>fired after a match has officially started.</p> <p>Robots are not allowed to leave the starting zone before the match officially starts.</p>		
<p><b>RoboMaster Referee System</b></p>	<p>Four small armor modules, a speed monitor module (17 mm projectile), an RFID interaction module, a main control module, a power supply management module, and a light indicator module</p>	<p>Robots not meeting the referee system installation requirements will not pass the pre-match inspection</p>	-

## 2.2.2 Robot Specification Manual

For all participating robots, the hardware platform and software environment should be installed and configured in accordance with the latest version of the ICRA 2019 RoboMaster AI Challenge Robot Specification Manual. A certain range and limit of modification are allowed based on the modification requirements. The participating robots that violate the requirements will not pass the pre-match inspection.

## 2.3 Referee System Mechanisms

The participating robots shall install the corresponding referee system in accordance with the latest version of the ICRA 2019 RoboMaster AI Challenge Robot Specification Manual. All robot actions throughout a match are monitored by this referee system.

During the referee system's monitoring process, the following related states will occur due to robot behavior:

Terms	Definition
<b>Defense</b>	Defense means that the armor module takes less damage when it is hit by projectiles and collisions. (This definition applies to the word "defense" mentioned in this manual.)
<b>Destroy</b>	One robot attacks the armor module of an opposing robot until the opposing robot's HP falls to 0.
<b>Destroyed</b>	A robot is "destroyed" when its HP is reduced to 0 due to attacks, exceeding the power consumption limit, exceeding the speed of launch, etc.

## 2.3.1 HP Deduction

During a match, a robot will lose HP when its launching mechanism barrel overheats, its initial speed exceeds the upper limit, its armor module is attacked by projectiles, important modules go offline, armor module collisions, and/or penalties take place.

### 2.3.1.1 Barrel Heat

The current initial speed is  $V$  (m/s), and the current barrel heat is  $Q$ .

#### The penalty mechanism for exceeding the initial firing speed limit:

Initial firing speed: the speed measured by the speed monitor module after a projectile has finished accelerating. The speed monitor module can only be installed at the end of the launching mechanism, and the measured value has to be the value after a projectile has fully accelerated. The initial speed limit for projectiles is 25 m/s.

If  $V > 25$ , when the referee system detects a projectile, the robot's HP is deducted by a value of  $L$ .

$V$	$L$
$25 < V < 30$	200
$30 \leq V < 35$	1,000
$V \geq 35$	2,000

#### Barrel Heat Mechanism:

When a match starts, the initial barrel heat value for every projectile launching mechanism is 0. Each time a projectile with a velocity of  $V$  (m/s) is launched, the robot's barrel heat is increased by the value of  $V$ .

During a match, the robot's barrel heat upper limit is 360 and the cooling value per second is 120. If the robot's HP is less than 400, then the cooling value per second is 240.

The barrel heat is settled at a frequency of 10 Hz (the cooling value of heat per period = cooling value per second / cooling settlement frequency).

- a) If  $720 > Q > 360$ , a value of  $(Q - 360) * 4$  of HP is deducted per period, and then the HP is settled and cooled.
- b) If  $Q \geq 720$ , a value of  $(Q - 720) * 40$  of HP is immediately deducted, and  $Q = 720$  after deduction.

### 2.3.1.2 Armor Attack

The armor module detects sources of damage based on its pressure sensor feedback and the frequency of hits. Sources of damage are divided into projectile damage and collision damage.

The highest frequency which the armor module can detect is 20 Hz. A projectile can only be effectively detected when it comes into contact with the armor module at a speed of 12m/s or higher.

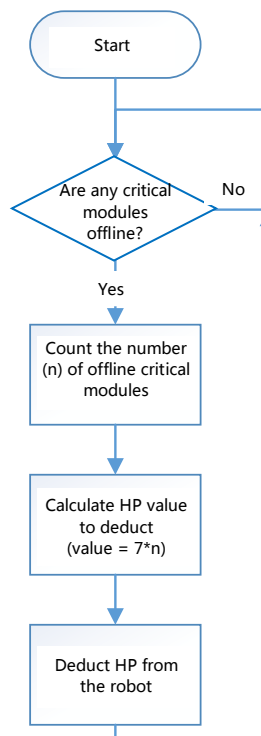
The following is the data of the armor module projectile test for HP damage, for reference only. Please note that situations during the actual competition may vary as the speed of launch and attack distance differentiate, and the results are subject to the determination by the referee system.

Attack Types	Description	Damage Value
<b>17 mm projectile attack</b>	The only permitted source of damage	50
<b>Collisions</b>	For the penalty regarding impermissible sources of damage, please refer to <a href="#">3.5.3.1 Attack and Compete</a>	10
	Collisions with other robots, throwing objects, or collisions with battlefield components are prohibited	

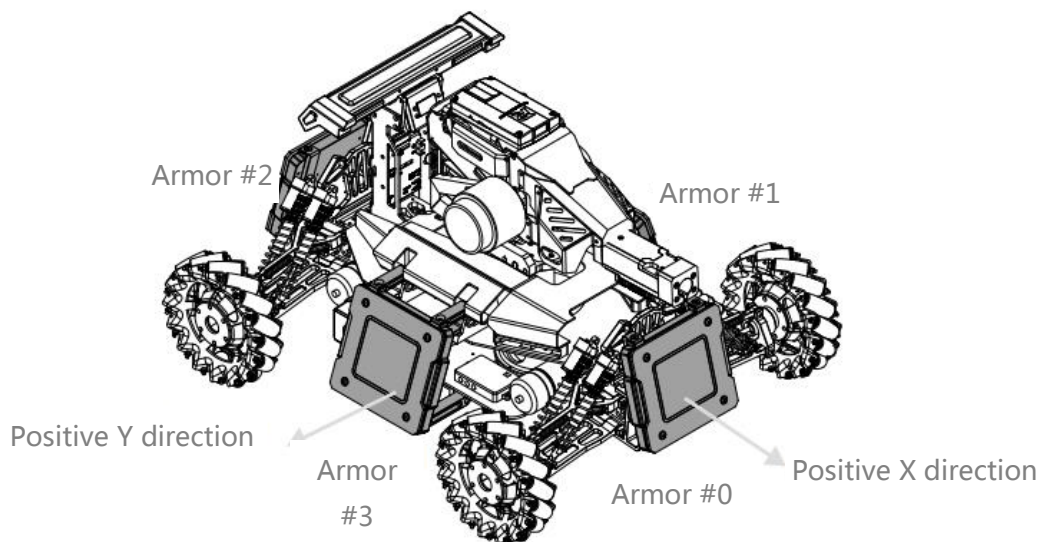
### 2.3.1.3 Offline Referee System

The referee system of the corresponding module of the robot should be installed according to the ICRA 2019 RoboMaster AI Challenge Referee System Specification Manual, and the stability of connection between each module and server of the referee system should be maintained during the matches. The referee system server detects the connectivity of each module at 2 Hz per second. If the important modules (the speed monitor module and the armor module of the referee system) go offline due to problems caused by the design and structure of the robot, the corresponding amount of robot HP will be deducted.

Module Initialization Flow Chart



The armor module must be configured with the correct ID number before the pre-match inspection. The specific requirements are as follows:  
The robot coordinate system established based on the armor module installation requirements:



The armor module ID in the positive direction of the X axis is set to 0; the armor module ID in the negative direction of the Y axis is set to 1. The armor module ID in the negative direction of the X axis is set to 2, and the armor module ID in the positive direction of the Y axis is set to 3. After entering the armor ID setting mode, hit the armor module in the positive direction of the X axis, the negative



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direction of the Y axis, the negative direction of the X axis, and then the positive direction of the Y axis to complete all the armor module ID settings for the robot.

## 2.3.2 Installation Specifications

The referee system is provided by the RoboMaster Organizing Committee. It records the relevant information when a robot is attacked during a match, such as the HP and initial speed, and sends real-time information to the referee system server to automatically determine the outcome of a match to ensure the fairness of the competition.

After purchasing the robot, each team needs to install the referee system itself. Robots that do not meet the referee system installation requirements will fail the pre-match inspection and cannot enter the stage.

The ICRA 2019 RoboMaster AI Challenge Referee System consists of the following modules:

<b>Module</b>	<b>Purpose</b>
<b>Speed Monitor Module</b>	This module detects the initial firing speed of a projectile when it is launched by a robot, and the referee system deducts the robot's HP when the speed exceeds the limit.
<b>Armor Module</b>	Comprised of armor plates and sensors, this module protects the internal structure of robots, detecting projectile impacts and deducting HP accordingly.
<b>RFID Interaction Module</b>	The RFID interaction module communicates with functional points around the competition area to activate their respective functions. Robots can also connect to the competition server through authorization of this module.
<b>Main Control Module</b>	This module monitors all referee system modules and sends the real-time status of the robot to the server.
<b>Power Management Module</b>	This module controls the chassis, gimbal and power supply of the launching mechanism. When the HP hits 0, it automatically cuts off the power supply for propulsion.
<b>Light Indicator Module</b>	The length of the light indicator indicates the level of HP, and the color of the light indicator can be used to distinguish between the red/blue teams and the status of the robot.

Refer to the ICRA 2019 RoboMaster AI Challenge Referee System Specification Manual for the installation interface and detailed dimensions of the referee system.

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# Chapter Three – Competition

## Rundown and Rules

This chapter mainly consists of the core competition rundown and penalty rules of the ICRA 2019 RoboMaster AI Challenge.

For the competition schedule, refer to [1.2 Competition Schedule](#)

Refer to [Chapter Four – Competition Area](#) for the competition area information.

In the warm-up competition (i.e. practice match), each team only has one chance to test their robots, which lasts for 10-20 minutes.

There will be multiple matches for each team on each competition day. The participating teams need to prepare for the matches in the "preparation area". Before the match, teams should be inspected in the "inspection area", then go to the "staging area" and finally enter the "competition area" to compete. Each team is required to leave the "competition area" and return to the "preparation area" after each match. Team members can repair and debug their robot after completing in a match and they have until the next match begins.

### 3.1 General Competition Rundown

The ICRA 2019 RoboMaster AI Challenge consists of the group stage and the knockout stage. Before each match begins, all robots entering the stage need to pass the pre-match inspection performed by the RoboMaster Organizing Committee. This is to ensure that all robots fulfill the technical specifications set by the Committee for the fairness ensured by the referee system. All teams must follow referees and volunteers when entering the competition area before each match. When a match ends, teams must clean up the projectiles left in the launching mechanism of each robot and return them to the designated areas.

Each match may have one or three rounds. Each round consists of a **five-minute setup period and a three-minute round**. There is a **referee system initialization period and an official initialization period (hereinafter referred to as the "official initialization period")** between the setup period and the round. There is no fixed time limit for the initialization period, but it usually takes two minutes.

#### **Five-Minute Setup Period:**

During the five-minute setup period, a maximum of four team members of each team can enter the battlefield to test and debug their robots, and start the program. The captain of each team should inform the side referees of the serial number of the robot which needs to be preloaded with 40

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projectiles. In the final 30 seconds of the five-minute setup period, the pit crew on the battlefield should exit the battlefield and leave the remote controls and mobile testing and debugging equipment in the operator area. After the five-minute setup period, the match enters the official initialization period.

**Two-Minute Official Initialization Period:**

In the two-minute official initialization period, the technicians pre-load the designated robots with projectiles according to the robot number selected by the captains of teams in the setup period. The organizer's technicians will pre-load each designated robot with 40 projectiles in the two-minute official initialization period, and place the robots randomly in the corresponding starting zone. The robots will be placed in the same way.

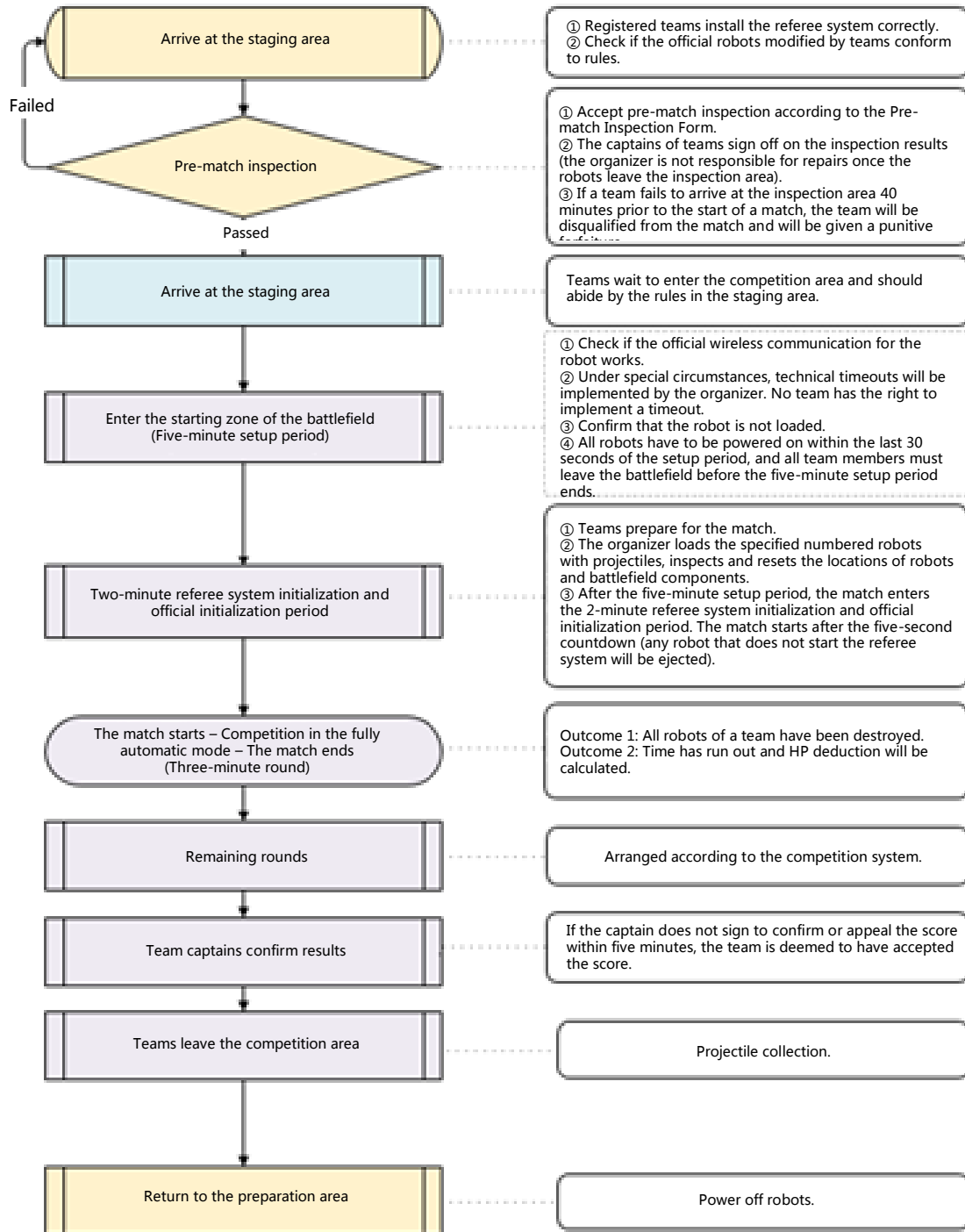
**Three-Minute Round:**

During the three-minute round, the robots from two teams will compete with each other in a fully automatic manner on the battlefield. The robots need to be installed with the referee system provided by the Organizing Committee. The referee system will record a robot's HP value and the relevant information when the robot is attacked in a match, monitor the functioning of the launching mechanism of the robot, and cut off the power supply when the robot's HP hits zero. During each round, the real-time status of all robots will be sent to the corresponding server of the referee system. The referee system server determines the outcomes of all rounds automatically. During each round, referees will issue penalties for rule violations by robots.

# ICRA 2019 RoboMaster AI Challenge

## Entry Procedures

(Single match)



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## 3.2 Criteria Required to Win

### Criteria for Winning an Individual Round:

A match may consist of one or three rounds, which are called BO1 and BO3 respectively according to the general competition system description rule of competitive sports. Depending on the differences between the group stage and knockout stage, a match can end in one of the following outcomes:

Competition System	Group Stage	Knockout Stage
BO1	1:0: The team winning one round gains one point, and the losing team gains 0 points. 0:0 (Tie): Each team obtains 0 points.	N/A
BO3	N/A	The team that wins two rounds is crowned the winner.

### HP Deduction:

1. The drop in HP accrued by the end of each round from one team successfully attacking the armor modules of the opposing robots is called a HP deduction, which is abbreviated as "deduction".
2. "Ejection of robots" means deducting the total HP of the robot and such penalty will be counted into the deduction inflicted by the opponents.
3. HP deductions caused by excessive initial firing speed, barrel overheat and offline referee system modules are not counted into the deduction inflicted by opponents.

### Criteria for Winning an Individual Round:

1. The match ends immediately when all the robots of a team are destroyed, and the team with surviving robot(s) wins.
2. When the entire time of a round is up, if robots of both teams have survived, the team with the higher damage output wins.

If neither team fulfills these criteria, the round is considered a draw.

### Rankings for Group Stage:

The following criteria are used to determine rankings in a descending order of priority:

1. The team with the higher number of total match points ranks higher.
2. If the total match points of several teams are the same, the team with the higher damage output among the teams that are tied during the group stage ranks higher.

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If two or more teams still share the same ranking, the RoboMaster Organizing Committee will arrange playoff matches on a round-robin basis.

## 3.3 Competition Area Staff

### 3.3.1 Team Member Standards for the Competition Area

1. The team members who are allowed to enter the staging area and the competition area are all called pit crew members. During each match, up to 8 pit crew members per team can enter the staging area, and a maximum of 4 pit crew members can enter the competition area to prepare for the match. (The pit crew members mentioned here include the team's supervisor and technical advisor.)

**Penalty:**

The referee will give a verbal warning to the team that violates the rule. If a team does not obey the rule after a referee has given several verbal warnings, the team will be given a punitive forfeiture.

2. In the two-minute official initialization period and the three-minute round, each team can send a maximum of two team members to watch the remote controls, computers and other electronic devices in the operator area, and observe the state of the robots. The team members are not allowed to operate the robots on the battlefield in any form unless under special circumstances or with the consent of the referee. Other pit crew members must stay in the pit area outside the battlefield.

**Penalty:**

After two team members have been sent to the operator area by each team, any other team member who enters the operator area without the referee's permission will be given a verbal warning by the referee. If the team member does not comply with the warning, he/she will be ejected from the operator area, and the team is forbidden from having a substitute member enter the operator area for all of the remaining rounds of the current match. If pit crew members do not obey a referee's order to leave the area, their team will be given a punitive forfeiture.

### 3.3.2 Event Staff

Competing teams will be guided by volunteers and staff members from the RoboMaster Organizing Committee throughout the competition. Apart from volunteers and general staff members, the teams will come into contact with the following event staff from the Organizing Committee. During the competition, only the chief referee has the final right of interpretation regarding competition rules. Any doubt about the competition rules shall be subject to the interpretation by the chief referee.

Role of Event Staff	Duty
Head Inspector	Oversees all pre-match inspections and has the final decision on whether a team passes the pre-match inspection.
Inspector	Assists with pre-match inspections but does not get involved in or assist any team with the maintenance of robots in any way.
Chief Referee	The chief referee is the only event staff member who has the right of final interpretation regarding competition rules. The chief referee has the right to issue penalties for severe violations of the rules (disqualification from the competition), process post-match appeals and issue additional penalties following an appeal.
Head Referee	The head referee is the chief authority who is responsible for enforcing the competition rules, controlling competition procedures, issuing official technical timeouts, receiving and confirming team technical timeouts, and confirming the validity of match results.  The head referee is the final person who confirms and executes penalties.
Side Referee	Executes competition procedures and leads team members in and out of the battlefield. Reports robots' violations to the head referee during matches. Receives the application for a team technical timeout and reports to the head referee for confirmation. Maintains components on the battlefield, assists team members in solving technical problems with the referee system during the five-minute setup period, requests official technical timeouts, but cannot assist team members in repairing the robots damaged in matches.

## 3.4 Pre-Match Procedures

### 3.4.1 Rules in the Preparation Area

1. It is forbidden to start the launching mechanism to test projectile firing. If such a test has to be conducted, it has to be reported to the relevant staff in advance and projectiles can only be launched into projectile bags. During the commissioning of robots, the teams need to ensure that their robots will not cause any harm to any person or equipment.

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2. The tags for the UWB locating system should not be connected to a power source in the preparation area.

**Penalty:**

A verbal warning will be given to the team when the rule violation occurs for the first time. The team will be disqualified from the competition when the team violates the rules again.

## 3.4.2 Inspection Regulations

To ensure that robots meet the required specifications, each team must undergo a pre-match inspection in the inspection area before each match. Refer to the [Appendix Four – Pre-match Inspection Form](#).

1. Each team must report to the inspection area to start the pre-match inspection at least 40 minutes before the match begins.

**Penalty:**

Except for special circumstances, the team will be given punitive forfeiture for the specific match if it fails to arrive at the inspection area on time. The actual situation is determined by the head inspector and the chief referee.

2. A maximum of five team members for each team can enter the inspection area. A robot can be brought to the inspection area by a maximum of two team members. One team member is responsible for assisting the staff with the pre-match inspection. Team members are prohibited from entering the inspection area without permission before their robots arrive.

**Penalty:**

Extra team members or team members who are not participating in the pre-match inspection must leave the inspection area.

3. During the pre-match inspection, inspectors will place a "Pass Card" on each robot that passes the inspection. Only robots with a "Pass Card" can enter the staging area and the competition area. If a robot fails to pass the pre-match inspection, the team must debug the robot in a designated area or the preparation area until it meets the requirements of the pre-inspection before it enters the stage.

**Penalty:**

Robots without a "Pass Card" cannot enter the staging area or the competition area.



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4. Each team has to have at least one robot that passes the pre-match inspection to be qualified for the match. When the inspection is complete, the team captain must sign the inspection form to confirm that they agree with the inspection results.

**Penalty:**

1. If all the robots from a team fail the pre-match inspection, it will be deemed that the team forfeits its qualification for the present match and it is ruled as punitive forfeiture.
2. After the captain signs for confirmation, the team can no longer raise any objections to the inspection results. Teams will be deemed as cheating if any robots that fail the pre-match inspection are found inside the competition area. Any rounds of the match that these robots competed in are ruled as punitive forfeiture. The final decision will be made by the head referee and chief referee based on the actual circumstances.

### 3.4.3 Staging Area Regulations

Robots under debugging in the staging area should also comply with the preparation area rules. No mechanical or hardware changes in any form related to the inspection process should be made to robots that have already passed inspections. If any mechanical or hardware changes related to the inspection process need to be made after the robot enters the staging area, the team should inform the staff at the staging area first. The stage area staff will then rip off the Pass Card to allow the team to re-debug the robot, which should then go through the inspection again. The team shall take full responsibility if the robot fails to enter the stage on time due to the re-debugging.

**Penalty:**

Teams will be deemed as cheating if any robots that fail the pre-match inspection are found inside the competition area. Any rounds of the match that these robots competed in are ruled as punitive forfeiture. The final decision will be made by the head referee and chief referee based on the actual circumstances.

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## 3.5 Match Procedures

### 3.5.1 Five-Minute Setup Period

Before the five-minute setup period of each round, the two teams are required to wait at the designated areas. After the referee confirms both of the teams are ready for competition, he or she will then report to the head referee. The head referee issues an instruction for the teams to enter the competition area. The side referee then opens the door and leads the teams onto the stage. The five-minute setup period countdown starts the minute the side referee opens the door.

The five-minute setup period is the only time when the robots can be debugged inside the competition area or the operator area by electronic devices such as remote controls and computers, which will be no longer allowed during the two-minute official initialization period and the three-minute round. During the five-minute setup period, the captain needs to inform the side referee of the serial number of the robot that needs to be loaded with 40 projectiles. [If the captain fails to inform the side referee, then the robot that will be loaded is robot #1.](#) After finishing the setup, the team members must place the robot remote controls and the computer for debugging in the designated operator area outside the competition area. During the two-minute official initialization period and the three-minute round, each team can have up to two team members in the operator area to check on the operation conditions of the robot, but they are not allowed to control the operation.

1. The pit crew on both sides place their robots within their own starting zones to detect whether the referee system equipment connected to the robot is operating normally. Both teams can only test robots in their own starting zone or within one meter around their starting zone. Testing robots is not allowed in other areas within the competition area.

#### **Penalty:**

[Team members who test robots in other areas of the competition area will receive a verbal warning to move their robots back to the designated testing area. If a team member repeatedly fails to heed the warning, the robot that fails to comply with the rules will be banned from this round of the match.](#)

2. The projectiles of the robot launching mechanism can only be launched into the projectile bag.

#### **Penalty:**

[\(1\) If a projectile is launched into the competition area during the five-minute setup period, it will be considered a foul and the team will receive a verbal warning. If a team member repeatedly fails to heed the warning, the robot that fails to comply with the rules will be banned from this round of the match.](#)

[\(2\) If there is any physical harm caused to the staff on site due to premature launching of projectiles](#)

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or a premature start, the team found to be responsible will be penalized with punitive forfeiture for this round of the match and held accountable for the consequences.

3. The projectiles of all the robots must be emptied until the robot can no longer fire projectiles.

**Penalty:**

Robots that have not emptied projectiles will not be allowed to enter the stage to compete.

4. The pit crew must not pick up the projectiles scattered on the floor of the competition area and directly supply them to their own robots.

**Penalty:**

(1) If a pit crew member picks up projectiles from the floor, he or she will receive a verbal warning from the referee; if he or she fails to heed the warning, the team will be ruled with punitive forfeiture by default.

(2) If a pit crew member picks up projectiles to load their own robots, the robot will be banned from the competition.

(3) If a pit crew member loads their robot with projectiles that are not provided by the RoboMaster Organizing Committee, the team will be disqualified for cheating by the referee.

5. When debugging the robot in the starting zone, the pit crew must ensure that their own robots operate safely and will not cause any harm to any personnel in the competition area.

**Penalty:**

If a team's robot launches projectiles during the five-minute setup period due to loss of control or misoperation and causes harm to the personnel on site, the team will be ruled with punitive forfeiture for that round.

6. All the robots must be powered on within the last 30 seconds of the five-minute setup period. Meanwhile, referees will also instruct the pit crew to leave the area.

**Penalty:**

In the last 30 seconds, pit crew members who do not leave the area will be given a verbal warning.

7. At the end of the five-minute setup period, pit crew of both teams must return to the designated area outside the competition area.

**Penalty:**

After the five-minute setup period, pit crew members who do not leave the area will be ejected directly from the operator area, and the team is forbidden from having other substitute members in

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the operator area for all the rounds of this match. If the pit crew member who has been ejected refuses to follow the penalty and continues to stay in the operator area, the team will be ruled with punitive forfeiture by default. The final situation is up to the judgment of the chief referee.

### 3.5.1.1 Technical Timeout

#### Official Technical Timeout:

During the five-minute setup period, if there are malfunctions with the referee system and modules related to the referee system such as the UWB Locating System, the head referee can initiate an official technical timeout and put the five minute countdown on hold. The following are the specific cases of malfunction:

Rules	Description
1	The official devices are malfunctioning.
2	During the five-minute setup period, there is a malfunction with the referee system modules at the robot end. For example, the robot cannot be connected to the server of the referee system.
3	The key battlefield components in the competition area have structural damages or malfunctions (for example, the official projectile supplier cannot provide projectiles).
4	Other situations where the head referee deems it necessary to call an official technical timeout.

An official technical timeout has to be reported by the technicians to the head referee, who will then initiate an official technical timeout after confirmation. Pit crew cannot request such a timeout.

#### Team Technical Timeout:

If there is any malfunction in the mechanical structure or software systems of all the robots from one team, the team can apply to the head referee for a team technical timeout during the five-minute setup period. The pit crew can enter the competition area to inspect and repair the robots during this timeout. The pit crew can only inspect and debug their robot in their own starting zone.

Each team will be allowed to initiate two team technical timeouts, which will last three minutes each. If a team has already used the two available team technical timeouts, it can no longer apply for team technical timeouts.

There might be new mechanisms that indicate other ways to obtain extra team technical timeouts in later stages.

#### Notes:

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1. A team technical timeout has to be applied for by the captain, who should explain how much time the team needs and the reasons for this timeout to the referee. After the referee negotiates and confirms with the head referee, the head referee will initiate a technical timeout. At this point, the five-minute countdown will be put on hold.
  2. Regardless of which team initiates the team technical timeout, the head referee will inform both of the two teams. Both teams can use this timeout to enter the competition area to inspect and repair their robots. The timeout countdown will start the minute the teams enter the competition area. Only the team that requests the timeout will consume one of its two opportunities to call technical timeouts. 20 seconds before the technical timeout is over, the referee will remind the pit crew that the timeout is almost over.
  3. If a team applies for a three-minute team technical timeout, but leaves the area after repairing the robot for only a few dozen seconds, this will technically still be counted as a complete three-minute team technical timeout. At this time, the head referee will continue with the timeout countdown, or end the timeout before the designated time is up after confirming that both teams are ready. If a team technical timeout is applied for and then confirmed by the head referee, it will be deemed that the team has consumed one timeout opportunity even if its pit crew do not enter the competition area in the end.
  4. The team technical timeout has to be submitted before the last 15 seconds of the five-minute setup period, that is, a team cannot apply for a team technical timeout during the last 15 seconds of the five-minute setup period and throughout the entire round.
  5. In order to ensure that everything runs according to schedule, the RoboMaster Organizing Committee will only accept one team technical timeout during one five-minute setup period. The match results confirmation form will record whether technical timeouts are used in the competition. The type of the technical timeout(s) will be determined by the head referee based on the application of the team. The captain cannot object to the type of the technical timeout(s) when signing the form, and the technical timeout procedures cannot be used as a basis for appeals after the match.

### **3.5.2 Two-Minute Official Initialization Period**

After the five-minute setup period is up, the two-minute referee system initialization period and the official setup period (hereafter referred to as the official initialization period) will begin.

In this process, the server will automatically inspect the conditions of the robot referee system modules, the battlefield components, etc. If the conditions do not meet the requirements for it to

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start a competition (for example, the robot is offline or the battlefield components are offline), the countdown for the official initialization period will be put on hold. Only the RoboMaster Organizing Committee staff and a pit crew member of the team can enter the competition area to check for the cause of the failure. No team member can apply for a team technical timeout during the referee system initialization period. After the faulty devices are repaired, the referee will resume the initialization and the countdown of the official initialization period continues. The server will restore the HP of all robots, ensuring that all robots reach full HP level before the competition officially begins.

The official technicians will load 40 projectiles into the magazine of the designated robot in the two-minute official initialization period and place the robots randomly in their respective starting zones. The robots should be placed in the same way on both sides.

After the initialization, there will be a 5-second countdown. The staff will give clear directions for the countdown. The five-second countdown will be immediately followed by a three-minute round.

### 3.5.3 Three-Minute Round

After the competition officially starts, a maximum of two pit crew members of each team will be allowed to observe the operation of the robots in the operator area. The rest of the team can watch the competition in the designated pit area beside the competition area.

During the competition, the robots will be monitored by the referee system in real time. The head referee in the referee area and the referees beside competition area will give penalties for fouls and deal with unusual situations. Major penalties and appeals in the competition will be made on public display.

#### 3.5.3.1 Attack and Compete

##### **Collision Penalty:**

The robot must have the ability to perceive other robots to avoid colliding with the opposing robot with any structures, regardless of whether the opposing robot is destroyed. *If one robot voluntarily makes fast and repeated frontal collisions with the opposing robots, or if one robot quickly collides with the opposing robots, which forces the opposing robots a long distance away and disrupts the normal operation of the opposing robots, the referee will deem this behavior as a serious malicious collision and eject the robot.*

Projectiles that meet the requirements on speed of launch can hit any part of any ground robot. Situations such as bended mechanical structures, damages to sensor modules or broken circuits

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caused by projectile attack will be deemed as "normal damages" and cannot be used as a basis for collision penalties or other kinds of penalties. However, if the referee system modules of the robot are damaged due to projectile attack during the competition, a technician on site will provide backup referee system modules.

**Penalty at the Supplier Penalty Zone:**

Robots of one team must not enter the supplier zone of the opposing team. Robots must have the ability to determine their current position and block the supplier zone of the opposing team from their motion planning. *If a robot enters and exits the opposing team's supplier zone multiple times, or stays in the other team's supplier zone for more than 5 seconds, or shows a clear intention to interfere with the projectile supply of the opposing team, the robot will be directly ejected. If a robot causes structural damages to the opposing team's official projectile supplier, which as a result can no longer provide projectiles as usual; or if a robot that has been ejected remains in the opposing team's supplier zone and the upper space, which causes the opposing team's robots unable to accept projectiles from the official projectile supplier, the offending team will be immediately ruled with punitive forfeiture.*

**Penalty for Getting Stuck Together:**

Stuck together: An intractable connection made by any part of one robot with the opposing robot during the competition.

*If one of the robots causes any of its parts to get stuck together to any part of an opposing robot for a long time due to its active interference, blocking or collision, thus disrupting the normal operation of the opposing robot, the offending team will immediately be ruled with punitive forfeiture. If the stuck together is not intentional, a rematch will be arranged depending on the situation. The final decision is up to the head referee and the chief referee based on the circumstances.*

### **3.5.3.2 Collision due to Loss of Control**

A robot needs to be equipped with abilities of locating and planning for obstacle avoidance, as well as monitoring the stability of its hardware and software. In the process of automatic motion planning, the robot needs to avoid hitting battlefield components such as obstacles and its own official projectile supplier as much as possible. *If one robot voluntarily makes fast and repeated frontal collisions with obstacles or its own official projectile supplier, collides with obstacles which forces*

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them a long distance away or keeps moving the obstacles, the referee will deem this behavior as collision due to loss of control and eject the robot.

### 3.5.3.3 Abnormal Conditions

1. When there is a serious safety hazard or abnormal condition with a robot in the competition area (such as battery deflagration, stadium power failure, etc.), the head referee will inform both teams and kill all the robots through the referee system after he/she discovers and confirms such situations. The results of such competition will be pronounced as invalidated. The competition will restart after the hazards or abnormalities are eliminated.
2. If a robot breaks down after it passes the pre-match inspection, this will be deemed as ordinary damages and the competition will proceed as usual. Robots with serious safety hazards due to damages imposed during the competition will be banned from entering the battlefield.
3. If the components in the competition area are damaged during the competition (such as damaged flooring adhesives), the competition will proceed as usual. If the key battlefield components are structurally damaged or functionally abnormal (for example, the RFID in the defense bonus zone has shifted or is unable to be activated, or an obstacle block is so poorly adhesive to the floor that a slight push easily shifts it), the head referee will inform both teams and kill all the robots through the referee system after he/she discovers and confirms the situation. At this point, the results of this round will be void. The technicians on site will enter the field for maintenance. There will be a rematch after the components are restored to their normal conditions.
4. If there is a problem with the official projectile supplier, the head referee will assess whether it affects the fairness for both teams. If it is determined that the fairness is affected, the operator room referee will notify both teams and kill all the robots through the referee system. This round will end immediately. The result of this round will be deemed void and there will be a rematch.
5. If the key battlefield components have logical faults that are not caused by the registered team members during the competition (for example, the buff effect fails to be triggered), the referee will manually deal with these faults through the referee system. There will be a certain delay due to the manual operation. The RoboMaster Organizing Committee will not be responsible for the resulting impact. If the fault cannot be handled manually through the referee system, the referee will notify both teams after confirming that the fault cannot be eliminated, and kill all the robots through the referee system. This round of competition will end immediately. The result of this round will be deemed void and there will be a rematch.



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6. If during the competition, the fairness of the competition is affected due to abnormalities or structural damages to the key battlefield components, and the head referee fails to confirm this situation and end the competition in time, which as a result, the competition that should have ended proceeds as usual and ends with a competition result, the result of this round will be deemed void after it is verified by the chief referee. A rematch will be required.

7. If there are severe fouls, the original result will be deemed void after this situation is confirmed by the chief referee or the appeal results. The offending team will be ruled with punitive forfeiture or disqualified.

### 3.5.4 Cheating and Severe Fouls

In order to ensure the fairness of the competition and put the competition rules into effect, severe fouls and cheating of a flagrant nature by either an individual or a team will result in the "disqualification" penalty: the team will be disqualified from the competition and from any award. The team's match results will still be kept on record as a reference for other teams to move to the next stage.

The following actions are considered cheating:

Rules	Types of cheating
1	The team modifies or sabotages the referee system, and uses technical means to block functions of the referee system such as power detection and damage detection.
2	The performance of the robot during the competition is inconsistent with its performance during inspection, such as inconsistencies in size and the installation process of the referee system.
3	The robot in the match does not belong to the team.
4	The team conducts manual operation on the robot.
5	The team uses projectiles not provided by the Organizing Committee.
6	Other behaviors that violate the spirit of the competition or are deemed by the chief referee as cheating.

The following actions are considered as severe fouls during the competition:

Rules	Types of Fouls
1	Violating any one of the "Penalty" rules stipulated in this chapter, and refusing to accept the penalty (for example, a pit crew member remains in the competition area even after he or she has already been ejected, interferes with referee's work, etc.).
2	Being deliberately reluctant or simply refusing to leave the competition area after the competition is over, affecting the schedule of the competition.
3	Loading explosives or installing prohibited items onto the robot.
4	Using robots to deliberately attack or collide with others, endangering the safety of themselves and others.
5	Maliciously sabotaging the opposing team's robot, the battlefield components and related equipment.
6	Having physical confrontations with referees, opponents or the audience.
7	Being reluctant or refusing to cooperate with the inspection during the time when the Organizing Committee processes appeals.
8	Other behaviors that seriously impede the course of the competition and violate the spirit of fair competition will be penalized by the head referee in accordance with the specific foul.
9	During the competition, if any team member violates the local laws and regulations in the competition area, the pit area, the stadium, etc., the RoboMaster Organizing Committee will not only disqualify this member but will also cooperate with relevant departments to hold this member liable for his or her behavior.

## 3.6 Post-Match Procedures

The end of each round will be immediately followed by the five-minute setup period of the next round. At this point, both teams need to immediately empty the projectiles in the robots and move them back to the starting zone to prepare for the next round.

If this round is the last round of the match, both teams need to immediately power off their robots, move them away from the competition area, empty the projectiles in the designated projectile unloading area, and return to the preparation area.

### 3.6.1 Results Confirmation

Throughout a match, the head referee will record the penalties of each round and the scores for both

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teams at the end of the competition on the match results confirmation form, and record the technical timeouts on the technical timeout form. After all the rounds in each match are finished, the captains need to go to the referee area to confirm the results and the remaining technical timeouts. Between two rounds in the same match, the referee will not accept a team's appeal against the results of the competition.

The captains from both sides must sign for results confirmation at the referee area within **three minutes after the end of a match**. If a captain fails to sign for results confirmation at the referee area within three minutes and does not file an appeal, it will be considered that the team acknowledges the results by default.

Once the captain signs for results confirmation, he or she can no longer file an appeal.

### 3.6.2 Appeals

Each team only has one opportunity to file an appeal. If the appeal is successful, the team will still have the one opportunity to file an appeal; otherwise the team can no longer appeal. When a team has exhausted its opportunity to appeal, the Organizing Committee will no longer accept any appeal from the team. The chief referee and the head of the RoboMaster Organizing Committee will form an arbitration committee to process the appeals. **The arbitration committee has the right of final interpretation on the arbitration results.**

If a round of competition has to be replayed due to the arbitration result of an appeal, namely, "rematch by both teams", then both teams can appeal again after the rematch. In this case, if the original appellant files an appeal again (referred to as "continuous appeal"), the original appellant's opportunity for one appeal will be consumed regardless of whether the appeal is successful or not. Since a continuous appeal will seriously affect the subsequent schedule, if a team needs to make a continuous appeal, the captain and the supervisor of the team have to file the appeal at the same time within three minutes after end of the competition (and sign the appeal form at the same time), and the process of the continuous appeal will also be compressed. The validity period for submitting the evidence/defense materials by both teams will be shortened to 30 minutes after an appeal is filed. The Organizing Committee will give the final arbitration on the appeal form within one hour after the continuous appeal is filed.

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### 3.6.2.1 Appeal Process

1. Within three minutes after the end of each match, the captain who wishes to file an appeal should submit a request for appeal to the referee area, fill out the appeal form and sign for confirmation. Only appeals made within three minutes after the end of the competition are considered valid. No appeals are allowed before and during the competition.
2. The chief referee will determine whether an appeal is justified for the situation.
3. After the chief referee accepts the appeal, the staff will inform the captains from both teams to meet in the arbitration room. Upon the request of the appellant, the arbitration committee will immediately transfer all robots of both teams to the arbitration room for separate inspection. A maximum of three members from one team will be allowed in the arbitration room and they can only be either the captain, the OPM, principal team members or the supervisor. The attendance of either the captain or the OPM is mandatory.
4. Members from both teams can collect evidence/defense materials and submit the materials to the arbitration committee.
5. After submitting the evidence/defense materials, the arbitration committee will further communicate with the team members from both sides who are involved in the appeal.
6. The arbitration committee will provide a final arbitration decision and both captains will sign the appeal form for confirmation. Once signed, both teams cannot question the appeal results any further.

### 3.6.2.2 Period of Validity

1. The validity period for appeal submittal: within three minutes after each match. Please refer to the time recorded on the appeal form. If the appeal is filed beyond the "validity period for appeal submittal", the arbitration committee will not accept the appeal.
2. The validity period for arrival at the arbitration room: within half an hour after the arbitration committee issues the notice. If one of the teams fails to show up within the "validity period for arrival at the arbitration room", the absent team shall be deemed as waiving the arbitration. If a team has more than three representatives present at the arbitration or has attendees not of the above-mentioned titles, it shall be deemed as waiving the arbitration.
3. The validity period for evidence/defense materials submittal: within 60 minutes after the appeal is

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filed. If the evidence and defense materials are submitted after the validity period, the arbitration committee will not accept new materials.

### 3.6.2.3 Appeal Material

1. Material type: Only materials stored on a USB flash drive and the robot itself will be accepted as appeal materials. Materials submitted in other forms will not be accepted by the arbitration committee.
2. Requirements on USB flash drives: The edited video (The video materials should be prepared by the team itself. The Organizing Committee will not provide any videos in order to stay impartial) and the text files for the appeal should be placed according to the catalog.
3. Format: Each video should be no longer than one minute and no bigger than 500MB in size. The video file name must indicate the match and the time and be able to be played on the latest version of Windows Media Player. Photos must be in jpg format. Text files must be in Word format and each text should not exceed 1,000 words.
4. Material naming: The file name of each video and photo must be within 30 Chinese characters.
5. Requirements on text: One text file can only correspond to one video or a photo and indicates the corresponding video or photo in the text. Text files only need to explain the fouls reflected in the corresponding materials.
6. Robot evidence: After the appeal is filed, the arbitration committee has the right to inspect the relevant robots of both teams separately. The inspection can last no longer than three hours, and the robot will be returned upon the announcement of the result at the latest.

### 3.6.2.4 Appealing Decisions

The arbitration committee will release their final decision on the appeal form within three hours after the appeal is submitted. The decision has three outcomes: Original Result Uphold, Original Result Reversed, or Rematch by Both Teams.

Neither team may appeal against the final decision of the arbitration committee. If a rematch by both teams is required by the arbitration result, the Organizing Committee will inform both teams of the time of this rematch when announcing the arbitration results. If neither party accepts the rematch, it will be deemed that the appeal is invalid. Both teams can retain their appeal opportunity and

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maintain the original competition results. If only one team accepts the rematch, then the team that refuses the rematch will be deemed to waive the competition and it will be ruled as punitive forfeiture.

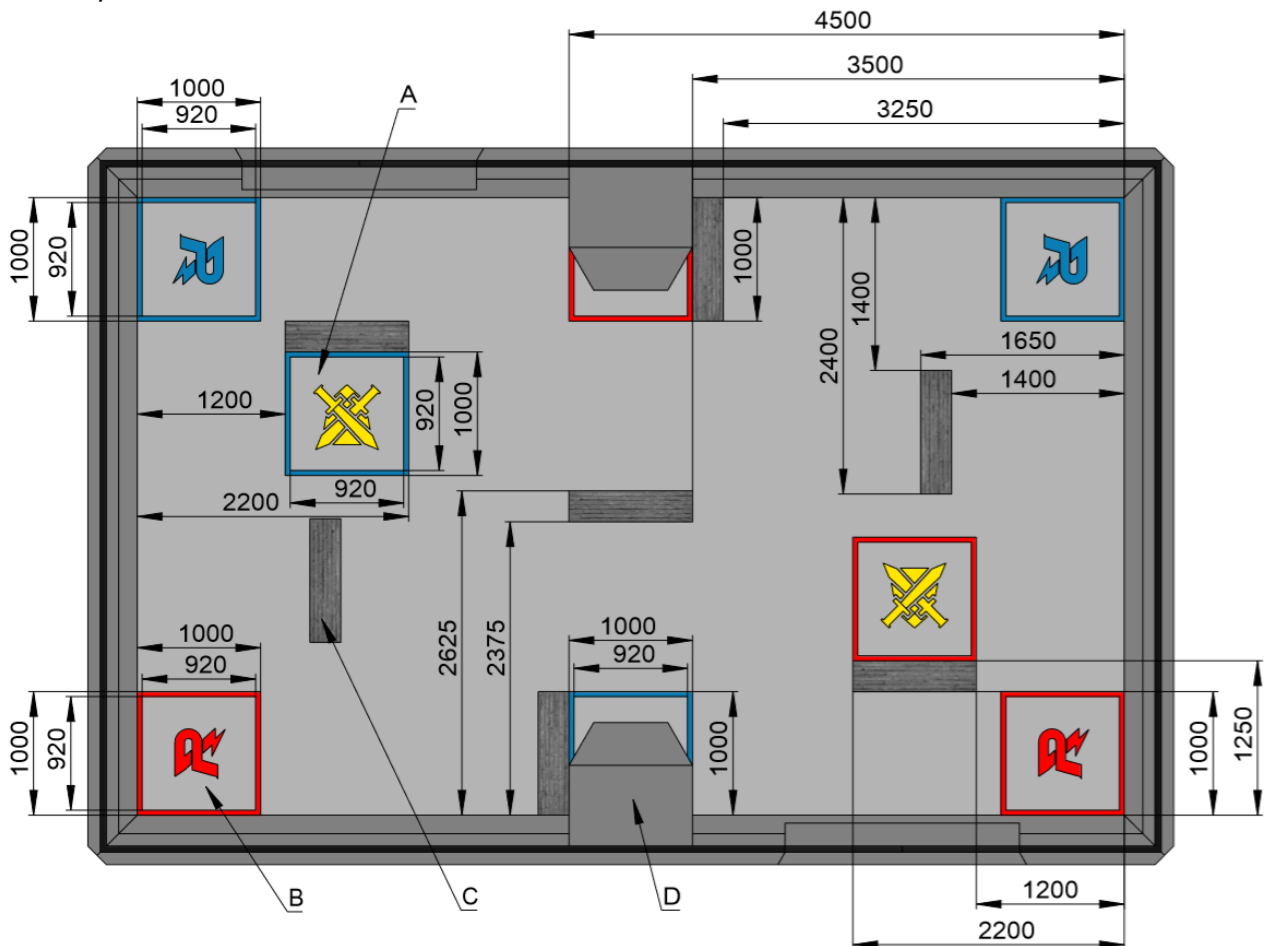
# Chapter Four – Competition Area

## 4.1 Competition Area Overview

The central competition area of the ICRA 2019 RoboMaster AI Challenge is called the "competition area", which is an area 8 meters long and 5 meters wide. It consists of the starting zone, the supplier zone, the defense bonus zone, the obstacle zone and the perimeter wall area.

**Note:** The error margin of all battlefield components described here is within  $\pm 5\%$ . Dimensions are in millimeters.

The competition area is shown below:



A: Defense bonus zone    B: Starting zone    C: Obstacle zone    D: Supplier zone

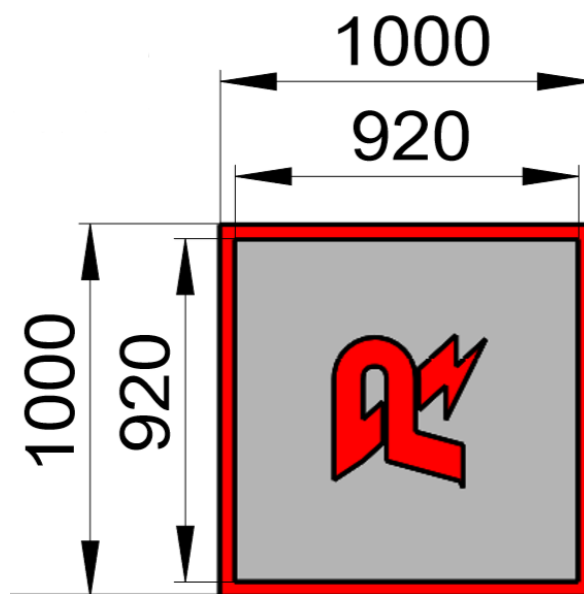
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## 4.2 Starting Zone

### Area description:

The starting zone is where the robots are placed before the competition officially begins. The four starting zones are arranged in the four corners of the competition area. The blue team and the red team will have two starting zones of exactly the same size respectively, in each of which only one robot will be allowed. When the team only has one robot, it can be placed on either of its two starting zones. The starting zone will be marked by a red or blue sticker on the flooring adhesive.

A starting zone is shown as below:

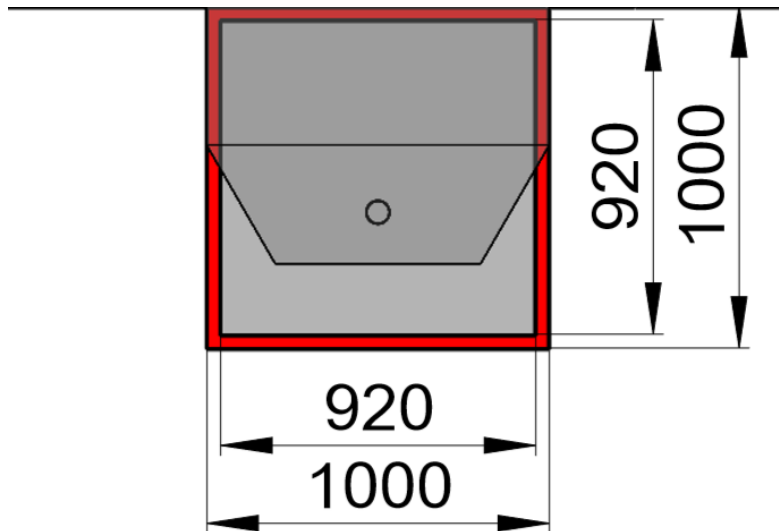


## 4.3 Supplier Zone

### Area description:

Supplier Zone is an important area for the supply of projectiles. Both the red and blue teams have one supplier zone respectively, and the official projectile supplier of one team is a supplier penalty zone for the opposing team's robot. The drawing and dimensions of supplier zone are as below:





**Note:** The exit of the projectile supply mechanism provided by the organizer is rather large. In order to prevent the projectiles from falling during the process of loading the projectiles onto the robots, it is recommended that the team increase the size of the loading port of the robot to avoid unnecessary loss. Please refer to the ["ICRA 2019 RoboMaster AI Challenge Robot Specification Manual"](#) for the modification specifications on projectile loading ports.

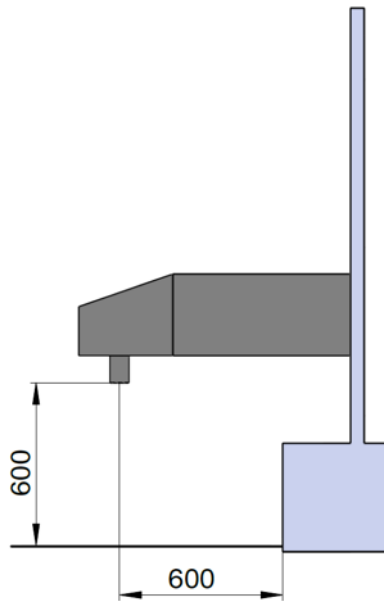
### 4.3.1 Supplier Penalty Zone

**Area description:**

The supplier zone of one team is the supplier penalty zone for the opposing team, that is, the inner and upper space of the octagonal yellow zone with a maximum outer contour size of 1000\*1000 mm. Robots from each team are prohibited from entering the supplier zone of the opposing team. Please refer to for specific penalty details. [3.5.3.1 Attack and Compete](#)

### 4.3.2 Official Projectile Supplier

The official projectile supplier provides 17 mm projectiles during a match, and each team has its own official projectile supplier. Each minute after the start of each round, the official projectile supplier is allowed to receive two projectile supply instructions from one of its own robots. 50 rounds of 17 mm projectiles are issued at each time.



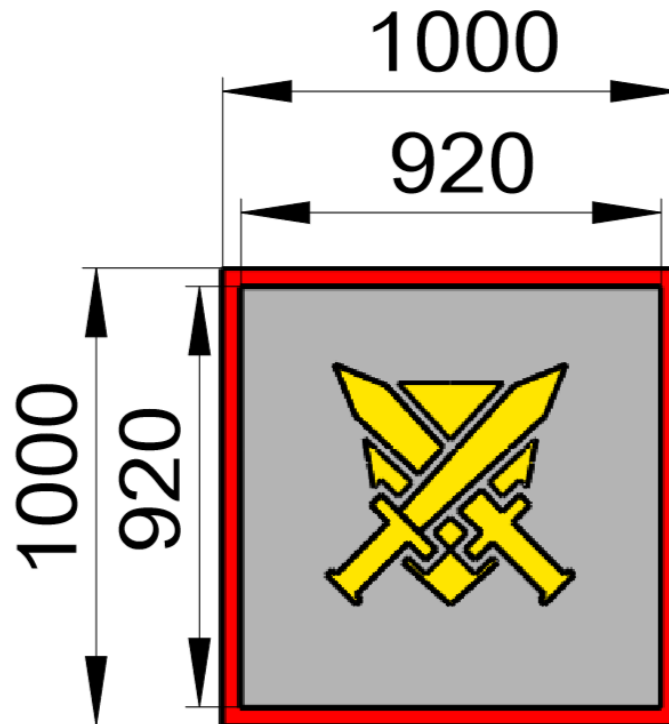
## 4.4 Defense Bonus Zone

Each team in the competition area has one dedicated defense bonus zone. Every robot in the area can activate and trigger the defense bonus zone. For the red team's defense bonus zone, no matter which team it is triggered by, the defense bonus only goes to red team's robots. The same rule applies to blue team's defense bonus zone.

When a robot stays in a defense bonus zone for more than five seconds, the zone would be triggered: the defense points for all robots from one designated team will be increased, which means the damage caused by 17 mm projectiles will be reduced from 50 HP to 25 HP each time. The duration is 30 seconds.

During the competition, the defense bonus zone will be refreshed and reset at the zero, one, and two minute marks. After the same defense bonus zone is triggered twice, it will be in a failed state and cannot be triggered again until it reached the reset marks. If the same defense bonus zone is triggered again and the defense bonus effect from the last time is still in effect, the team of that defense bonus zone continues to hold the defense bonus effect (the effect cannot be multiplied), and the duration is reset to 30 seconds.

The layout of a single defense bonus zone is as follows:

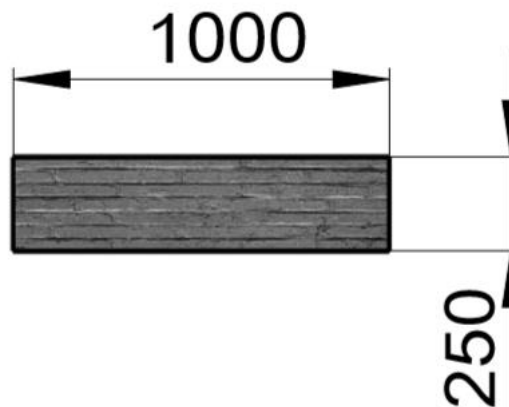


## 4.5 Obstacle Zone

Within the specific zones in the competition area, there are seven immovable wooden obstacles that are of the same size. Robots from both the red and the blue team should avoid colliding with the obstacles during the competition. Out of control collisions with the obstacles will be penalized. Refer to [3.5.3.2 Collision Due to Loss of Control](#) for specific penalty details.

Specifications of one single obstacle is: length x width x height = 1000 × 250 × 400.

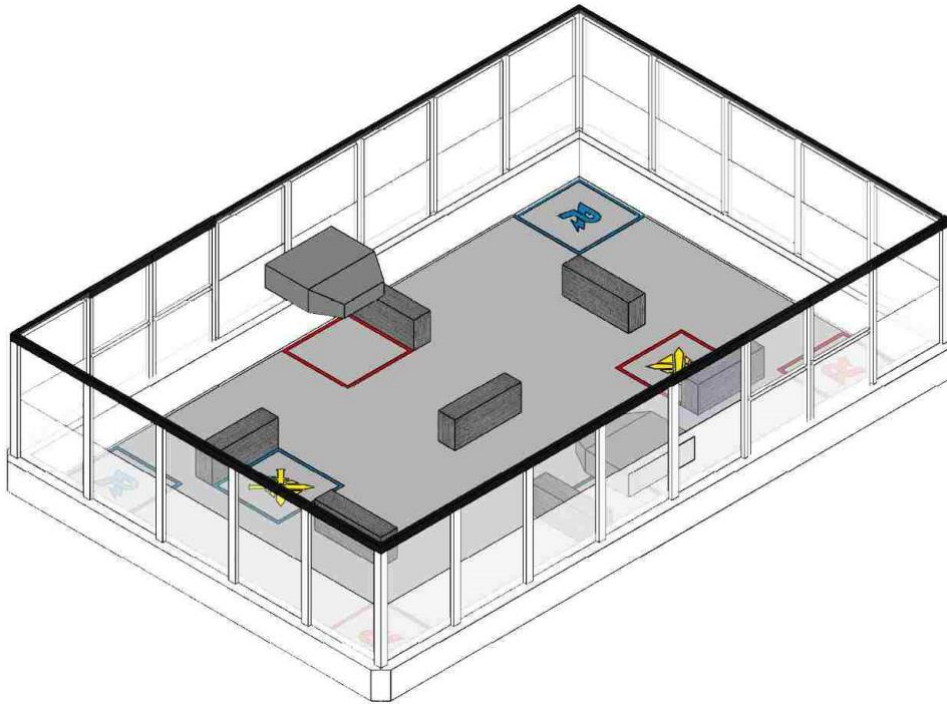
The plan view is shown below:



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## 4.6 Protective Perimeter Wall Zone

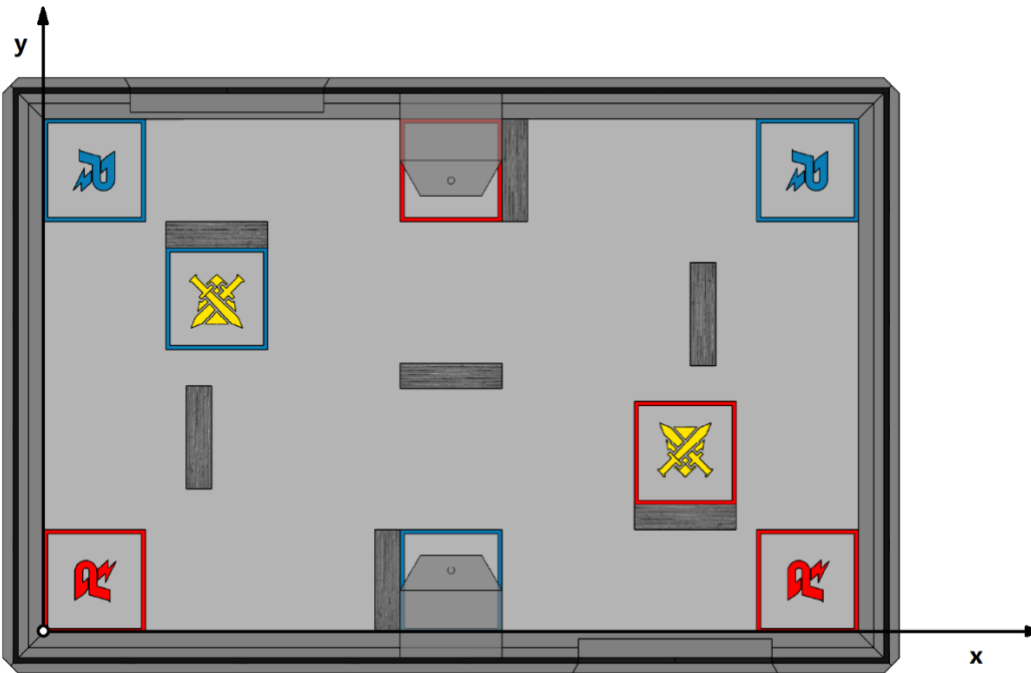
In order to prevent accidental injuries to the audience due to circumstances such as 17 mm projectile firing and robots losing control, a protective perimeter wall is set up around the competition area. Robots from both the red and blue teams should avoid colliding with the wall. Collision with the wall due to loss of control will be penalized. Please refer to [3.5.3.2 Collision Due to Loss of Control](#) for specific penalty details.



## 4.7 Anchor for UWB Locating System

UWB anchors are built above the protective perimeter wall. These UWB anchors are available for purchase on the market. Team members can use supporting UWB tags available on the market to assist robots in locating.

Map coordinate located by UWB is shown below:



## 4.8 Operator Area

The operator areas for both teams are located in the fixed areas on the same side outside the competition area. The red and blue team are allowed to send up to two people each to carry the remote control and mobile debugging equipment in the [3.5.1 Five-Minute Setup Period](#) to setup and debug their programs.

## 4.9 Projectiles

Launching projectiles is the only acceptable method for attacking other robots. Robots must use projectiles to hit the armor sensors of opposing robots, thereby causing damage to any opposing robots' HP in order to destroy them. 17 mm projectiles are used during a match.

The specifications are as follows:

Type	Appearance	Color	Size	Weight	Shore Hardness	Material
<b>17 mm standard projectiles</b>	Round	White	16.9 mm (±0.1 mm)	2.9 g (±0.1g)	90 A	Plastic (TPU)

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**Notes:**

In ICRA 2019 RoboMaster AI Challenge, the projectiles used have to be those provided by the RoboMaster Organizing Committee.

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# Chapter Five – Updates to the Rules and FAQs

## 5.1 Q&A Platform

If you have any questions about the AI Challenge, please send them via the official channels below and staff will get back to you within 1-3 business days.

1. Official email: [robomaster@dji.com](mailto:robomaster@dji.com)
2. Official BBS: <https://www.reddit.com/r/ROBOMASTER/>

## 5.2 Code of Communication

1. The email subject should be: school/company/institution name + AI Challenge + question
2. Post on the "AI Challenge" subsection of the RoboMaster's official BBS (<https://www.reddit.com/r/ROBOMASTER/>) for discussion.

The suggested format for rule/technology-related questions is "school + team + rule manual page number + question".

3. Answers by the Organizing Committee are posted on the "AI Challenge" subsection of the RoboMaster's official BBS (<https://www.reddit.com/r/ROBOMASTER/>). Please look out for updates.

## 5.3 Updates to the Rules

Based on the overall preparations and actual events during the competitions, the RoboMaster Organizing Committee may make adjustments to the rules in the following aspects:

1. Minor adjustments to balancing specifications (such as the number of projectiles allowed, etc.)
2. Modifications to the rules that provide advantages through non-technical means.
3. Additional penalties or amendments for actions that result in an unfair advantage during competition.
4. Minor adjustments to the manual that are not related to the rules (such as competition check-in time, etc.)
5. The FAQs are regularly compiled and updated into the Rules Manual.

All updates of the Rules Manual will be issued with a new version number. The latest version will be released and highlighted on designated channels such as RoboMaster's official website and BBS.

Refer to the latest version of the Rules Manual and FAQs for the referee's ruling standards during the competition.

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## 5.4 Contact Us

Official phone number: +86 (0)755 36383255

Official email: [robomaster@dji.com](mailto:robomaster@dji.com) (email subject: "school name + team + AI Challenge questions")

Official address: Room 202, Floor 2, Integrated Circuit Design & Application Industrial Park, No. 1089, Chaguang Road, Nanshan District, Shenzhen City, Guangdong Province

Organizing Committee office hours: 10: 00 AM - 7: 00 PM, Monday to Friday



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# Appendix One - Safety Instructions

Every team and all its members must fully understand and accept that safety is of paramount importance when competing at the ICRA 2019 RoboMaster AI Challenge. To protect the rights and interests of all those who participate in the competition, as well as the rights and interests of the event organizers, everyone who enters the competition must acknowledge and abide by the following safety clauses in accordance with applicable laws and regulations:

1. All participants shall state that they are fully capable of civil conduct and can independently manufacture and operate robots. Prior to using the robots made by the undertaking organization SZ DJI Technology Co., Ltd., all participants shall ensure they have carefully read relevant documents such as the Registration Guide and Rules of ICRA 2019 RoboMaster AI Challenge.
2. During the competition, all participants will ensure that their actions, including the manufacturing, testing, and use of robots will not cause any injury or damage to his or her teammates, members of the opposing teams, referees, staff members, audience members, equipment or the competition area.
3. The team must ensure that the structural design of their robots will not hinder the safety inspections that take place prior to the commencement of the competition and agree to cooperate fully with the pre-match inspections carried out by the RoboMaster Organizing Committee.
4. The team guarantees that it will not use any internal combustion engines, explosives, high-pressure air products, or energetic materials
5. Throughout the R&D stage as well as the competition stages of the event, all team members must pay full attention to potential safety issues, and the team advisors must be responsible for instructing and supervising the teams on safety issues.
6. The team must guarantee the safety of all its robots entering into the competition. This includes ensuring the projectile launchers installed on the robots are safe, and that the projectiles will not cause any harm (either directly or indirectly) to any operator, referee, staff member, or audience member.
7. The team will take sufficient and necessary safety precautions during R&D, training, and competition stages of the event regarding any hazardous situations that may occur. This includes but is not limited to: preventing the control systems from failing; urging team members to anticipate every potential operation prior to carrying out the operation to avoid wrongful operation or a collision between team members or between robots and team members; prohibiting team members from engaging in solo training; making sure that one or more persons have been appointed as an emergency responder; wearing goggles and helmets; properly applying the lock function in the robot control system before engaging in debugging; and including an emergency stop function on all robots.
8. The team will be held responsible for all accidents and losses that occur as a result from robot failures, loss of control, and any other unexpected circumstances during training or competitions.
9. The materials bought from or provided by the organizer of this competition (SZ DJI Technology Co., Ltd.) such as batteries and the referee system must be used in accordance with the information

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contained in their user manuals. SZ DJI Technology Co., Ltd. will not be held responsible for any injuries that arise from the improper use of these materials. The team will be held responsible for any injuries caused to its own members or any other persons, as well as for damage caused to property arising from the manufacture and operation of its robots.

10. All participants must remain in strict compliance with the applicable laws and regulations of the country or region. All participants must also pledge that their robots will only be used for RoboMaster events and competitions and that their robots will not be illegally modified or used for any illicit purpose(s).

# Appendix Two - Definitions of RoboMaster Terminology

Terms	Definition
<b>Competition Names</b>	
<b>Warm-up Competition</b>	Practice matches held after the teams have checked in on the first day of the ICRA meeting.
<b>Group Stage</b>	The first phase of the official competition. The teams will be grouped and compete within the groups. The teams with high points will enter the knockout stage.
<b>Knockout Stage</b>	The second phase of the official competition. The first to eighth places of the competition will be decided.
<b>Staff Responsibilities</b>	
<b>Supervisor</b>	Supervisors are general responsible individuals for their respective teams. They are in charge of the building and management of their teams.
<b>Advisor</b>	Advisors are supporting team members who provide guidance on team strategy, technology, and management.
<b>Captain</b>	Captains are responsible for their team's technology and strategy development. Captains' scope of work also includes dividing team member responsibilities, logistic management, as well as strategy development and adjustment during the competition. They also serve as their team's point of contact for the RoboMaster Organizing Committee.
<b>OPM</b>	OPMs are managers for the overall project. They manage project schedules, results, budgets, and safety.
<b>Team Member</b>	They are in charge of electrical (embedded system), algorithm (computer vision), mechanical and other different technical directions.
<b>Pit Crew Member</b>	Team members who enter the staging area and the competition area.
<b>Head Inspector</b>	An inspector who oversees all the pre-match inspections and makes the final decision on whether the team passes the pre-match inspection or not.
<b>Inspector</b>	An event staff member that assists with pre-match inspections.
<b>Chief Referee</b>	The chief referee is the one that has the final decision and right of interpretation regarding competition rules. The chief referee issues penalties for severe violations of the rules and processes appeals post competition. He/she has the right to issue additional penalties before or after the competition.

<b>Head Referee</b>	The main person responsible for referees and for controlling competition procedures and penalties.
<b>Side Referee</b>	Side referees execute competition procedures and penalties from their stations around the perimeter of the competition area.
<b>Field Technician</b>	Field technicians repair the components as well as the referee system equipment around the competition area.
<b>Technical Assessment</b>	
<b>Technical Proposal</b>	Optional. Including hardware (sensor type and usage, computing device type and communication hardware link analysis) and software (functional modules and algorithmic proposals).
<b>Technical Report</b>	Required. A check to see if the robots that are scheduled to compete meet the basic technical assessment required for the competition.
<b>Technical Specifications</b>	
<b>Energy Source</b>	Robots can only be electrically powered.
<b>Optical Approach</b>	The method for participating robots using different visible lights of different power, colors and wavelengths to achieve various purposes in the competition.
<b>Computer Vision Characteristics</b>	Images used to assist robots.
<b>HP</b>	
<b>Initial Blood</b>	The initial HP for each robot which set by the referee system at the beginning of every round.
<b>Current HP</b>	A real-time HP measurement of robots during a match.
<b>Maximum HP</b>	The maximum HP available for each robot.
<b>HP Deduction</b>	<ol style="list-style-type: none"> <li>1、 The drop in HP accrued by the end of each round from one team successfully attacking the armor modules of the opposing robots is called a HP deduction, which is abbreviated as "deduction".</li> <li>2、 "Ejection of robots" means deducting the total HP of the robot and such penalty will be counted into the deduction inflicted by the opponents.</li> <li>3、 HP deductions caused by excessive initial firing speed, barrel overheat and offline referee system modules are not counted into the deduction inflicted by opponents.</li> </ol>
<b>Referee System</b>	
<b>Speed Monitor Module</b>	This module detects the initial firing speed of a projectile when it is launched by a robot, and the referee system deducts the robot's HP when the speed exceeds the limit.

<b>Armor Module</b>	Comprised of armor plates and sensors, this module protects the internal structure of robots, detecting projectile impacts and deducting HP accordingly.
<b>RFID Interaction Module</b>	The RFID interaction module interacts with RFID-enabled battlefield elements to activate predetermined functions.
<b>Main Control Module</b>	This module monitors all referee system modules and sends the real-time status of the robot to the server.
<b>Power Management Module</b>	The power management module controls the power supply of the robot, and automatically cuts off the power supply when the HP is zero.
<b>Light Indicator Module</b>	The length of the light indicator indicates the level of HP, and the color of the light indicator can be used to distinguish between the red/blue teams and the status of the robot.
<b>Functional Areas</b>	
<b>Preparation Area</b>	The preparation area.
<b>Staging Area</b>	Where qualified robots and participants prepare for a match.
<b>Competition Area</b>	The only competition area for the participating robots. It includes the "starting zone", "supplier zone", "defense bonus zone", "obstacle zone" and "protective perimeter wall zone".
<b>Inspection Area</b>	Where the participating robots undergo pre-match inspections.
<b>Referee Area</b>	Where the head referee and chief referees implement competition procedures, give match results confirmations, process appeal requests, and carry out other official duties.
<b>Projectile Unloading Area</b>	An area to unload projectiles from all robots after a match finishes.
<b>Arbitration Room</b>	A room for representatives of the RoboMaster Organizing Committee and the chief referee to process appeal requests.
<b>Battlefield Components</b>	
<b>Starting Zone</b>	The zone where robots are placed before the competition officially begins.
<b>Obstacle Zone</b>	Immovable wooden obstacles.
<b>Defense Bonus Zone</b>	This zone can trigger an increase in the defense capacity of all robots from one team, reducing HP deductions from projectile attacks.
<b>Official Projectile Supplier Zone</b>	The supplier zone supplies projectiles for robots. The supplier zone for one team is the supplier penalty zone for the opposing team.
<b>Supplier Penalty Zone</b>	The supplier penalty zone is the supplier zone for the opposing robots. Penalties will be imposed if a robot from the opposing team enters this zone.

<b>Judging</b>	
<b>Five-Minute Setup Period</b>	The participating teams enter the competition area and start the five-minute setup period, in which they place their own robots in the starting zone to check the official equipment and the participating robots, ensuring that the teams are all setup for the competition.
<b>Three-Minute Round</b>	A three-minute round for teams to compete on the battlefield.
<b>Two-Minute Official Initialization Period</b>	The referee system confirms the system communication link and equipment, and the official technicians inspect the site and robots as required to ensure that everything is set for the competition to begin.
<b>Pass Card</b>	The Pass Card indicates that a robot has passed the pre-match inspection. Only robots with a Pass Card can enter the staging area and competition area.
<b>Official Technical Timeout</b>	During the five-minute setup period, technicians can request that the chief referee provide an official technical timeout when the referee system or other equipment in the operator room malfunction, or functional problems occur with critical equipment in the competition area.
<b>Team Technical Timeout</b>	Teams may request a technical timeout during the five-minute setup period to address specific needs. Teams are required to confirm the timeout with signatures after the match.
<b>Safety Hazards</b>	On site safety inspectors will handle possible safety hazards and problems that may occur during the competition.
<b>Robot Projectile Unloading</b>	Robots are required to unload all projectiles during the five-minute setup period between rounds to ensure that both teams have the same number of projectiles and the competition remains fair.
<b>Foul</b>	If a team member violates any rule stated in the Rules Manual during competition, he/she will receive different levels of penalties from the referees.
<b>Collision</b>	During the competition, the referee will impose penalties on the offender for abnormal collision between robots and/or with official components based on the seriousness of the offense.
<b>Stuck Together</b>	During the competition, in the case where a robot from one team is stuck together with an opposing robot, the referee shall impose a penalty on the offender based on the seriousness of the situation and its impact on the competition.
<b>Punitive Forfeiture</b>	A penalty imposed by the referees in accordance with the rules for serious violation of rules or other forms of cheating during a round.
<b>Cheating</b>	Forms of cheating are clearly set out in the rules. Referees will punish cheating by declaring the current round to have been ruled as punitive

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	forfeiture by the offending team, with more serious forms of cheating leading to disqualification from this year's competition and its awards.
<b>Appeal</b>	After a match ends, either of the two teams that has doubts over the result could appeal to the arbitration commission of the Organizing Committee within the time specified in the rules. Appeal opportunities for each team are restricted by the rules and regulations. The complainant must submit relevant materials, and the members of the official arbitration committee and the representatives of both teams will discuss in the arbitration room to confirm the arbitration results.
<b>Match Results Confirmation</b>	Captains or representatives from both teams must go to the referee area to confirm match results from each round. If they have no objections to the result of the round, they should sign off on the results within a specified period after each match.

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# Appendix Three - Technical Assessment Specifications

Note: For technical assessment related information, please refer to [1.2 Competition Schedule Technical Assessment](#)

Teams will receive rate from committee when each time they passed the item of Technical Assessment. Teams that get 60 scores (Rate C) or above would pass the specific progress.

Score	Rate
$95 \leq X \leq 100$	S
$85 \leq X < 95$	A
$70 \leq X < 85$	B
$60 \leq X < 70$	C
$45 \leq X < 60$	D
$0 \leq X < 45$	E

## Technical Proposal Assessment Specifications:

After reading the rules and the official robot manual, use the block diagram and text to describe the hardware and software system structure for a robot that can complete the competition.

### a. Submission format:

Teams need to submit a PDF file, containing all pictures, text and video link addresses (passwords included). The format for PDF file names is "school name + team name + ICRA Technical Proposal". The entire text of the plan should be written in English, size 12, Times New Roman font. The overall length should not exceed 10 pages of A4 paper.

Video display is encouraged. Teams can upload encrypted videos on YouTube or other online platforms, and indicate the video link addresses and corresponding passwords in their reports.

### b. Assessment standards:

Teams are required to explain their robot system and technology implementation from the following aspects.

- **Hardware Description**



- 
- ◆ Sensor type and usage, combined with parameters to explain the reasons for such choice.
  - ◆ Computing device type, combined with parameters to explain the reasons for such choice.
  - ◆ The communication hardware link analysis. Consider the choice of communication links and methods among controllers, onboard computers and sensors, and explain the reasons for such choice.

- **Software Description**

1. Explain the functional modules and planned algorithms required to complete the competition. Analyze and consider them one by one in terms of computer vision recognition and tracking, locating, motion planning, gimbal, and chassis in servo control during automatic firing and supplying. Point out the advantages and disadvantages of relevant algorithms. Explain the key problems that different modules may encounter and analyze the bottlenecks of their respective solutions.
2. Describe the plan for decision-making and overall deployment of different functional modules. Explain the reasons for such choice, the key problems that may be encountered and analyze the bottlenecks of their respective solutions
3. It is recommended that the participating teams list each team member's learning, research or competition experience related to robot systems and the above algorithms. Relevant projects, papers or videos can be listed for reference.

### **Technical Report Assessment Specifications:**

Technical reports include the video display section and the written description section. The following are the specific requirements for the two sections.

#### **1. Video display:**

##### a. Display method:

Teams can upload encrypted videos on YouTube or other online platforms, and indicate the video link addresses and corresponding passwords in their reports.

##### b. Assessment standards:

- Basic information such as the school name, team name, date and location of the video should be indicated at the beginning of the video.
- Teams need to film and describe the sensors they use, and the tasks shown must include but are not limited to:
  - Robot locating and obstacle avoidance planning tasks (such as mock navigation to the bonus zone).

- 
- Identifying moving robots and performing firing or chasing tasks.
  - Motion planning to enter the mock official projectile supplier for alignment and supply tasks.
  - Performing the entire competition process under the referee system server configurations, including the automatic startup during the competition, the supply of projectiles from the official projectile supplier as well as independent firing and confrontation with the enemy robots, etc.

Note: Each section requires a title caption. Subtitles can be added for description if necessary.

- The filming lighting and angles need to be guaranteed to clearly see the details of the robot's actions for each task.
- Do not include meaningless scenes in the video. Make sure the whole video is concise and clear, and the duration is under 6 minutes.
- It is recommended to take multiple clips of different tasks and edit these clips within reasons to ensure the readability of the entire video. Misleading special effects or post-processing are strictly prohibited, as well as positioning the camera or using manual control to achieve automatic task execution. Any violations will be treated as cheating, and those deemed as serious offenders will be disqualified.

## **2. Written Description:**

### a. Submission format:

Teams need to submit a PDF file, containing all pictures, text and video link addresses (passwords included). The format for video names is "school name + team name + ICRA technical report". The entire text of the report should be written in English, size 12, Times New Roman font. The overall length should not exceed 10 pages of A4 paper.

### b. Assessment standards

Teams are required to explain their robot system and technology implementation from the following aspects.

- **Hardware Description**

- 1) Mechanical Structure

A description of the mechanical changes based on the official robot, as well as the layout for each actuator, sensor, arithmetic unit, and communication link between them.

- 2) Sensor

Indicate the sensor type and sensor parameters used. For example, when it comes to cameras, the shutter type, resolution, field of view, maximum frame rate, etc. should

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be indicated. While for radar, its maximum measurement angle, the number of sampling points per second, measurement accuracy and the maximum frame rate, etc. should be indicated, as well as the reasons for the choice and requirements of the corresponding algorithm.

3) Computing Device

Indicate the type and parameters of the computing device used, and analyze the reasons for the choice in terms of program performance.

4) Others

Describe other communications or other equipment used and analyze the reasons for the selection.

● **Software Description**

Teams are required to provide a system diagram to describe the software system for their robots, and explain technical solutions of the software from the following aspects:

1) Automatic Recognition

- ◆ Describe the sensors and corresponding algorithms used, and explain the superiority of the algorithm from the aspects of high-speed motion recognition and precision ranging etc.
- ◆ Point out the performance of the algorithm, such as target recognition accuracy, frame rate and distance precision. If a learning scheme is adopted, it is necessary to point out the referenced algorithm, network architecture and learning framework employed.

2) Locating

- ◆ Describe the sensors and corresponding algorithms adopted, and explain the superiority of the algorithm from the aspects of random initial locating and high-speed motion locating.
- ◆ Point out the performance of the algorithm, such as the locating precision, frame rate, and so on.

3) Motion Planning

- ◆ Describe the obstacle avoidance sensors adopted and corresponding algorithms. Introduce the superiority of the algorithm used from the aspects of path planning, trajectory planning, and multi-robot motion planning.
- ◆ Point out the performance of the algorithm, such as the frequency of planning, maximum motion speed, obstacle avoidance ability and so on.

4) Automatic Firing

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- ◆ Describe and recognize the gimbal control algorithm adopted by automatic firing under algorithm integration, and illustrate the superiority of the algorithm from the following aspects of firing under high acceleration motion.
  - ◆ Point out the performance of the algorithm, such as the farthest strike distance, the strike precision, and so on.

5) Automatic Supply

- ◆ Describe the computer vision or other servo control schemes and algorithms used in the automatic supply process and outline their advantages.
- ◆ Point out the performance of the algorithm, such as the speed of the supply alignment, the error and precision of the supply.

6) Smart Decision

- ◆ Describe the decision framework used. If a traditional method is adopted, such as a finite state machine or behavior tree, then a logic diagram is needed for operations. If a learning scheme is adopted, the referenced algorithm, network architecture and learning framework employed should be explained. The introduction process needs to be accompanied by the execution process in the video display. A simulation environment can be used as a supplement but not as a key material.

# Appendix Four - Pre-match Inspection Form

Category	Inspection Items	Description
<b>Size and mass of a single robot</b>	Initial Size of the Robot	600 x 600 x 500 mm (length x width x height)
	Robot Expansion Size	700 x 700 x 600 mm (length x width x height)
	Robot Mass	20 kg (the weight of the referee system is not included)
<b>Robot modules</b>	Referee System Completeness	The referee system modules should be complete (intact) and unmodified.
	Armor Module	<ol style="list-style-type: none"> <li>1. Only official mounts are allowed. They must not be modified or damaged.</li> <li>2. The imaginary connection lines between the X-axis armor plates and Y-axis armor plates respectively should be perpendicular to each other and intersect the geometric center of a robot. X-axis and Y-axis armor modules allow a <math>\pm 50</math> mm deviation from the geometric center.</li> <li>3. The weight-bearing surface and the armor plate mount must be firmly and rigidly connected, and the two screws of each mount must be installed;</li> <li>4. Within <math>145^\circ</math> of the armor's exterior should not be blocked, and the HP can be deducted normally.</li> <li>5. The height of the lower edge of the armor before and after transformation must be between 50~150 m.</li> <li>6. The projected vectors of the normal vectors of the armor module's stress-bearing surface on the XY plane must be equal to the positive/negative X axis and Y axis in the body coordinate system, respectively.</li> </ol>
	Robot Firmware Updates	Robot modules should be updated to their latest versions.
	Power Tests	<ol style="list-style-type: none"> <li>1. The power curve should be normal.</li> <li>2. A chassis should stop moving after its power is cut off.</li> </ol>
	RFID Interaction Module	<ol style="list-style-type: none"> <li>1. The RF card on the bottom should flash normally when being read.</li> <li>2. Only an Engineer with a slot may be provided with an IC card unit.</li> </ol>

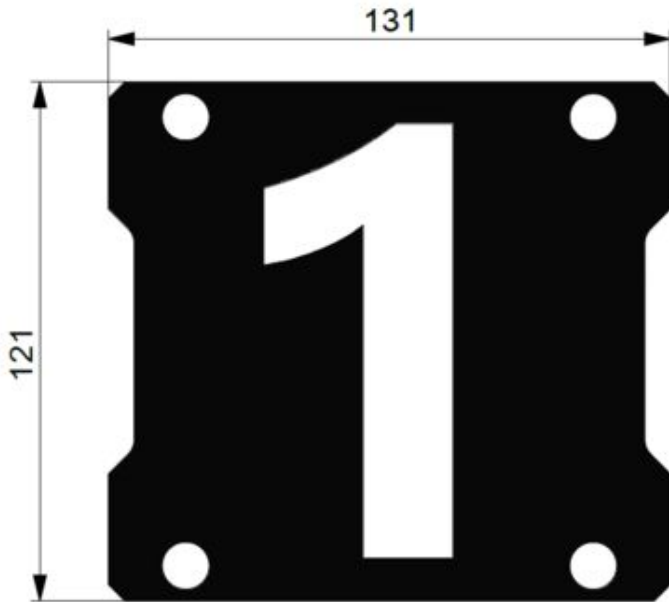
	<p>Speed Monitor Module</p>	<ol style="list-style-type: none"> <li>1. The speed of launch and rate of fire should be displayed (each robot must be capable of firing using a remote control for the convenience of inspection).</li> <li>2. The area covered by any obstruction on the light indicator on each side of the speed measurement module must not exceed 1/5 of the original area of the light indicator.</li> <li>3. Re-calibration should be completed each time a robot leaves the inspection area.</li> </ol>
	<p>Locating System Module (Optional)</p>	<ol style="list-style-type: none"> <li>1. Only the UWB tag available on the market can be used.</li> <li>2. Complete the configuration of the ID used in competition.</li> </ol>
	<p>Others</p>	<ol style="list-style-type: none"> <li>1. Use TB47D or TB48D as the battery, the innovative lithium battery product of DJI Technology Co., Ltd. The total power of each robot must not exceed 200 Wh. The power supply voltage should not exceed 30 V, and there should be no risk of short circuits.</li> <li>2. Each robot should be equipped with at least one remote control, and the remote control should be a product of DJI Technology Co., Ltd.</li> <li>3. Only Wi-Fi wireless data links of 2.412-2.472GHz or 5.725-5.850GHz can be used, and the usage must be reported.</li> <li>4. A robot should not be installed with official equipment that emits or reflects light. The exterior decoration should avoid red and blue colors.</li> <li>5. Robots should not have equipment that damages the stadium.</li> <li>6. Robots should not have a mechanism that may get stuck together with other robots.</li> </ol>
<p><b>Wireless frequency band reporting and other notes</b></p>		

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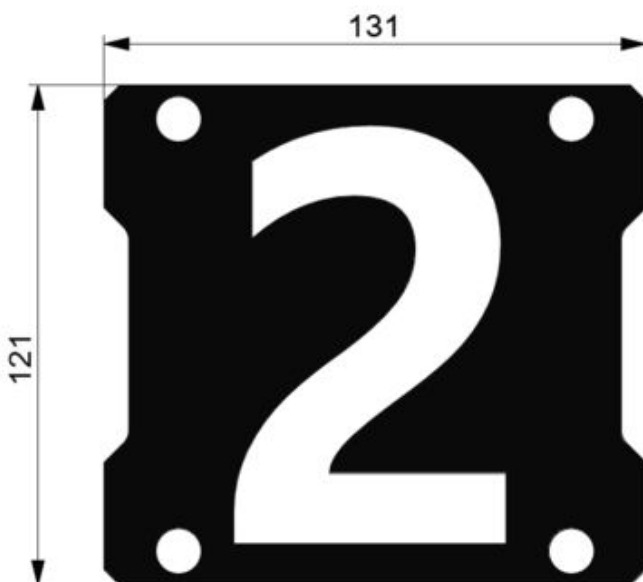
# Appendix Five - Reference Pictures

## Armor Plate Stickers

Digital sticker 1 for a Standard is shown below (unit: mm):



Digital sticker 2 for a Standard is shown below (unit: mm):





**E-mail:** [robomaster@dji.com](mailto:robomaster@dji.com)

**Forum:** [bbs.robomaster.com](http://bbs.robomaster.com)

**Website:** [www.robomaster.com](http://www.robomaster.com)

**Tel:** +86 (0)755 36383255 (UTC+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