

V1.2

Using a 55-56 motor driver chip and closed-loop control (FOC), the RoboMaster C650 Brushless DC Motor Speed Controller enables precise control over motor torque.

Exclusively designed for the RoboMaster M6000 PMSM Brushless DC Motor Motor and C650 Brushless DC Motor Speed Controller, the M15500 Servomotor Kit includes several cables and a terminal board.

Reference System Specification Manual, Reference System User Manual, Introduction of Reference System Module

The M6000 Servomotor Kit includes several cables and a terminal board, ensuring a complete plug-and-play system solution for your independent contest.



The 23rd China University Robot Competition

ROBOMASTER 2024

University Series

Robot Building Specifications Manual

Prepared by RoboMaster Organizing Committee

Released in April 2024

Release Notes



The manual will take effect from the specified date after its release.

Date	Version	Release Notes	Effective Date
2024.04.18	V1.2	<ul style="list-style-type: none"> ● Revised the safety regulations and requirements for laser products. ● Revised the scope of Battlefield visual features. ● Revised the appearance requirements for custom controllers. ● Revised the installation requirements for Speed Monitor Modules. ● Revised the rules regarding the use of remote controllers and receivers. ● Included the Dart Trigger in the configuration of the Referee System. 	2024.04.18
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1. Foreword

Teams participating in RoboMaster are required to develop and build their robots. Participating robots are required to meet all specifications listed in this document. A Pre-Match Inspection will be carried out against the specifications. If any safety incident has occurred due to a violation of rules, the RoboMaster Organizing Committee (“RMOC”) reserves the right to hold the offending team legally responsible. Any dispute arising from this specifications manual will be settled based on interpretations provided by the Chief Referee or Head Inspector.

In RMUC, robots need to meet all requirements of this specifications manual. In RMUL, robots may not meet the following regulations:

- A Sentry Robot must have the ability to launch 17 mm projectiles. Please refer to “P32”.
- Positioning System Modules must be mounted on robots. Please refer to “P46”.
- Robots with a 17 mm Launching Mechanism must be equipped with a fluorescent energy-charging device. Please refer to “P17”.
- The Speed Monitor Module must avoid the influence of ferromagnetic materials on the angle of magnetic force on the module. Please refer to “P81”.




- For RMUL, please refer to “RoboMaster University Series 2024 Robot Building Specifications Manual V1.1.1”.
 - For RMUC, please refer to “RoboMaster University Series 2024 Robot Building Specifications Manual V1.2”.
-

2. Technical Specifications

2.1 General Technical Specifications

2.1.1 Energy Source

- It is prohibited to use combustion engines, explosives, and hazardous chemicals.
 -  ● It is prohibited to use mains supply in the competition area (except for Radars).
 - It is prohibited to use hydraulic or other propulsion methods that may cause pollution.
-

S1 Robots can be powered only by electricity and gas.

S2 For robots limited by their chassis power, the horizontal movements of their chassis can only be propelled by electricity.

S3 With the exception of custom controllers and darts in the dart system, the rest of the robots will need to retrieve a battery identification sticker at Pre-Match Inspection and stick it near the battery.

2.1.1.1 Power Supply

S4 Only batteries produced by DJI or other official manufacturers can be used on robots. In addition, darts and custom controllers may use lithium batteries produced by other official manufacturers.

S5 The total nominal energy of one Supercapacitor Module of Hero, Standard and Sentry Robots must not exceed 2,000 J, and their actual energy must not exceed 2,200 J. The formula for calculating the nominal energy of one capacitor module is $E = \frac{1}{2} * C * U^2$ (U is the withstand voltage of the capacitor, C is capacitance).

S6 Only Hero, Standard, and Sentry Robots can use the Supercapacitor Module. Each robot is allowed to use no more than one Supercapacitor Module.


2.1.1.2 Gas Source

S7 The compressed gas pressure inside the gas cylinder (for storage) must not exceed 20 Mpa. The gas cylinder (for storage) used should have a nominal pressure of no less than 30 MPa. A double-gauge regulator should be mounted directly at the outlet of the gas cylinder (for storage). The working pressure must not exceed 0.8 Mpa.

S8 The working gas must be non-flammable, non-toxic and non-polluting, such as air, nitrogen, and carbon dioxide.

- S9 Any mechanism for using or storing gas (cylinders for storage, cylinders for propulsion, air spring, etc.) must come with an approval certificate or nameplate stamp that is easy to inspect when required.
- S10 If a gas cylinder (for storage) is still within its service life, it must be returned to the factory for maintenance within the period specified by the user manual or product label, after which the proof of maintenance must be submitted.
- S11 The gas cylinder must have been issued an approval certificate by an officially recognized approving institution in its country of manufacture.
- S12 The gas cylinder (for storage) must be firmly and safely mounted on the robot, with at least two fixed points that are more than 1/5 of its length apart or with one fixed surface that is more than 1/5 of its length. The gas cylinder (for storage) and pipe must be protected to avoid any damage caused by tumbling over, collision, rotation or faulty moving parts. The cylinder’s opening must not be exposed, so as to prevent it from being hit and damaged by projectiles. To ensure safety, the cylinder’s opening must be kept horizontal or facing up.
- S13 The gas cylinder (for storage) should be mounted in a way that the cylinder and the gas pipe never touch the ground, regardless of how the robot spins around.
- S14 No inflammables are allowed to be within 50 mm from the gas cylinder.
- S15 All gas pipes and parts must be able to withstand the maximum working pressure of the system. It is recommended that a safety relief valve is installed on the low pressure gas circuits.

2.1.2 Communication Equipment

- The RMOC recommends that teams use the Video Transmitter Module Link (hereinafter referred to as “VTM Link”) to control their robots.
-  ● The VTM Link refers to the link in the Video Transmitter Module used to transmit robot control-related data. It can replace the DT7 and offer superior stability.
- For protocols related to the VTM Link, please refer to the [Referee System Serial Port Protocol Appendix](#).

S16 The control methods specified for this competition season are shown in the table below.

Table 2-1 Summary of Control Methods




Data Link	Information Transmitted
DT7 Remote Controller	Mouse and keyboard commands, control stick movements
Other Remote Controllers	Control stick movements
VTM Link	Custom Controller, mouse and keyboard commands


Data Link	Information Transmitted
Serial port of the Referee System	Inter-robot communication, Dart launching command

S17 In addition to the Radar, robots must be equipped with DT7 Remote Controllers or other remote controllers for debugging that meet the requirements during the Pre-Match Inspection, so that functions such as launching projectiles, chassis movement, and gimbal movement can be demonstrated during the inspection.

S18 The remote controllers specified for this competition season are shown in the table below. Only remote controllers within the frequency band of 2.4G are permitted to be used, and only DT7 Remote Controllers may be connected to the client. The RMOC only ensures the stability of the VTM Link.

Table 2-2 Summary of Remote Controllers

Name	Image
DT7	
FS-i6X	
WFLY ET08	

Name	Image
WFLY ET16S and WFLY ET16	



The remote controllers are limited to the models described in the table. Other models of the same controller cannot meet the specification requirements.

S19 Remote controllers have a one-to-one correspondence with receivers.

S20 Remote controllers cannot be modified.

S21 Robots are not allowed to carry wireless communication equipment other than the remote controller (RC) and Referee System Module.

2.1.3 Optical Equipment



- Teams are advised not to set up a laser sight when building a robot.
- The use of custom UI is recommended, instead of a laser sight.

S22 The laser beam from the laser sight must be red and the optical power consumption of the laser beam must be less than 35 mW. The projection angle of the laser sight must not exceed 5° (i.e. the diameter of the laser spot enclosing circle perpendicularly projected by the laser sight on a vertical wall with a horizontal distance of 1 m must be less than 90 mm).

S23 Each launching mechanism and dart launcher can be equipped with a maximum of one laser sight. Engineers can be mounted with not more than three laser sights. Apart from those needed to position the Launching Mechanism, no additional laser sights may be used by other robots.

S24 Besides laser sights, Engineers can also be mounted with a white supplement light and a display not larger than 7 inches. The light can only be used for enhancing computer vision recognition features when the robot is acquiring a mobile component. The display screen must not interfere with the robot's visual features. Other

robots must not be equipped with other obvious visible and invisible light emitting equipment. The light sources of robots' status indicators are not deemed obvious visible light emitting equipment.

S25 The optical equipment used by a robot must not cause any physical harm to any person.

S26 All laser products must conform to the Class I requirements.

2.1.4 Vision Feature


Referee System Armor Modules should have clear lighting effects on both sides to facilitate the development of automatic recognition and sighting algorithms. The environment in and around the Competition Area is relatively complex. The RMOC cannot guarantee that the computer visual features of the Battlefield will not cause visual interference. The computer vision algorithm should adapt to the changes in the lighting of the venue and other possible interferences around the venue.

The following specifications must be followed when designing a robot:

S27 The Armor Module cannot be blocked.

S28 It is prohibited to simulate visual features.

S29 One team must not, through any means, interfere with the detection of its robot visual features by the other team's robot.

-
- Robot visual features: Light indicators on both sides of the Armor Module, and armor stickers.
- 
- Battlefield visual features: Dart Launching Stations, Status Indicators of Exchange Stations, Light Indicators of Mineral Receptacles, Visual Markers, Localization Markers, Power Rune Light Effects, and Dart Guiding Lights.
-

2.1.5 Armor Stickers

During Pre-Match Inspections and matches, RMOC staff will provide armor stickers to robots based on their robot numberings. For drawings of the stickers, please refer to “Appendix 2: Reference Drawings”. For robot numberings, please refer to the “Robot Line-up” chapter in the [RoboMaster 2024 University Championship Rules Manual](#).

The following specifications must be followed when attaching armor stickers on robots:

S30 The armor stickers and serial number of a robot must match one another according to the numbering rules. The number and symbol must be placed in the correct direction, with no visible air pockets and no damage to the stickers. One Armor Module may be attached with not more than one armor sticker.

S31 The armor stickers provided by the RMOC can only be attached to the Armor Module. Except for the armor stickers provided by the RMOC, no other stickers that resemble the armor stickers in their patterns may be attached to a robot’s Armor Module or its other external structures.

2.1.6 Aesthetic Design

To ensure the protective shells of robots do not affect the shootout battles in the Competition Area and the match-viewing experience, the following specifications must be followed when designing and creating a robot’s exterior:

Basic Requirements:

S32 The cables of robots are neat and not exposed. Exposure that is unavoidable requires cables protection using materials such as drag chains and cable managers.

S33 Do not use materials that will have an obvious impact on the aesthetics of the robot, such as washbasins, plastic bottles, corrugated paper, bed sheets, white foam boards, bubble wrap, etc.

S34 Fishing net cannot be used as an aesthetic material, but can be used in the protective guard of an Aerial Robot.

S35 Do not design or use sharp structures to avoid causing damage to the Battlefield or injury to personnel.

Gloss:

S36 The exterior gloss of robots must not exceed 30Gs.



An exception is made for optical equipment, such as camera lenses and other equipment that cannot be made non-glossy. However, they must be kept more than 100 mm away from the edge of the Armor Module side indicators.

Paint Color:



All the robots of a team should preferably have a consistent aesthetic style.

S37 The Red Team's robots may use a color from the red spectrum for their protective shell, while the Blue Team may use any color from the blue spectrum. However, neither team should use the opposing team's color.

S38 A robot must display two school badges or team badges, each facing a different side. The size of a single school badge or team badge must not be larger than 100 mm*100 mm. The school badges or team badges must be displayed prominently on a robot, and their distance with the Armor Module side indicators must be more than 30 mm. If the exterior of a robot does not meet specifications, the Pre-Match Inspection staff may require the position or size of a school badge or team badge to be altered.

S39 The inkjet or stickers of the school and team badges must not affect the robot's visual features, and cannot be illuminated.

S40 Inverse colors can be applied on a school badge or team badge, or its original colors can be retained.

Mounting of Protective Shells:



It is recommended that teams use tough materials that are not easily damaged for the protective shell and conduct reliability tests, to avoid any violation of rules caused by breakage of the protective shell from battles in the Competition Area.

Aesthetic Requirements:

S41 Inverse colors can be applied for advertising spaces, or their original colors can be retained.

S42 The advertising spaces should be displayed on the left and right sides of the robot, and their distance with the Armor Module side indicators must not be less than 30 mm.

S43 The inkjet or stickers of the advertising spaces must not affect the robot's visual features, and cannot be illuminated.

S44 The size of a single robot advertising space should not be more than 100 mm × 100 mm. Each robot can be set with up to two advertising spaces for the display of sponsor information. If the exterior of a robot does not meet specifications, the Pre-Match Inspection staff may require the position or size of an advertising space to be altered.

S45 Custom controllers and their associated components shall not provide advertising spaces for the display of sponsor information.

2.1.7 Launching Mechanism



Launching Mechanism: A mechanism capable of launching a projectile from a robot on a fixed trajectory and at a certain initial speed.

S46 Robots using compressed gas as the propellant for projectiles must not have an acceleration length exceeding 200 mm (the acceleration must be completed before the projectile enters the Speed Monitor Module).

S47 The launching mechanisms of robots must be able to stably launch 10 rounds of 17 mm projectiles or 5 rounds of 42 mm projectiles.

S48 Each Launching Mechanism must be installed with a Speed Monitor Module in accordance with the rules. In RMUL, the 17 mm Launching Mechanism doesn't have to be mounted with a 17 mm Fluorescent Energy-Charging Device.

2.1.8 Custom Controller

The Custom Controller is a set of multi-purpose controllers made by the participating team and is used to control and monitor robot movements and status.

- The Custom Controller includes but is not limited to VR goggles and their supporting control equipment, the joystick, self-built wired controller, and other self-built control modules.
- If the joystick is mapped onto the mouse, the joystick and Remote Controller combo shall be deemed as one set of control equipment and not part of the Custom Controller.
- L*W*H: Size, length*width*height

Table 2-3 Custom Controller Building Parameters

Item	Limit	Remarks
Applicability	Each robot can be equipped with one Custom Controller at most.	-
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage (V)	30	-

Item	Limit	Remarks
Maximum Initial Size (mm, L*W*H)	500*500*500	-
Maximum Expansion Size (mm, L*W*H)	No restrictions	Excluding the size of data or power cables of any equipment as well as wearable devices such as video glasses
Video Transmission	Standard HDMI Type A Plug	The recommended resolution is 1920*1080. Otherwise compression or distortion issues may occur.
Data Transmission	Data is sent and received through the serial port.	<ul style="list-style-type: none"> ● The serial port standard is RS232. ● A device is considered a Custom Controller when and only when it uses a custom controller link
Protocol	Refer to the “Referee System Serial Port Protocol Appendix” .	-

Mounting Requirements:

S49 It is recommended that a non-slip pad is placed under the Custom Controller.

S50 Do not put any sticky or sharp items such as double-sided tape and screws in direct contact with the desk in the operator room.

S51 Keep the cables of the Custom Controller neatly stored in the device without being exposed.

S52 The interface between the Custom Controller and the computer in the operation room should strictly comply with the requirements specified in “Table 2-3 Custom Controller Building Parameters”. Unauthorized connection is strictly forbidden.

How to Use:

S53 Before you start to use the Custom Controller, you should test whether it functions properly by placing it on the computer desk corresponding to the robot in the Operator Room and connect it to the data interface available in the room.

S54 The Custom Controller must not be equipped with any wireless transmitter or receiver.

S55 The operator room is equipped with a standard HDMI Type A receptacle, which can be used to connect to the display devices such as video glasses. The operator can display the client images on the video glasses by using the screen mirroring function of the computer.

S56 An RS232 plug is provided in the Operator Room, for connecting Custom Controller signals. The Operator can connect them on their own.



For self-produced video glasses, the power supply must be provided by the Custom Controller. No battery is allowed to be mounted in the glasses (excluding commercial video glasses which come with batteries).

2.1.9 Other Requirements

S57 No materials that are fragile, easy to fall off, and difficult to clean may be used in the production of robots, such as feathers and cotton. No glue or adhesive materials may be used to attach robots to the Battlefield or Battlefield components.

S58 While acquiring or exchanging a mineral, a robot must not cause any obvious marks on or damage to the mineral.

S59 Robots are not allowed to grab the Referee System Module of any robot.

S60 With the exception of dart launchers in the dart system that fire darts, robots may not disintegrate into sub-robots or multiple subsystems connected by flexible cables, and may not intentionally cast off or launch their own parts.

2.2 Rules of Usage for Fully Assembled Robots and Open-Source Robots

- Only teams that did not qualify for the on-site competitions of the RoboMaster 2023 University Series are allowed to deploy a maximum of one non-modified RoboMaster Robot Self-Assembled Version Type A or one RoboMaster AI Robot 2020 Standard Version whose modification meets the new design criteria.



- When building their robots, the remaining teams must not modify the above-mentioned robots into a newly designed robot or directly use their frame, material or other important components during the production process, and are only allowed to use the motor coupling, launching mechanism, loading mechanism, or other such parts of the above-mentioned robots.
 - When building their robots, participating teams are forbidden from using third-party assembly modules, except for the flight system of Aerial Robots (including the frame, propulsion system, flight control, and perception system).
 - Third parties: Entities other than the RMOC and participating teams.
-

- Assembly modules: Special function components formed by several basic function components, used for assembling a system with full functionality, such as robotic arms, chassis, supercapacitor control panels and their supporting codes, gimbals, Darts, suspension wheels, loading mechanisms, and Launching Mechanisms.
-

For the RoboMaster University Series, the RMOC have defined the ownership of intellectual property over the participating robots. Only team members involved in the design and production of the robots and the universities or colleges they represent shall own the intellectual property rights related to the robots' design and form. Only the teams representing their colleges or universities having the intellectual property rights over the robots' design and form or teams made up of individuals with such rights are allowed to use the robots' design and form in the competition. Other teams wishing to incorporate such design and form must perform a redesign to their robot by at least satisfying one complete redesign criterion or three partial redesign criteria. Once these criteria are satisfied, the design will be deemed new and the team may use the newly designed robots in the competition. Such redesigns include but are not limited to the examples mentioned in this document.

Meanwhile, the RMOC will conduct random checks on robots during the competition. Participating teams are obligated to show their robots' mechanisms, circuit design drawings and relevant code documents to the RMOC and answer relevant technical questions. The RMOC has the right to photograph/record the configurations and information of the robots of the participating teams.

S61 Before a robot is inspected, the team is required to submit its photographs clearly showing the primary structures of the robot to the Inspection Area. Any protective shell must be removed to capture the robot's main body in the photographs.

S62 Any team using a redesigned, fully assembled robot or open-source robot must submit descriptions of the relevant modifications to the Inspection Area.

S63 In the event of a situation where robots do not satisfy each other's redesign conditions and the open-source robot is not referenced, it is stipulated that the owner of the intellectual property rights will be the team that first uses the robot to participate in the official competition. This means that as long as the affiliated team is still participating in the RoboMaster University Series, all subsequent robots from other teams that come on stage must meet the redesign requirements relative to the robots that were once on stage.

2.2.1 Complete Redesign



Complete redesign: An enhancement of the core components of the robot that implicates a broader range of systems.

1. Chassis

- Changes to wheels. For example, Mecanum wheels, steering wheels, omni wheels, Ackermann steering wheels, continuous tracks, etc.
- Changes to wheel transmission. For example, unsprung power, sprung power, etc.
- Changes to suspension. For example, double wishbone suspension, torsion beam suspension, double-trailing-arm suspension, lift suspension, etc.
- Changes to chassis power. For example, AC, DC, brushed, brushless, decelerating, direct-drive, etc.
- Changes to chassis form. For example, body-on-frame, layered, unibody, etc.

2. Gimbal

- Changes to gimbal transmission. For example, subset relationships and quantities of the yaw, pitch and roll axes.
- Changes to projectile supply principle. For example, changes of robot's projectile supply link from a simple, direct connection to supply to launching mechanism through the yaw-axis joint.
- Changes to positions of magazines. For example, fixed linkage between magazines and the chassis, yaw axis, pitch axis, etc.;
- Changes to transmission from the gimbal's motor. For example, changes to direct drive, pulleys, connecting rods, and gears (not including swapping between pulleys, gears, and sprockets);
- Increased quantity of effective Launching Mechanisms.

3. Actuators

- Changes to the topological structures of mechanisms other than the terminal executive mechanisms. For example: the combined sequences, quantities and types of revolute pairs and sliding pairs;
- Increasing the power efficiency of actuators. For example: reduced power value when the functions remain the same; power value remains consistent after an increase of effective functions; increase in power value after an increase of effective functions.

2.2.2 Partial Redesign



Partial redesign: Enhancements involving fewer systems

- More than 10% change in the suspension's hard point parameter;
- Changes to the quantity of effective power wheels;
- More than 10% change in the axle track and wheelbase;

- Changes to the gear ratio of the chassis motor;
- Changes to the positions of at least three Referee System Modules;
- Adding new independent functional modules. For example, adding an independent rescue device, image transmission turntable, mineral diverter, or visual module;
- Changes to the vertical and horizontal positions of the friction wheels;
- Changes to transmission from the gimbal's motor. For example, swapping between pulleys, gears, and sprockets.
- Changes made to the power supply. For example, pneumatic, electrical changes;
- Changes to the types and solutions of terminal executive mechanisms. For example, changing rotational grabbing to lateral grabbing;
- Layout of core electronic devices (main controller, power supply, computing platform, and sensor modules). For example, changing their position from the gimbal to the chassis;
- Change of the gimbal's rotating range from limited to unlimited.

2.2.3 Minimal Redesign



Minimal redesign: Modifications with a small impact on the core functions.

Minimal redesign includes but is not limited to the following modifications:

- Changes to secondary load-bearing and shielding structures. For example, a hollowed space or their shape;
- Changes to the quantities of models for standard parts;
- Switching the gas cylinder (for propulsion) and the electric actuator;
- Change of material of the same characteristics. For example, switching between fiberglass and carbon fiber sheets.
- Non-principle changes. For example, changing the hardness of the projectile supply tube, such as by replacing it with a soft tube.

2.3 Robot Technical Specifications



- **Maximum Initial Size:** A robot's maximum size before transformation, including the Referee System and its bracket.
-

- **Maximum Expansion Size:** A robot's maximum size at any time, and the maximum size the robot's mechanisms can possibly expand to, including the Referee System and its bracket.

2.3.1 Hero Robot

S64 A Hero Robot must have the functions for horizontal movement and launching 42 mm projectiles.

S65 The building parameters for Hero are as follows:

Table 2-4 Hero Building Parameters

Item	Limit	Remarks
Operating Mode	There are no restrictions. One remote control and one Custom Controller can be configured at most.	-
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage (V)	30	-
Launching Mechanism	One 42 mm launching mechanism	-
Maximum Weight (kg)	35	Including battery weight, but not the weight of the Referee System.
Maximum Initial Size (mm, L*W*H)	800*800*800	There is a state where the orthographic projection of the robot on the ground does not exceed an 800*800 square and the highest point of the robot is no more than 800 from the ground.
Maximum Expansion Size (mm, L*W*H)	1200*1200*1200	In any case, the orthographic projection of the robot on the ground does not exceed a 1,200*1,200 square and the

Item	Limit	Remarks
		highest point of the robot is no more than 1200 from the ground.
Referee System	<ul style="list-style-type: none"> ● Large Armor Module ● Speed Monitor Module (42 mm Projectile) ● Video Transmitter Module (Transmitter) ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module ● Light Indicator Module ● Supercapacitor Management Module 	Weight: 4.21 kg

2.3.2 Engineer Robot

S66 An Engineer Robot must have the functions for horizontal movement and grabbing minerals at any Resource Island.

S67 The building parameters for Engineer Robots are as follows:

Table 2-5 Engineer Building Parameters

Item	Limit	Remarks
Operating Mode	There are no restrictions. One remote control and one Custom Controller can be configured at most.	-
Maximum Power Supply Capacity (Wh)	265	-

Item	Limit	Remarks
Maximum Power Supply Voltage (V)	30	-
Launching Mechanism	No Launching Mechanism is allowed to be installed.	-
Maximum Weight (kg)	35	Including battery weight, but not the weight of the Referee System.
Maximum Initial Size (mm, L*W*H)	600*600*600	There is a state where the orthographic projection of the robot on the ground does not exceed a 600*600 square and the highest point of the robot is not more than 600 from the ground.
Maximum Expansion Size (mm, L*W*H)	1200*1200*1100	<ul style="list-style-type: none"> ● In any case, the orthographic projection of the robot on the ground does not exceed a 1200 * 1200 square and the highest point of the robot is not more than 1100 from the ground. ● All components of an Engineer cannot exceed their Maximum Expansion Size during its transformation.
Referee System	<ul style="list-style-type: none"> ● Small Armor Module ● Video Transmitter Module (Transmitter) ● RFID Interaction Module ● Positioning System Module ● Main Controller Module 	Weight: 3.04 kg

Item	Limit	Remarks
	<ul style="list-style-type: none"> ● Power Management Module ● Light Indicator Module 	

2.3.3 Standard Robot

S68 A Standard Robot must have the functions for horizontal movement and launching 17 mm projectiles.

S69 The building parameters for Standard are as follows:

Table 2-6 Standard Building Parameters

Item	Limit	Remarks
Operating Mode	There are no restrictions. One remote control and one Custom Controller can be configured at most.	-
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage (V)	30	-
Strength	Free-falling from a vertical altitude of 0.2 m three times without any damage to any part of the body	-
Launching Mechanism	One 17 mm Launching Mechanism	-
Maximum Weight (kg)	25	Including battery weight, but not the weight of the Referee System.
Maximum Initial Size (mm, L*W*H)	600*600*500	There is a state where the orthographic projection of the robot on the ground does not exceed a 600 * 600 square and the highest point of the robot is not more than 500 from the ground.

Item	Limit	Remarks
<p>Maximum Expansion Size (mm, L*W*H)</p>	<p>800*800*800</p>	<p>In any case, the orthographic projection of the robot on the ground does not exceed an 800*800 square and the highest point of the robot is not more than 800 from the ground.</p>
<p>Referee System</p>	<ul style="list-style-type: none"> ● Small Armor Module (Balancing Standard Robots shall be installed with Large Armor Modules) ● Speed Monitor Module (17 mm Projectile) ● Video Transmitter Module (Transmitter) ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module ● Light Indicator Module ● 17 mm Fluorescent Projectile Energy-Charging Device ● Supercapacitor Management Module 	<p>The Referee System of a Balancing Standard Robot weighs 2.60 kg, while those of Regular Standard Robots weigh 3.25 kg.</p>

The definition of Balancing Standard Robots:

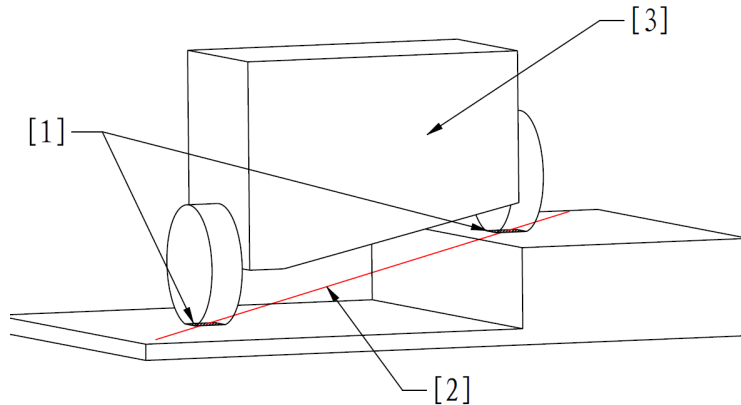
A robot’s contact surface shall be any bordered Battlefield surface that it has contact with. Any robot that meets all the following criteria is deemed a Balancing Standard Robot:

Criterion 1: When the robot is alive, the largest axial projections of all its wheels in contact with a horizontal surface are always round in shape.

Criterion 2: When the robot is alive, there is at least one straight line intersecting all the contact surfaces.

Criterion 3: When the power is off, the robot’s z-axis cannot remain vertical against a horizontal surface.

Example: As shown below, the robot, when alive, has two wheels in contact with the Battlefield, and their largest axial projections are round in shape. There are only two contact surfaces, one on the step and the other parallel with the first surface, with a 200 mm height difference in between. One straight line also intersects with the two contact surfaces. As such, the robot is a Balancing Standard Robot.



- | | | | | | |
|-----|--|-----|--|-----|--------------------------|
| [1] | Contact surface between the wheels and the Battlefield | [2] | The straight line intersecting with the contact surfaces | [3] | Balancing Standard Robot |
|-----|--|-----|--|-----|--------------------------|

Figure 2-1 A Balancing Standard Robot



When alive, a Balancing Standard Robot may use other propulsion mechanisms to balance itself only when it is in an unbalanced state (i.e. the robot has any contact surface that does not meet the definition of a Balancing Standard Robot) and it is regaining its balance. After the robot has regained its balance, the propulsion mechanisms must be retrieved immediately.

2.3.4 Aerial Robot

S70 An Aerial Robot must have the function for sustained flight for 10 seconds and the participating team must provide a video of that robot in flight at Pre-Match Inspection.



- The video needs to make it clear that the robot shown is the one under Pre-Match Inspection.
- The video should show the Aerial Robot flying for at least 10 seconds and include content that proves the video’s timeliness and authenticity, such as the time the video was shot and a photo that contains both the robot and the pilot.

- The video should be shot in advance. The competition venue will not provide a dedicated space for video shooting.

S71 The building parameters for Aerial Robots are as follows:

Table 2-7 Aerial Building Parameters

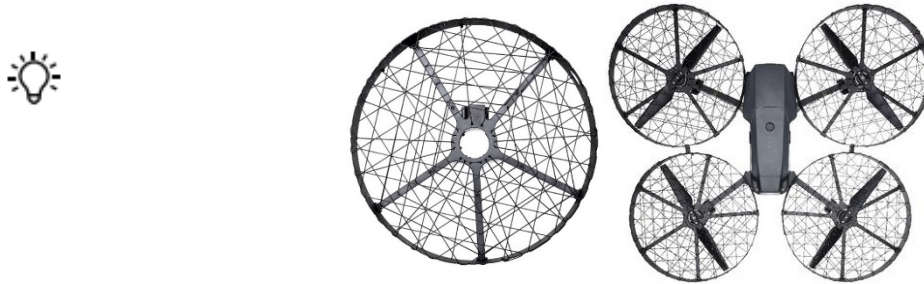
Item	Limit	Remarks
Operating Mode	There are no restrictions. Two remote controls and one Custom Controller can be configured at most.	-
Maximum Power Supply Capacity (Wh)	800	-
Maximum Power Supply Voltage (V)	52	-
Launching Mechanism	One 17 mm Launching Mechanism	-
Maximum Weight (kg)	15	Including battery weight, but not the weight of the Referee System.
Maximum Expansion Size (mm, L*W*H)	1700*1700*800	In any case, the orthographic projection of the robot on the ground does not exceed a 1,700*1,700 square and the highest point of the robot is not more than 800 from the ground (the dimension of the vertical rigid safety rod not included).
Referee System	<ul style="list-style-type: none"> ● Video Transmitter Module (Transmitter) ● Positioning System Module 	Weight: 0.84 kg

Item	Limit	Remarks
	<ul style="list-style-type: none"> ● Main Controller Module ● Power Management Module ● Speed Monitor Module (17 mm Projectile)	

The following requirements must be adhered to when building an Aerial:

S72 An Aerial must be mounted with a fully covered propeller guard, where the propellers must not be exposed. The Aerial should be able to strike a rigid surface at a horizontal speed of (1.2 ± 0.1) m/s without suffering significant damage.

- Fully covered propeller guard: A structure that fully protects each propeller.
- DJI Mavic Pro Propeller Guard is displayed as below for reference:



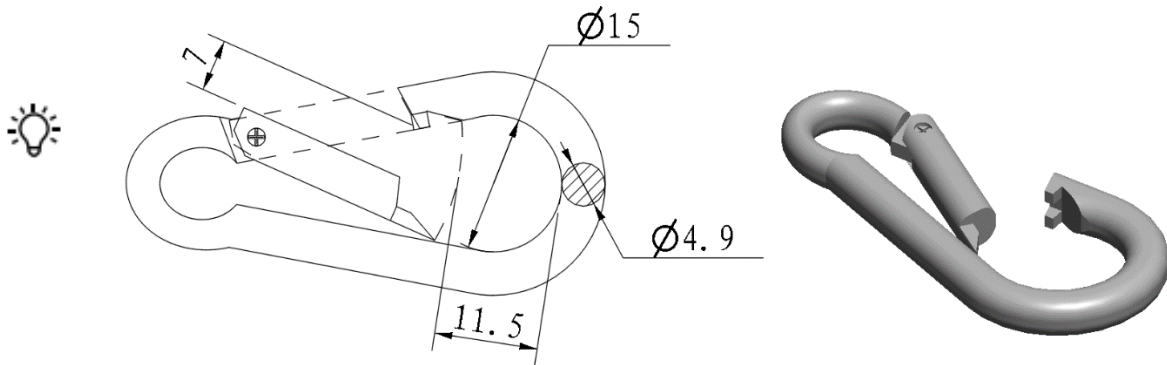
S73 While the fully enclosed propeller guard is being shot by a 42 mm projectile at the speed of 12 m/s from a distance of 2 meters, no part of the propeller cage is allowed to transform and touch the propeller nor interfere with its normal spinning. The 42 mm projectile must not penetrate the mesh of the propeller cage from any angle, which should not have a surface area bigger than 9 cm².

S74 If an Aerial crashes into a tall cylindrical object of any diameter from any angle and at a certain horizontal speed, its propeller guard should protect its propellers from making direct contact with the cylindrical object, and should not suffer any significant deformation.

S75 Cables, slip rings and retractable Aerial Safety Ropes are in place above the Battlefield to ensure the flying safety of Aerial. The top of an Aerial must be mounted with a vertical rigid safety rod that is 350±5 mm higher than the surface on which the robot propeller blades' center of gravity is located (for coaxial robot models, the surface on which the center of gravity of the upper propeller blades is located shall be the reference point). The bottom end of the vertical rigid safety rod must be joined with the Aerial, and its top end must have a rigid ring to be hooked onto the Aerial Safety Rope. The vertical rigid safety rod and its top and bottom connection points are able to withstand the weight of the robot. During inspection, attach the robot to a pull string, raise it

vertically by 50 mm, and release it into free fall once – the robot should not suffer any significant deformation and damage.

Teams must ensure the rigid ring on the protective rod can be joined normally with the Aerial Safety Rope hook. The dimensions of the Aerial Safety Rope hook are as follows:



S76 Teams should reasonably evaluate and fully test whether the propulsion system and power supply system of Aerial can meet the requirements of loading and combat, to prevent safety incidents or accidents during the competition.

S77 Teams can mount light indicators on Aerials to indicate their current flight status. Light indicators should not be installed in more than six places. The max illuminance of each light at 100 mm away must not exceed 3,500 Lux. Light indicators shall not disturb the match on the Battlefield (for example, installing high-power LED lights that beam directly into the Battlefield, etc.).



Reference data: The maximum illuminance of the flight status indicators on a DJI Matrice 100 Drone is 3200 Lux at a distance of 100 mm.

S78 Teams are required to design and mount their own external navigation lights on their Aerial to enhance its visual recognition. External navigation lights must ensure the projection planes on the front and back, left and right, and top of an Aerial can be effectively monitored. The specific requirements are as follows:

- a) The distance between the external navigation lights and the center of an Aerial must exceed 1/3 of the radius of the maximum top view field of the robot.
- b) External navigation lights must use Light Indicators and be joined with the Aerial securely, but cannot be mounted on propeller blades. The Light Indicators must be at least 180 mm in total length, and must appear aesthetic, symmetrical and not create any parallel light rays.
- c) External navigation lights must be mounted facing up or on the side, and must not be mounted facing down. The external navigation lights of Aerial should be able to switch to red and blue, so as to be

consistent with the team color during a match. For instance, the external navigation lights on a Matrice 600 should have an effective illumination area shown as the red grid below.

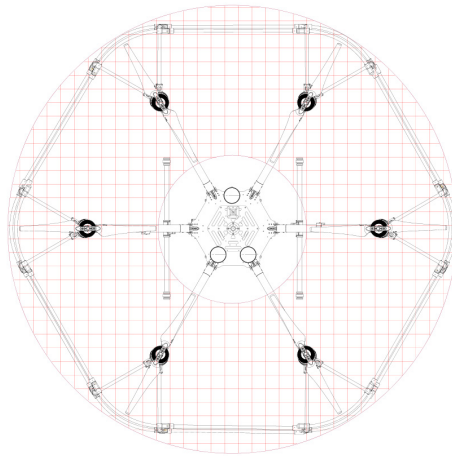


Figure 2-2 Effective Area for External Navigation Light

S79 A single area of external navigation light of Aerial must have an illuminance at 100 mm away ranging between 500 - 2,000 Lux.

S80 The batteries and battery frame on Aerial must be fixed in position using a mechanical structure. After being fixed in place, batteries should not wobble.

S81 Aerial should have a corresponding structure to keep projectiles secure in the magazine. Projectiles should not be allowed to fall out of the magazine in flight.

S82 The remote controller used by an Aerial must have an emergency cut-off function, to ensure the Aerial Robot is able to stop its propellers instantly through the Remote Controller in an emergency.

2.3.5 Sentry Robot

S83 In RMUC, a Sentry Robot must have the functions for horizontal movement and launching 17 mm projectiles. In RMUL, a Sentry Robot must have the functions for horizontal movement.

S84 The building parameters for Sentry are as follows:

Table 2-8 Sentry Building Parameters

Item	Limit	Remarks
Operating Mode	Fully automatic, with no more than one remote controller for debugging	-

Item	Limit	Remarks
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage (V)	30	-
Launching Mechanism	Maximum two Fixed 17 mm Launching Mechanisms	Two Speed Monitor Modules (17 mm projectile) must be installed.
Maximum Weight (kg)	25	Including battery weight, but not the weight of the Referee System.
Maximum Initial Size (mm, L*W*H)	700 x 700 x 700	There is a state where the orthographic projection of the robot on the ground does not exceed a 700*700 square and the highest point of the robot is not more than 700 from the ground.
Maximum Expansion Size (mm, L*W*H)	800*800*800	In any case, the orthographic projection of the robot on the ground does not exceed an 800*800 square and the highest point of the robot is not more than 800 from the ground.
Referee System	<ul style="list-style-type: none"> ● Small Armor Module ● Speed Monitor Module (17 mm Projectile) ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module ● Light Indicator Module 	Weight: 3.47 kg

Item	Limit	Remarks
	<ul style="list-style-type: none"> ● 17 mm Fluorescent Projectile Energy-Charging Device ● Supercapacitor Management Module ● Video Transmitter Module (Transmitter) 	

2.3.6 Dart System

Dart System consists of Dart and Dart Launcher. A Dart Launcher is the carrier of Darts and provides them with initial propulsion.

S85 A Dart Launcher must have the functions for loading darts and launching them for more than 5 m. A Dart Trigger must be mounted on the dart. Participating teams are required to provide a video of the dart launching system firing darts over 5 m at the Pre-Match Inspection.

S86 A Dart uses its own vision system to locate a Dart Detection Module, and controls its flight direction using a propeller (maximum one allowed to be used), rudders, air jets and other means, to strike and attack the Dart Detection Module. The thrust-to-weight ratio of the Dart must be lower than one.

S87 Dart Trigger has built-in red-blue bicolor LED light beads, which will be set as the corresponding color according to the team during the match. The colors of all Darts taken into the Competition Area must be set by staff at the Inspection Area.

- A Dart will land in the Battlefield after it is launched and may collide with or be crushed by other robots. In addition, a Dart will receive a rather large impact when it hits a subject. It is recommended that teams incorporate buffer and strength designs to avoid damage to their Darts.
- A Dart Trigger will enter normal work mode after being powered on for 3 seconds or going through Pre-Match Inspection setup. A Dart Trigger will emit a light of the corresponding team's color after being subject to an acceleration of 2 g. Each trigger lasts five seconds, at the end of which the light will turn off. If the acceleration of 2 g occurs again during the trigger period, the trigger time will be refreshed.
- If the Dart Trigger experiences irregularities such as red-and-blue alternate lights and faulty light beads, it means the trigger device is damaged and the Base and Outpost may not be able to detect dart hits. Please replace with a backup Dart Trigger, otherwise all resulting losses shall be borne by the team.
- The use of compressed air is prohibited in propelling a Dart.

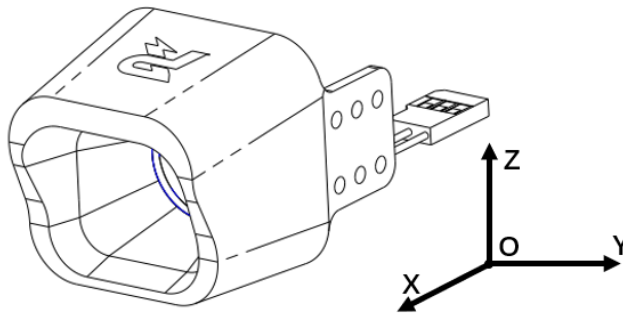


S88 The building parameters for a Dart is as follows:

Table 2-9 Dart Building Parameters

Item	Limit	Remarks
Maximum Power Supply Capacity (Wh)	4	-
Maximum Power Supply Voltage (V)	8.4	-
Maximum Weight (kg)	0.35	Not including the Dart Trigger (0.02 kg)
Maximum Expansion Size (mm, L*W*H)	250*250*150	<ul style="list-style-type: none"> The flight length of a Dart is no longer than 250 The wingspan of a dart is not greater than 250
Referee System	Dart Trigger	Weight: 0.02 kg

The forward direction of the Dart Trigger is the Dart flight direction, and the y and z directions in the figure represent the wingspan and height of the Dart, respectively.



S89 Dart can only be in the ready-to-launch state during the Seven-Minute Round.



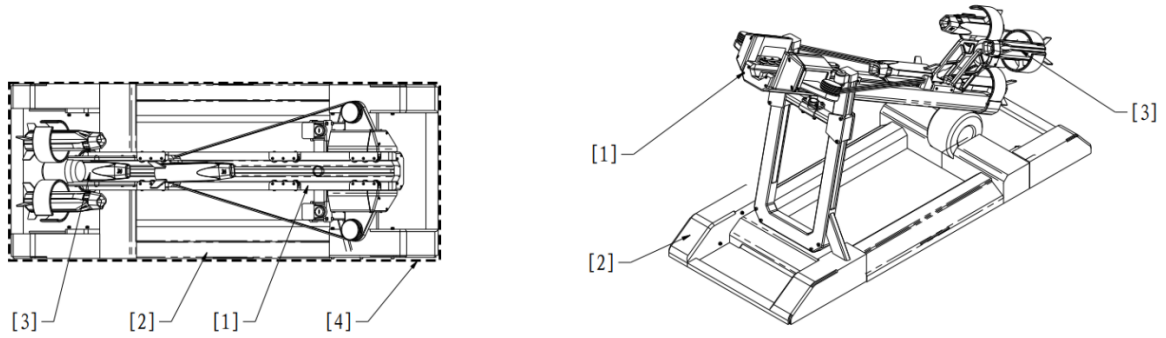
Ready-to-Launch State: The energy storage component used for providing initial kinetic energy for Darts is in a tense, inflated, and rotating state. Energy storage component includes but is not limited to rubber band, cylinder, friction wheel, etc.

S90 The building parameters for Dart Launcher are as follows:

Table 2-10 Dart Launcher Building Parameters

Item	Limit	Remarks
Operating Mode	No restrictions, configure up to 1 remote controller	Use of the Referee System Serial Port is recommended.
Rotation Angle (°)	<ul style="list-style-type: none"> ● Yaw angle: No restrictions ● Pitch angle: 25-45 	-
Maximum Total Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage (V)	30	-
Maximum Operating Power (W)	No restrictions	-
Maximum Dart Load	4	-
Maximum Weight (kg)	25	Including battery weight, but not the weight of the Referee System.
Maximum Expansion Size (mm, L*W*H)	1000*600*1000	<ul style="list-style-type: none"> ● The Maximum Expansion Size should be the size of the Dart Launcher after being loaded with four Darts. ● In any case, the orthographic projection of the Dart System on the ground does not exceed a 1,000*600 square and the highest point of the dart system is not more than 1,000 from the ground. ● The orthographic projection of the Dart Launcher and the Darts to be launched on the ground must not extend beyond the outermost edge of the contact area between the Dart System and the plane on which the Dart System is placed at any given time, as shown in “Figure 2-3 Dart System Size Limit”.

Item	Limit	Remarks
Referee System	Main Controller Module and Power Management Module	Weight: 0.22 kg



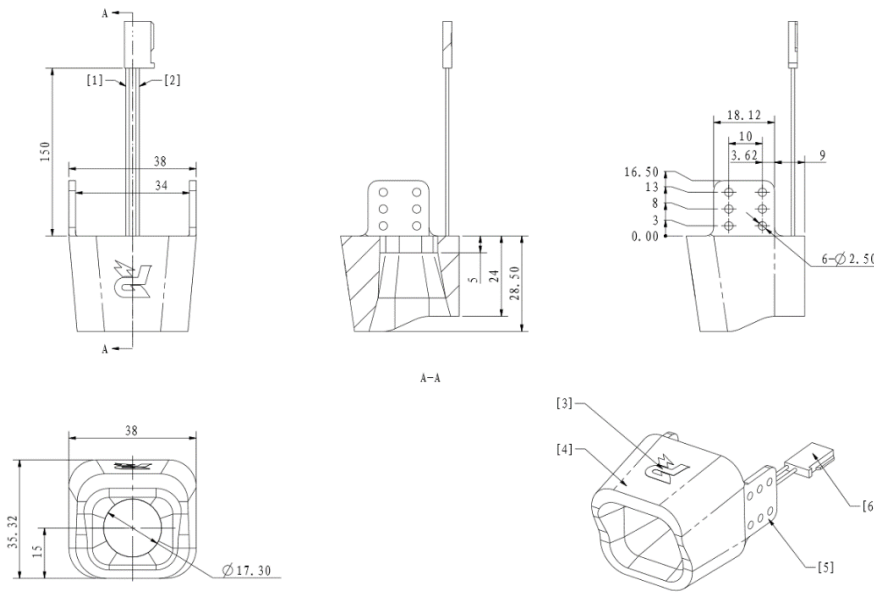
- [1] Dart Launcher
- [2] Dart System Bottom
- [3] Dart Body
- [4] Outermost Edge of the Contact Area

Figure 2-3 Dart System Size Limit

2.3.6.1 Mounting Specifications

Dart must be mounted with Dart Trigger provided by the RMOC. A Dart Trigger is a cream-white translucent shell made of TPU, with a mass of 20 g. Its external form and dimensions are shown below.

Drill in mounting holes on the Dart head according to the size of Dart Trigger.



- [1] GND Cable [2] +5 V Cable [3] Logo
- [4] Dart Trigger [5] Installation Lug [6] 3P 2.54 mm cable

Figure 2-4 Dart Trigger

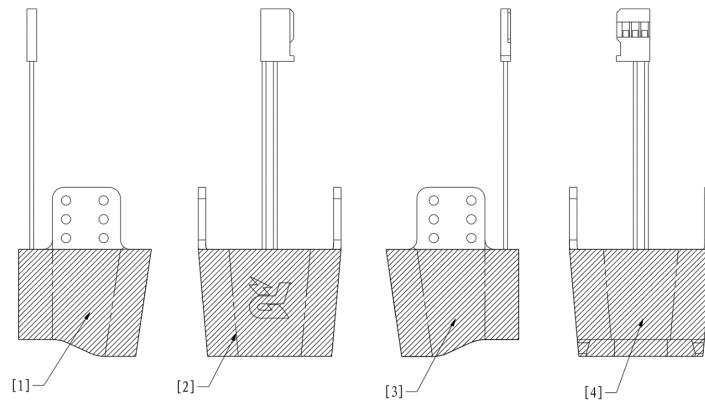
2.3.6.1.1 Installation Steps

1. Secure the Dart Trigger on the Dart head position using at least four M2.5 screws (two for each installation lug). Gaskets should be used when mounting screws.
2. Connect the power port of Dart Trigger with 5 V power supply.

2.3.6.1.2 Installation Requirements

S91 The Dart Trigger will be dimmed when the battery voltage is low, and the participating teams need to ensure that the battery voltage used for the darts during the competition is at least 4 V. If the actual operating voltage of the Dart Trigger is lower than 4 V, the Base and Outpost may not be able to detect dart hits.

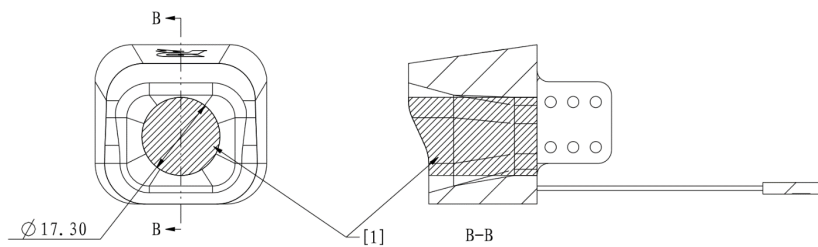
S92 After mounting Dart Trigger, its up and down, left and right sides must not be blocked by the Dart structure, as shown below.



[1] Left side [2] Upward side [3] Right side [4] Downward side

Figure 2-5 Areas Not Allowed to Be Blocked on a Dart Trigger

S93 Dart camera or other devices can be mounted in the internal cavity of Dart Trigger. The mounting area must not exceed the shadow area as shown below.



[1] Shadow Area

Figure 2-6 Internal Cavity of a Dart Trigger

2.3.6.2 Guidance Feature

Guidance feature, which is used to assist the Dart System to aim, is the green LED integrated light beads mounted on the Dart Detection Module. Please refer to the relevant descriptions of Outpost and Base in the [RoboMaster 2024 University Championship Rules Manual](#).

2.3.6.3 Dart Launching Station

A Dart Launching Station is considered an official Battlefield component. The gate of a Dart Launching Station can be in either the open or closed status. The Dart Launcher is set within the Dart Launching Station. For details, please refer to the relevant descriptions of the Dart Launching Station in the [RoboMaster 2024 University Championship Rules Manual](#).

2.3.7 Radar

S94 A Radar consists of the computing platform and the sensor. Both ends need to be connected by an electric cable. A Radar must include a computing platform and sensor, and be able to display commissioning images.

S95 The building parameters for a Radar Computing Platform are as follows:

Table 2-11 Radar Computing Platform Building Parameters

Item	Limit	Remarks
Operating Mode	Fully automatic, with no more than one remote controller for debugging	-
Maximum Power (W)	750	If overpower occurs during the use of the Radar in a round, the mains supply to the Radar Computing Platform will be cut off, and all consequences arising therefrom will be borne by the participating teams.
Power Supply Voltage (V)	220	These are based on the electrical power standards in Mainland China. Users in other countries or regions may refer to their local electrical power standards. Other universal power standards can also be applied.
Power Supply Frequency (Hz)	50	These are based on the electrical power standards in Mainland China. Users in other countries or regions may refer to their local electrical power standards.
Maximum Expansion Size (mm, L*W*H)	600*350*600	In any case, the orthographic projection of the Radar Computing Platform on the ground does not exceed a 600*350 square and the highest point of the Radar Computing Platform is not more than 600 from the ground.
Referee System	<ul style="list-style-type: none"> Main Controller Module 	Weight: 0.22 kg

Item	Limit	Remarks
	<ul style="list-style-type: none"> Power Management Module 	

S96 The parameters for a Radar Sensor are as follows:

Table 2-12 Radar Sensor Parameters

Item	Limit	Remarks
Maximum Weight (kg)	30	-
Maximum Expansion Size (mm, L*W*H)	1200*1200*1500	<ul style="list-style-type: none"> In any case, the orthographic projection of the Radar Sensor on the ground does not exceed a 1,200*1,200 square and the highest point of the Radar Sensor is not more than 1,500 from the ground. The recommended height for the mounting bracket of Radar sensor is at least 1.2 m.

2.3.7.1 Mounting Specifications



- The surface of the Radar Foundation is made of iron. Teams are advised to use magnetic materials to fix the Radar sensor mounting bracket on the installation surface of the Radar Foundation.
- The Radar Sensor is relatively far away from the installation position of the Radar Computing Platform. Teams are advised to prepare connecting cables with an effective length of at least 3 m.

2.3.7.2 Computing Platform

During the Three-Minute Setup Period, teams shall place their computing platforms on a designated surface near the Radar Foundation. The surface should provide at least two 10 A five-hole power outlets supplying utility power, a video signal transmission cable for connecting the official display devices (with an HDMI Type A plug), and an official display device. A monitor not larger than 23 inches and some input devices such as a mouse and keyboard for the computing platform can also be placed on the surface.

S97 The Referee System of a Radar can only be mounted on the Computing Platform.

S98 No wireless devices shall be installed or used on the computing platform. If the wireless device cannot be removed, it needs to be set to disabled in the operating system.

S99 The Main Controller Module and Power Management Module must conform to the module installation standards and be firmly installed on the Radar Computing Platform. The referee system and the computing platform can share the same power supply or use the batteries designated by the RMOC for this season.



- The alternating current provided by the organizer is 220 V 50 Hz, and the power outlets are based on Chinese national standards. Teams shall prepare their own power supply adapters as needed.
 - The RMOC only ensures the normal operation of the official display device on the Radar Foundation and the HDMI cable provided by the RMOC. Teams must resolve connection issues on their own.
-

2.3.7.3 Sensor



Teams need to install their own protective guards on their equipment, to prevent damage caused by projectile impact during the competition.

S100 Sensors must be fixed on the Radar sensor mounting bracket and placed on the Radar Foundation.

S101 Teams must design their own Radar sensor mounting bracket to increase the elevation for the installation of sensors.

S102 The size of the Radar sensor mounting bracket should allow for proper installation on the surface of the Radar Foundation and be able to be lifted with one arm. The specifications of the Radar foundation should follow the relevant descriptions of the Radar Foundation in the [RoboMaster 2024 University Championship Rules Manual](#). The signal transmission and power supply of the sensor must be handled by the participating teams themselves.


3. Referee System Mounting Specifications

Users are advised to read the manuals for the various Referee System modules to learn about their respective functions and how to install them. After installing the Referee System modules, refer to the Referee System User Manual to understand its overall functions. The document can be downloaded at this link:

<https://www.robomaster.com/en-US/products/components/referee>

3.1 Overview

The robots designed by each team must have reserved mechanical and electrical ports, and each Module of the Referee System must be correctly mounted according to the specifications stated in this chapter.

- The RMOC provides Referee Systems for loan. Teams will obtain permissions to borrow the Referee System through passing technical assessments. See the “Season Schedule” in the [Participant Manual](#) for details.
 -  Chassis Power: The power propulsion system that enables a robot to conduct translational and rotational motion in the horizontal direction, not including the power used for special tasks (e.g. power consumption for functional movements such as moving the upper mechanical structure, climbing steps or overcoming obstacles). Therefore, the power generated by the power supply used by the power system actuator for mechanical structures related to chassis horizontal movements counts as chassis power. For example, the motors, steering gears, electromagnetic switches and other components for regulating the direction of chassis motors or other energy storage mechanical structures (including but not limited to springs, pneumatic systems, rubber bands, and tension springs).
 - Any equipment used by the participating teams must not interfere with the normal operation of the Referee System. If interference exists, the participating teams must cooperate with the committee to deal with the source of interference until no more interference is generated.
-

A Referee System consists of the following modules:

Table 3-1 Referee System Component Modules

Module	Introduction
Main Controller Module	A Main Controller Module is the core control module of a Referee System. It can monitor the operation of the entire system, and integrates functions such as human-machine interaction, wireless communication and status display.
Power Management Module	A Power Management Module has such functions: controlling the chassis, gimbal, and power supply for the Launching Mechanism of a robot; transmitting data; detecting chassis power; etc.
Light Indicator Module	A Light Indicator Module indicates statuses such as the red/blue side of robot, robot HP, buff, module going offline through the LED Light Indicator.
Armor Module	An Armor Module is used to detect situation where the robot is hit by projectiles. There are Small Armor Modules and Large Armor Modules.
Speed Monitor Module	A Speed Monitor Module is used to detect the Initial Projectile Speed and Barrel Heat of robots. They are divided into Speed Monitor Module (17 mm projectile) and Speed Monitor Module (42 mm projectile).
RFID Interaction Module	An RFID Interaction Module can exchange information with RFID Interaction Module Card in the Battlefield or on robots, to perform corresponding functions.
Video Transmitter Module	A Video Transmitter Module consists of a Transmitter and a Receiver. The Transmitter is mounted on the robot while the receiver is mounted on the client in the Operator Room. Its function is to capture the view in front of the robot through the camera, and transmit the first-person view image back to the display in the Operator Room.
Positioning System Module	A Positioning System Module can detect a robot’s location on the Battlefield.

Module	Introduction
Supercapacitor Management Module	The Supercapacitor Management Module is used to test the capacitance of the Supercapacitor Module and the energy of the Supercapacitor Module during the competition.
Dart Trigger	The Dart Trigger is mounted on the Dart and used by the Referee System to detect whether the Dart hits the target.

3.2 Configuration of Robot Referee System

The configuration of Referee System Modules for each robot is as follows:

Table 3-2 Robot Referee System Module Configuration

Robot Type / Quantity	Hero Robot	Engineer Robot	Standard Robot	Balancing Standard Robots	Aerial Robot	Sentry Robot	Dart System	Radar
Main Controller Module	1	1	1	1	1	1	1	1
Power Management Module	1	1	1	1	1	1	1	1
Light Indicator Module	1	1	1	1	0	1	0	0
Large Armor Module	4	0	0	2	0	0	0	0
Small Armor Module	0	4	4	0	0	4	0	0
Video Transmission Module	1	1	1	1	1	1	0	0

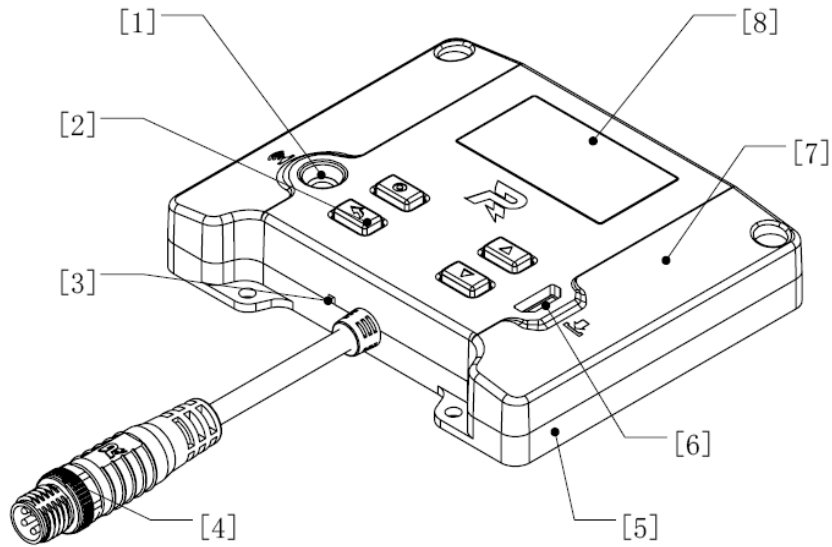
Quantity \ Robot Type	Hero Robot	Engineer Robot	Standard Robot	Balancing Standard Robots	Aerial Robot	Sentry Robot	Dart System	Radar
(Transmitter)								
RFID Interaction Module	1	1	1	1	0	1	0	0
Speed Monitoring (17 mm) Module	0	0	1	1	1	2	0	0
Speed Monitor Module (42 mm) Module	1	0	0	0	0	0	0	0
Positioning System Module	1	1	1	1	1	1	0	0
Supercapacitor Management Module	1	0	1	1	0	1	0	0
Dart Trigger	0	0	0	0	0	0	4	0



Positioning system modules do not have to be mounted on robots in RUML.

3.3 Mounting Specifications for Main Controller Module

Drill in mounting holes on specified positions on the robot according to the size of the Main Controller Module.



- | | | | |
|------------------------|-----------------------|-----------------------|--|
| [1] IR receiver | [2] Button | [3] Power indicator | [4] Aviation connector with black metal ring |
| [5] Metal bottom cover | [6] Upgrade interface | [7] Plastic top cover | [8] Screen |

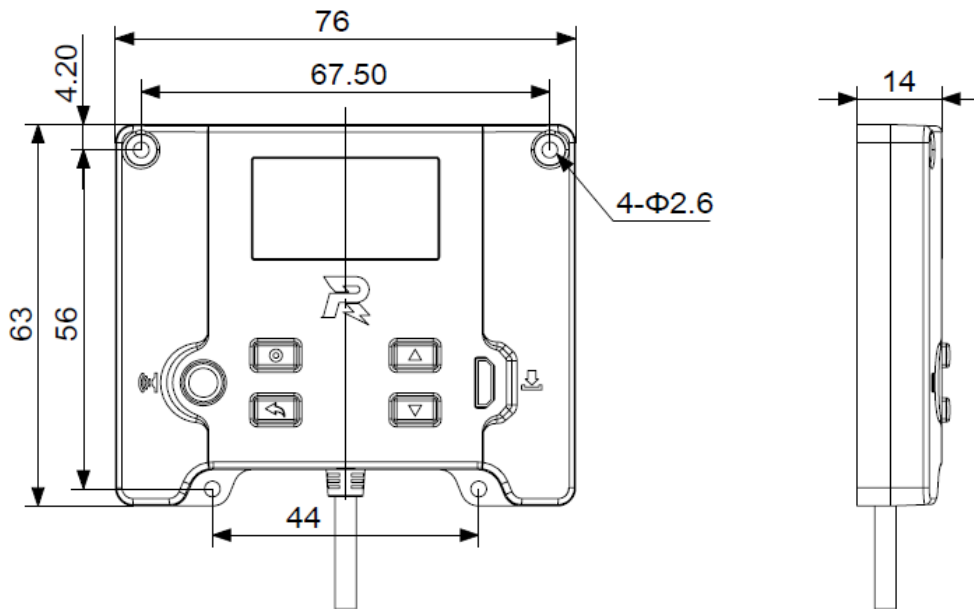


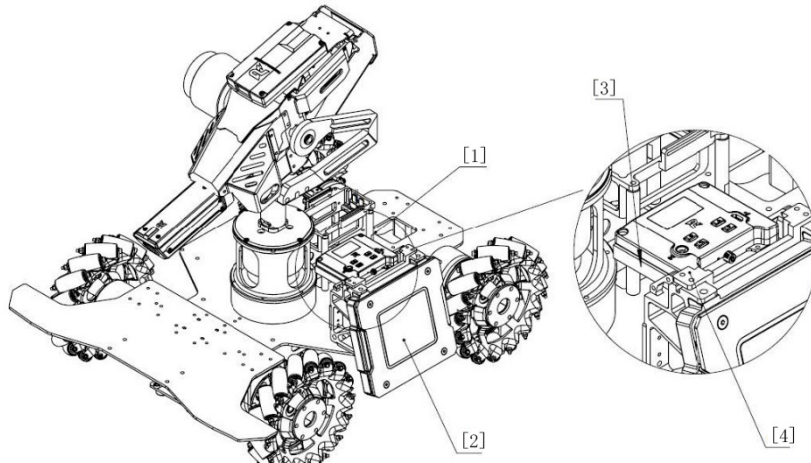
Figure 3-1 Main Controller Module

3.3.1 Installation Steps

1. Secure the Main Controller Module on the specified position on the robot using four M2.5 screws.



Mounting reference: Teams may design parts by themselves and install them on the back of the upper edge of the Armor Module (the reserved M3 threaded hole on the armor support frame can be used), with non-metal guards installed around them to prevent projectile hits.



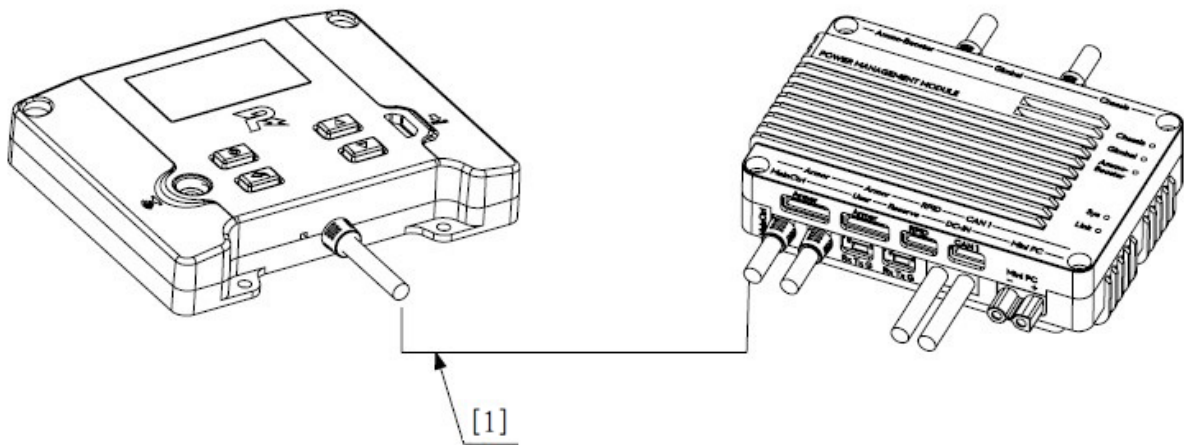
- | | | | | | | | |
|-----|------------------------|-----|--------------|-----|--------------------------------|-----|--------------------|
| [1] | Main controller module | [2] | Armor module | [3] | Self-designed protective guard | [4] | Self-designed part |
|-----|------------------------|-----|--------------|-----|--------------------------------|-----|--------------------|

Figure 3-2 Mounting Main Controller Module

2. Use the aviation cable inside the package to connect the Main Controller Module to the aviation connector port with the black metal ring on the Power Management Module.



When the Main Controller Module connects with the Power Management Module, between them, there should be no other Referee System modules serially connected.



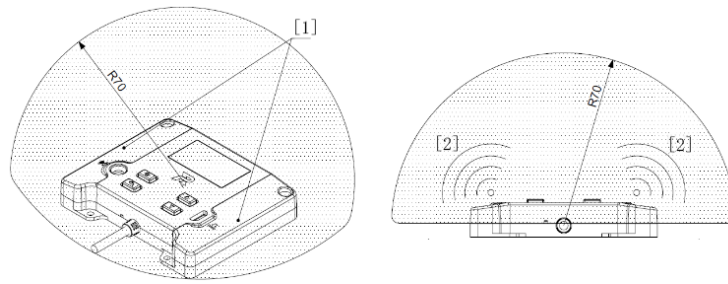
[1] Aviation cable

Figure 3-3 Main Controller Module Connection

3.3.2 Installation Requirements

The mounting of a Main Controller Module must meet the following requirements:

- S103 Ensure the top surface of the Main Controller Module of a robot faces up horizontally when it is in working condition.
- S104 The space above the main controller module screen, keys, ports, and infrared receiver must not be obstructed. When designing a protective device, only transparent materials that are easy to open can be used. If it cannot be opened, the screen, keys, ports, and infrared receiver need to be fully exposed for easy operation by staff.
- S105 No electromagnetic shielding material (including but not limited to metals, carbon fiber, conductive rubber, wave-absorbing materials, and conductive complexing agents) or other equipment carrying electromagnetic interference should be placed within a 70 mm radius to avoid interfering with the WiFi signal, with the center being 14.5 mm directly below the center point of the logo.



[1] Antenna position [2] Signal direction

Figure 3-4 Mounting Position of the Main Controller Module

S106 During the official competition, the Dart System and Radar must connect to the Power Management Module and Main Controller Module in the manner specified by the RMOC.

For Radar:

The Battlefield provides the Radar with wired connection to the Battlefield network and servers. The Radar Computing Platform is provided with a wired access point, where there is a 100 mm aviation cable with a plug on one end. Pit Crew must connect the main controller in the Power Management Module on the Radar Computing Platform to the wired access point through the official aviation cable.

To connect the Radar efficiently, please follow the requirements below:

- During the competition, the Radar does not need to carry the main controller. Please remove the main controller for debugging from the robot before the Pre-Match Inspection.
- The Power Management Module of the Radar must be exposed and placed where it is easy for the staff to operate.
- The main controller on the Radar Power Management Module must be connected to one end of an official aviation cable, and the other end of the cable cannot be connected to any device. This aviation cable must be straightened without getting intertwined. It should be easy to pull out and connect to the wired access point.

For Dart System:

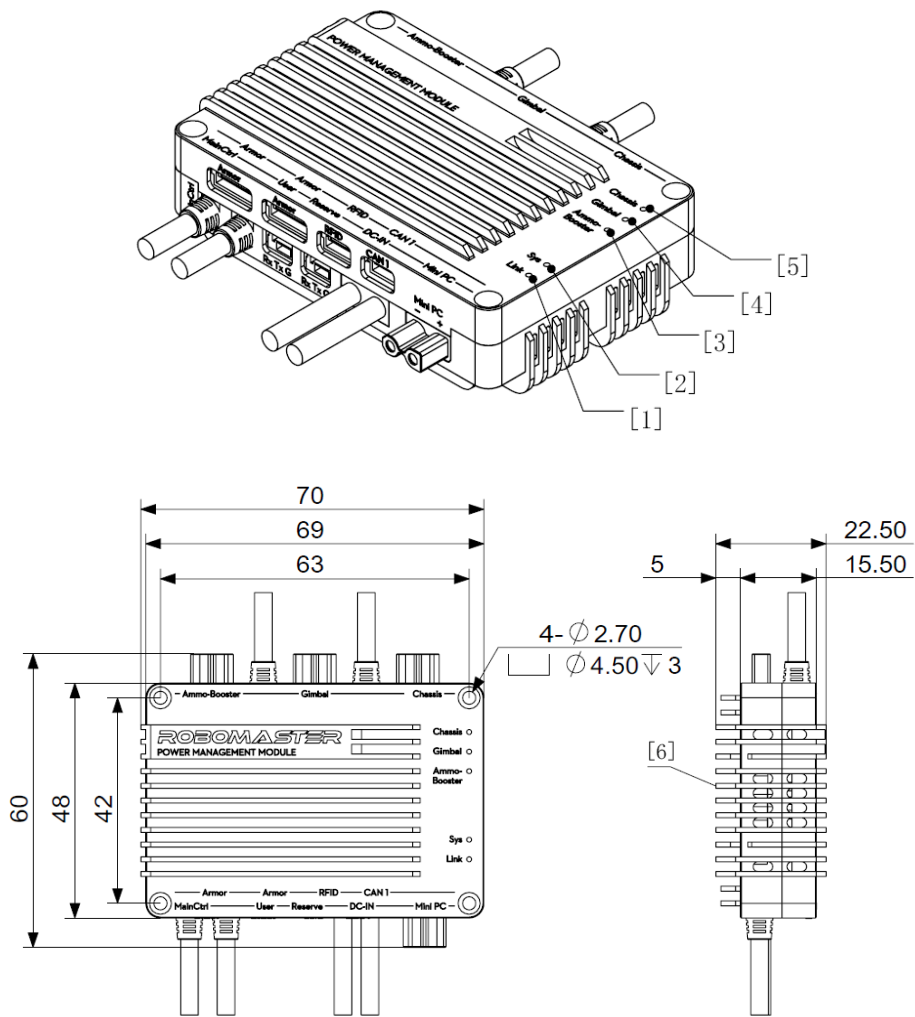
The Battlefield provides Radar with both wireless and wired connection to the competition network and servers. During the competition, RMOC will specify the connection method based on the wireless interference conditions on the Battlefield via the pre-match captains meeting and announcement. When using the wired connection, participating teams must connect the main controller in the Power Management Module on the Dart System to the wired access point through the official aviation cable.

To connect the Dart System efficiently, please follow the requirements below:

- The aviation cable connecting the Power Management Module and the main controller can be easily unplugged and plugged in without using any tools.
- The Power Management Module of the Dart System must be exposed and placed where it is easy for the staff to operate.
- The Main Controller Module of the Dart System must be placed on the left of the dart launching direction, and it should not be more than 300 mm from the lowest point of the robot when measured vertically. The upward projection of the main controller should not be shielded. The staff who stands 2 m in front of the Dart Launching Station with a sight height of 1.7 m should be able to see the entire front panel of the main controller.

3.4 Mounting Specifications for Power Management Module

Drill in mounting holes on specified positions according to the size of the Power Management Module.



- [1] Connection Status Indicator
- [2] System Status Indicator
- [3] Launching Mechanism Power Output Indicator
- [4] Gimbal Power Output Indicator
- [5] Chassis Power Output Indicator
- [6] Bottom Mounting Surface

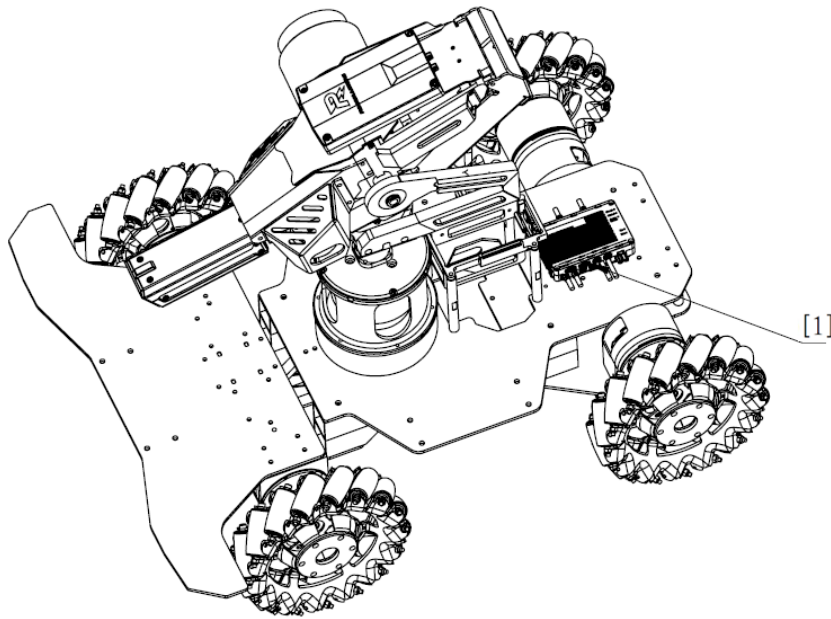
Figure 3-5 Power Management Module

3.4.1 Installation Steps



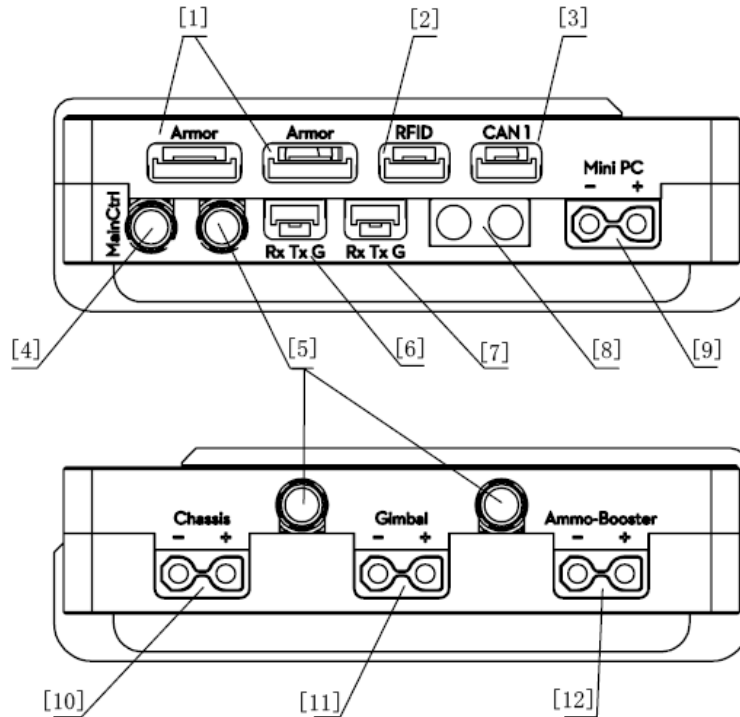
The aviation connector port of the Light Indicator Module, Video Transmitter Module (Transmitter), Speed Monitor Module and Positioning System Module are all equivalent ports and can be serially connected to each other.

Secure the Power Management Module on the robot using four M2.5 screws.



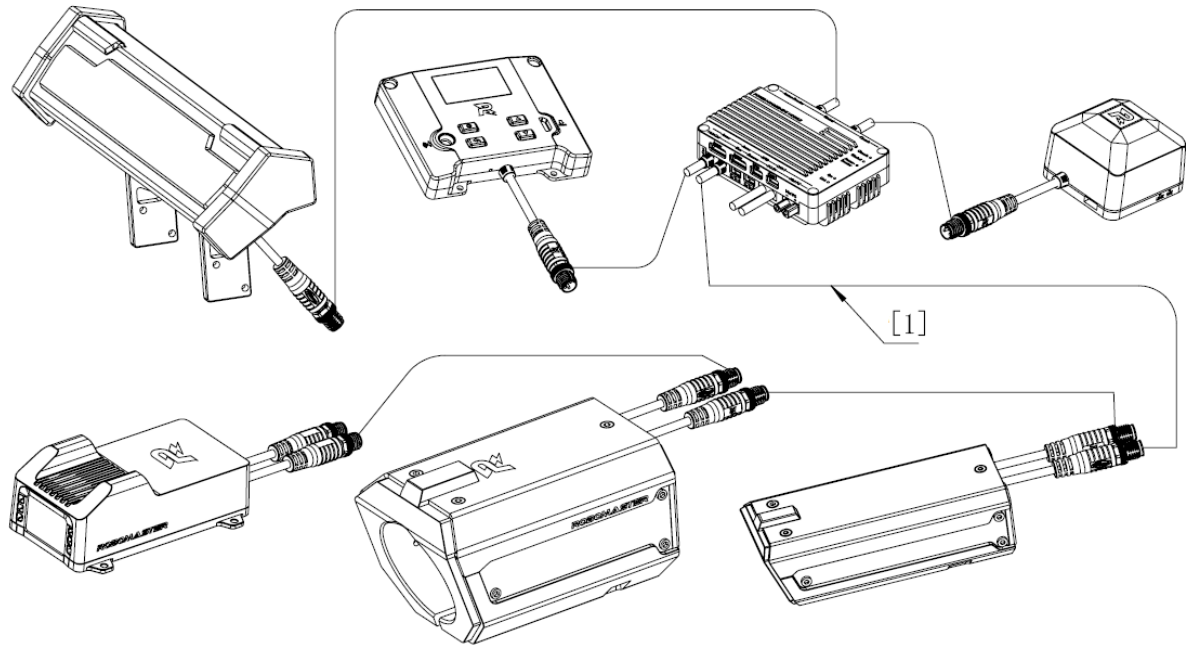
[1] Power Management Module

Figure 3-6 Mounting Power Management Module



- [1] Armor Module SM06B-GHS-TB Port
- [2] RFID Interaction Module SM04B-GHS-TB Port
- [3] Capacitor Management Module SM04B-GHS-TB Port
- [4] Main Controller Module Port (the metal ring of the aviation connector port is black)
- [5] Ports of other Referee System Modules (Speed Monitor, Positioning System, Video Transmitter, and Light Indicator; the metal ring of the aviation connector port is silver in color)
- [6] Referee System Serial Port SM03B-GHS-TB Port
- [7] System Level Up SM03B-GHS-TB Port
- [8] Referee System Power Supply XT60 Port (input)
- [9] Mini PC Power Supply XT30 Port (output)
- [10] Referee System Power Supply XT30 Port (output) - connecting to the chassis
- [11] Referee System Power Supply XT30 Port (output) - connecting to the gimbal
- [12] Referee System Power Supply XT30 Port (output) - connecting to the Launching Mechanism

Figure 3-7 Power Management Module Port



[1] Aviation cable

Figure 3-8 Power Management Module Connection

3.4.2 Installation Requirements

The mounting of a Power Management Module must meet the following requirements:

- S107 The status indicators of the Power Management Module are not blocked.
- S108 Each port on the Power Management Module is protected, to prevent projectile hits. However, the outer shell cannot be completely wrapped, so as to ensure good heat dissipation.
- S109 Do not use glue such as 3M tape to secure the Power Management Module.
- S110 For a robot with a chassis power limit, the electric power consumed by the chassis power mechanism must be taken into account to ensure it does not bypass the monitoring of the Power Management Module.
- S111 Participants must use the Main Controller Module installed by the RMOc on the site for their Dart Systems and Radars. As such, teams are required to meet the following requirements when designing their robots:
 - Expose the Power Management Module and Main Controller Module port when designing the Dart System and Radar.
 - Install the Power Management Module close to the portal of the Dart Launching Station when designing the Dart System.

S112 Carefully differentiate between the ports on the Power Management Module to ensure correct cabling.

Except for the chassis power supply for Standard, Sentry and Hero Robots, the other power supply interfaces of a robot may be connected to a battery to ensure a stable power supply for these interfaces (such as for the gimbal or 42 mm Launching Mechanism). The power may be controlled through a relay or other method, but its on-off control must be operated via the corresponding Power Management Module interface shown in the table below (the relay or other method must be powered through the corresponding interface; make sure the Referee System is able to turn on and off all power supply connected to the robot’s Referee System Power interface (output); any failure to do so will be considered as cheating).



- The Supercapacitor Module is not allowed to power the robot when the Chassis port of the chassis power supply is disconnected.
- If the Radar or Dart Launcher requires a 24 V power interface, it can be powered directly through the “Mini PC” interface of the Power Management Module or the battery.
- The symbol “-” in the table signifies a non-power supply interface.

Table 3-3 Power Management Module Port Instruction

Robot type/power supply	Chassis power supply	Gimbal power supply	17 mm Launching Mechanism power supply	42 mm Launching Mechanism power supply	Mini PC Power Supply
Hero Robot	Chassis	Gimbal	-	Ammo-Booster	Mini PC
Engineer Robot	Chassis	Chassis or Gimbal	-	-	Mini PC
Standard Robot	Chassis	Gimbal	Ammo-Booster	-	Mini PC
Aerial Robot	-	Gimbal	Ammo-Booster	-	Mini PC
Sentry Robot	Chassis	Gimbal	Ammo-Booster	-	Mini PC
Dart Launcher	-	-	-	-	-
Radar	-	-	-	-	-

S113 For a robot with a Launching Mechanism (except for the Dart System), when the Ammo-Booster port on the Power Management Module is powered off, the Launching Mechanism (such as the friction wheel motor, pan magazine motor, and electromagnetic valve) must also be powered off at the same time.

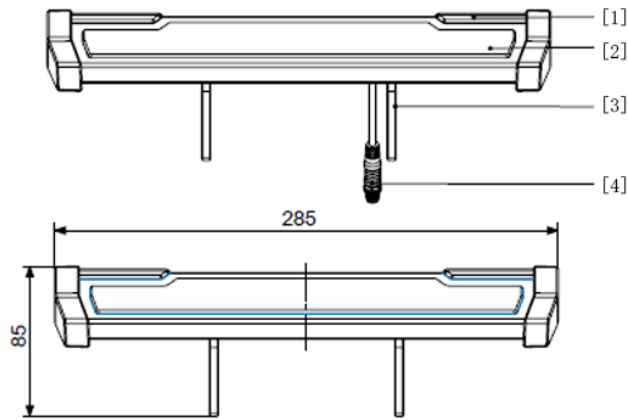
S114 The circuit board and circuit of a robot with a chassis power limit must meet the following requirements:

- The circuit board related to the chassis power supply must be independent of the gimbal and Launching Mechanism power supply. A circuit board powered through the “Chassis” port on the Power Management Module cannot be connected to other power ports on the Power Management Module.
- All chassis-related circuits of a robot must be clearly laid out. A referee may conduct random inspections on a robot after a match, and, where required, the team must cooperate in the random inspection and disassemble the relevant robot parts to show the relevant circuits. It is recommended that teams consider the random inspection requirements of referees when designing the layout of circuits, as any loss of preparation time due to disassembling of robots for circuit inspections will be borne by the team itself.
- A robot’s circuit connected to the “Chassis” port on the Power Management Module, i.e. a chassis-related circuit, and other circuits connected to other ports on the Power Management Module are connected using only cables with a diameter specification of 24 AWG or smaller, and can only be used for communication, with the total current flow equal to or smaller than 50 mA.



- Input voltage requirements for a Power Management Module: 22 V-26 V. Power output ports No. 10, 11 and 12 in the drawing can be connected and disconnected by the Referee System.
- For the payload threshold of single port on the Power Management Module, please refer to the [Power Management Module User Guide](#).
- Take care to protect the power output ports No. 9-12 on the Power Management Module, where frequent plugging and unplugging may cause the ports to loosen.
- The voltage on the power output ports No. 9-12 will fluctuate if the system load experiences large fluctuations. Teams are advised to take voltage-regulating measures for loads that are sensitive to voltage (such as Mini PC).
- The outer casing of the Power Management Module heats up under high power conditions. Do not touch it with your hands. Avoid installing the Power Management Module on non-heat resistant materials, such as 3D printing materials.

3.5 Mounting Specifications for Light Indicator Module

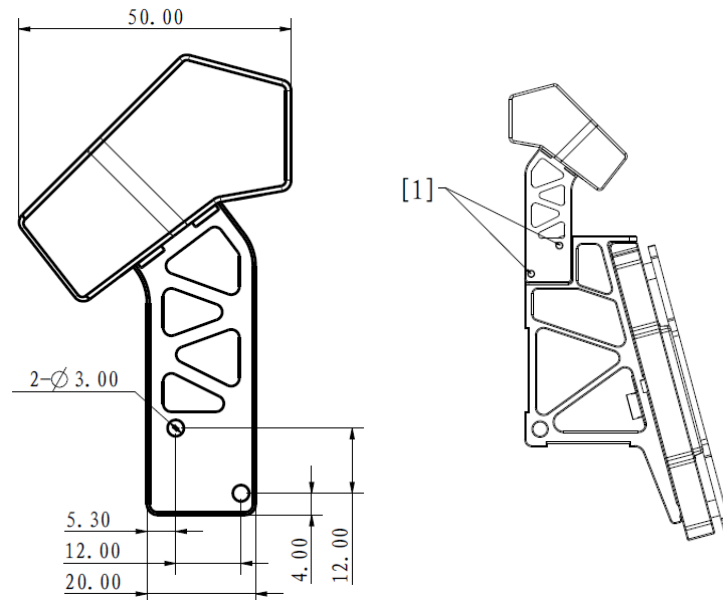


- [1] Auxiliary light indicator
- [2] Main light indicator
- [3] Mounting bracket
- [4] Aviation connector port

Figure 3-9 Light Indicator Module

3.5.1 Installation Steps

1. A Light Indicator Module can be mounted on an Armor Module and secured to the armor support frame using ten M3 screws.



[1] Screw Hole Mounting Position

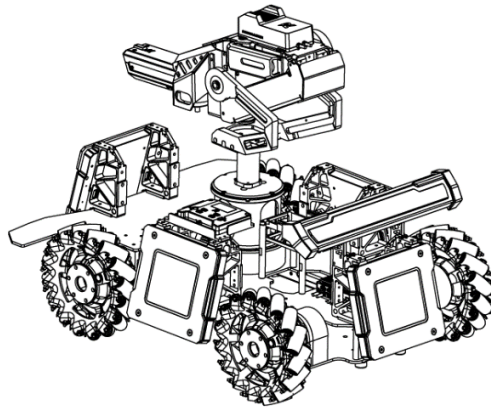


Figure 3-10 Mounting Light Indicator Module

- Optional Mounting: The Light Indicator Module can be secured using the bottom screw hole of the mounting bracket and installed on a suitable position on the robot.

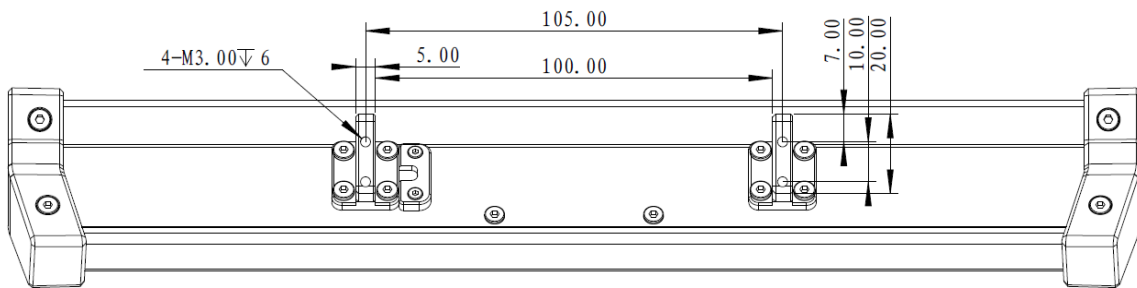
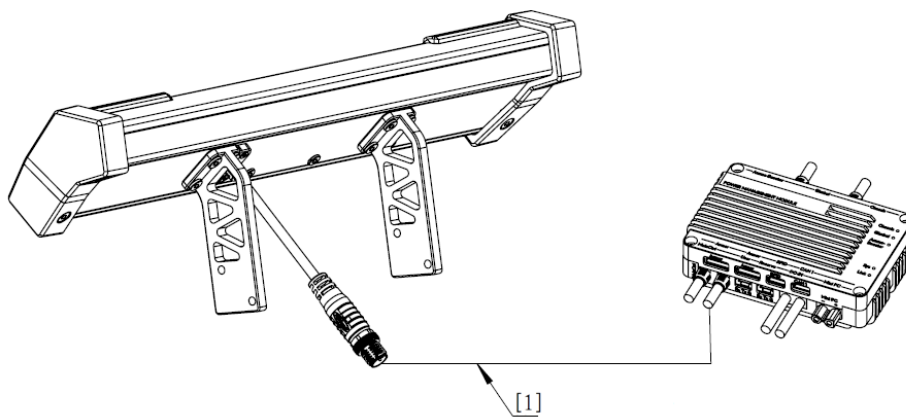


Figure 3-11 Bottom of Light Indicator Module

- Use the aviation cable inside the package to connect the Light Indicator Module to the aviation connector port with the white metal ring on the Power Management Module.



[1] Aviation cable

Figure 3-12 Light Indicator Module Connection

3.5.2 Installation Requirements

The Mounting of a Light Indicator Module must meet the following requirements:

- S115 The connection cables of the left and right auxiliary Light Indicators are parallel to the ground.
- S116 The main and auxiliary Light Indicators should be fully visible from at least one horizontal viewing angle.
- S117 Except for Sentry and Engineer Robots, the Light Indicator Module must be installed firmly on the robot chassis mechanism.
- S118 When mounting Light Indicator Modules on a Ground Robot, the illuminant part must be at least 200 mm from the ground.
- S119 When mounting Light Indicator Modules on a Sentry, the modules are always situated at the highest point of the robot (except for the Positioning System Module and its mounting bracket), and at least 80% of their illuminant part must be exposed when viewed from the top of the robot.

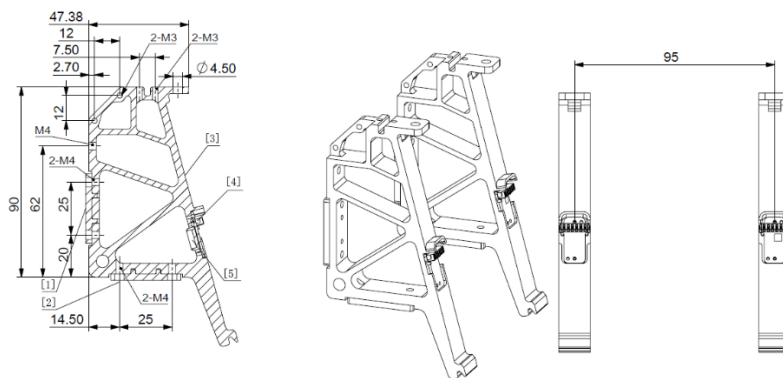
3.6 Mounting Specifications for Armor Module

An Armor Module is mounted on a robot using a designated armor support frame.



- The Armor Support Frame designated for use in this season shall be Armor Support Frame Type A.
- The 17 mm Speed Monitor Module is not considered a blockage of the armor. However, it must not be used to obstruct the Armor Module or interfere with the armor’s visual features intentionally.

Below shows the designated armor support frame:

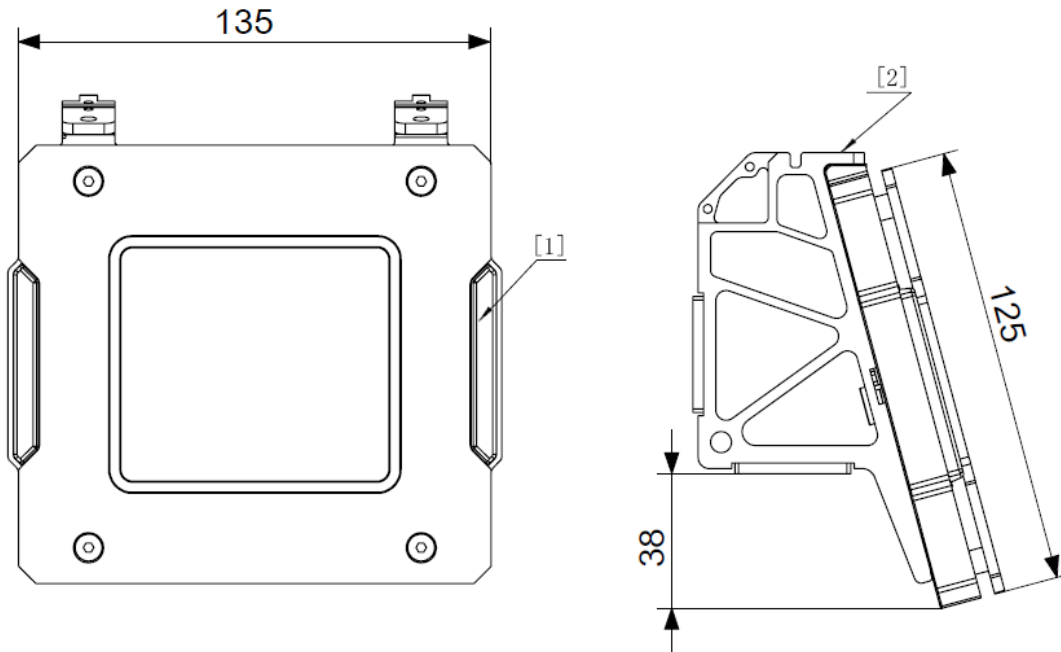


- [1] Back Mounting Surface
- [2] Bottom Mounting Surface
- [3] Armor Module Mounting Surface
- [4] Electrical Connection Point
- [5] JST 6-pin Port

Figure 3-13 Designated Armor Support Frames

S120 The Armor Module can only be mounted on an Armor Support Frame provided by the RMOC. The Armor Support Frame must not be tampered with or damaged.

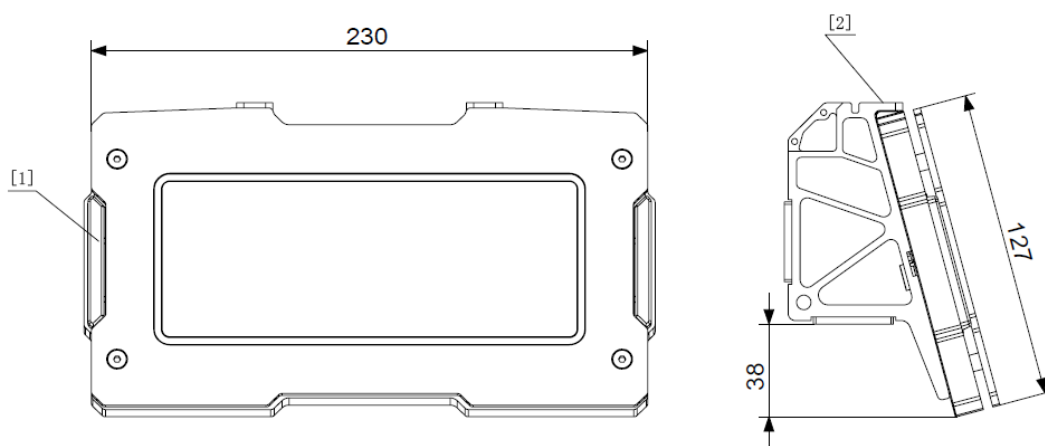
Below shows the small armor support frame:



[1] Side light indicator [2] The top fastened with M4 screws

Figure 3-14 Small Armor Modules

The Large Armor Module is shown in the figure below:



[1] Side light indicator [2] The top fastened with M4 screws

Figure 3-15 Large Armor Modules

S121 Do not modify or decorate the Armor Modules.

3.6.1 General



Robot Chassis: A mechanism that carries the robot propulsion system and its accessories; a mechanism that supports the body of a robot.

In the below description, the standard Cartesian coordinate system consisting of x, y and z axes is used for the robot, and the origin is the robot's center of mass. According to the installation requirements for Armor Modules on ground robots, the direction with theoretically the greatest efficiency based on the robot's chassis structure shall be the robot's X-axis (if multiple directions with the greatest efficiency exist, then any of them may be fixed as the X-axis), and the direction pointing to the center of the earth shall be the Z-axis. Together, these will form the robot's coordinate system. The X-axes for various chassis structures are shown below:

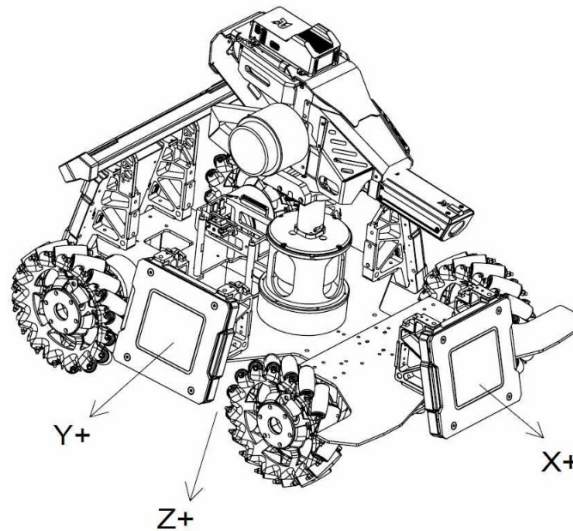


Figure 3-16 Robot Coordinate System

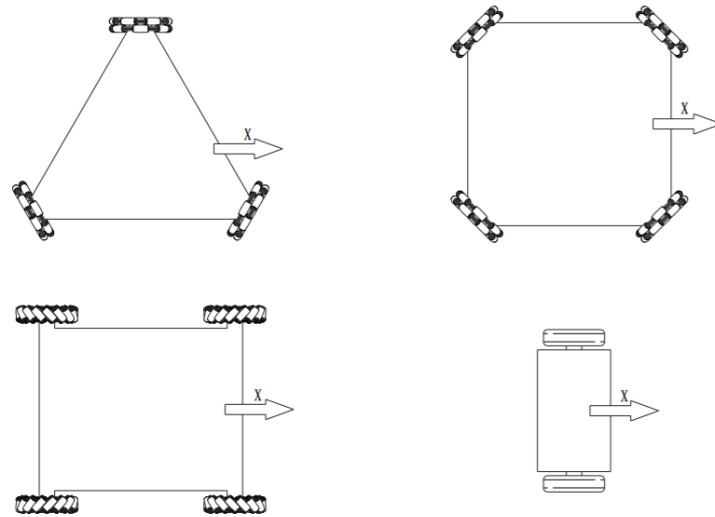


Figure 3-17 The X-axes of Different Robot Chassis Structures

3.6.1.1 Mounting the Armor Module

S122 When an Armor Module is mounted on a robot, the Armor Module and the Armor Support Frame must be connected firmly together. The bottom connecting surface of the Armor Support Frame must be parallel to the XY plane, so that the acute angle between the normal vector of the plane on which the force-bearing surface of the Armor Module lies and the straight line in the negative direction of the Z-axis is 75° . The two sides of the Armor Module without sidelights should be parallel to the XY plane. Define the projection of the normal vector of the plane of the impact surface (forming an acute angle with the negative Z-axis) of the mounted Armor Module on the XY plane as the mounted Armor Module's direction vector. The direction vectors of the four Armor Modules must be in a one-to-one correspondence between the positive X-axis, the negative X-axis, the positive Y-axis, and the negative Y-axis of the robot's body coordinate system (the positive X-axis and negative X-axis for Balancing Standard Robots), and the angular error between the direction vector and the corresponding coordinate axis vector cannot exceed 5° .

S123 The kinematic equations of the robot should also be based on the above reference coordinate system. The mounting procedures for the Armor Modules must use the same reference coordinate system as the robot's own structural or kinematic characteristics. The geometric center point line of the Armor Modules mounted on the X-axis and the geometric center point line of the Armor Modules mounted on the Y-axis should be perpendicular to each other. The offset of the Armor Module from the geometric center of the robot must not exceed 50 mm on the X or Y axis.

3.6.1.2 Rigid Connection

S124 A mounted Armor Module and Support Frame must be rigidly connected to the chassis. During the competition, the Armor Module and the chassis must not shift relative to each other. The rigid connection of the Armor Module is defined in the figure below. A vertical upward force of 60 N is applied to the midpoint of the lower edge of the Armor Module. Angle α of the Armor Module's impact surface must not change by more than 2.5° .

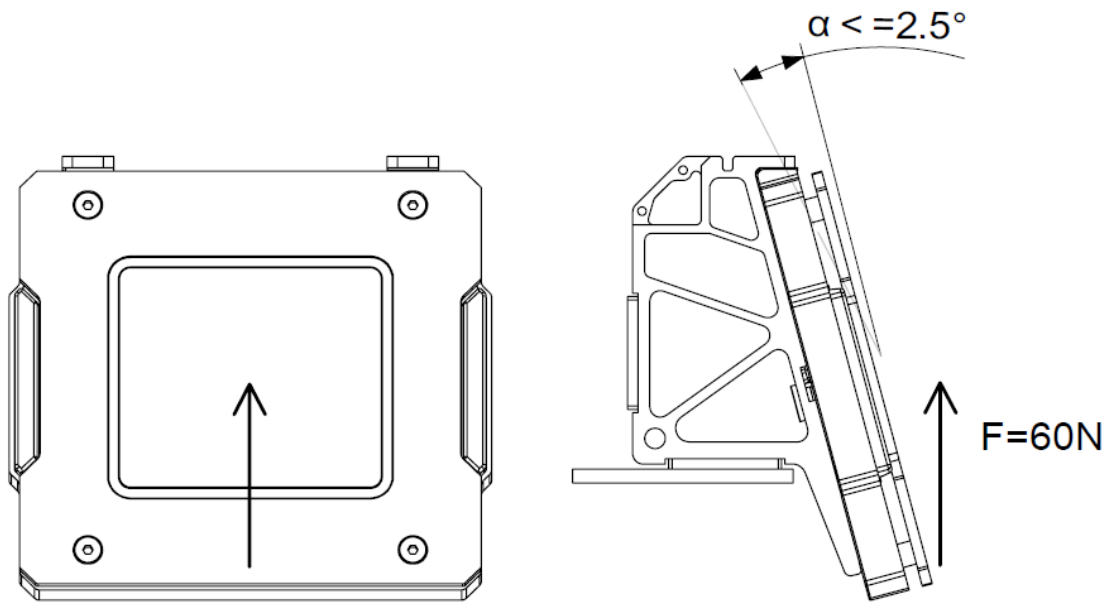


Figure 3-18 Force Application on Armor Module

3.6.1.3 Robot Transformation

S125 In principle, after a competition has started, any Armor Module must not actively move relative to the robot body's center of mass. If a robot's shape is transformable due to its structural design, its Armor Modules must meet the following requirements: No Armor Module is allowed to move rapidly, continuously and reciprocally relative to the robot's chassis. The definition of moving fast is the movement speed exceeding 0.5 m/s.

S126 The difference in height between the lower edges of any two Armor Modules of the Ground Robot should not be more than 100 mm.

S127 For a Ground Robot, the altitude of the lower edge of its Armor Module from the ground before and after transformation must be within the range of 60 mm - 400 mm.



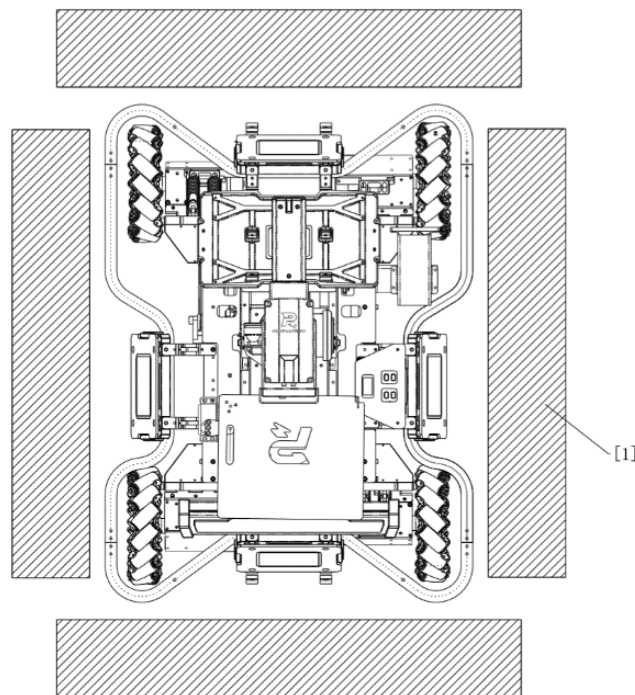
- When the plane that supports the robot body is no longer ground, the requirement of the Armor Module mounting height should be subject to the robot body support plane.

- The height limit from the lower edge of a robot's Armor Module to the ground can be exceeded only when the robot is climbing the road or stairs on the road, or overcoming obstacles.

3.6.1.4 Armor Module Protection

S128 Teams should design safety rods for ground robots to reduce any damage caused by collision of Armor Modules.

S129 When any side of a robot is closely up against a vertical rigid plane (wall), its Armor Module must not have any direct contact with the rigid plane (wall), as shown below:



[1] Wall

Figure 3-19 Robot Protection

S130 Self-designed protective shells cannot have any contact with the Armor Modules provided by the RMOC.

3.6.2 Installation Steps

Ground Robots (excluding Balancing Standard Robots):

The installation steps for the Armor Modules of Ground Robots (excluding Balancing Standard Robots) are the same. Below is an illustration of the installation steps using the Armor Modules of Standard as an example.

1. As per the dimensions in the drawings below, four sets of built-in holes should be preserved on the chassis, with each corresponding to one Armor Module. The sizes and locations of the four holes in each set must be kept aligned.

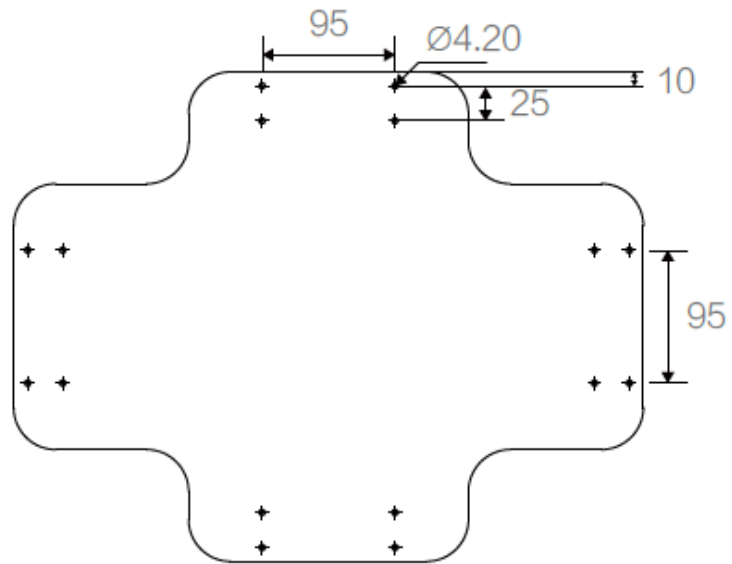


Figure 3-20 Reserved Holes on the Chassis

2. Each Armor Support Frame must be secured to the chassis using two M4 screws. The completed installation should be as shown in the figure below.

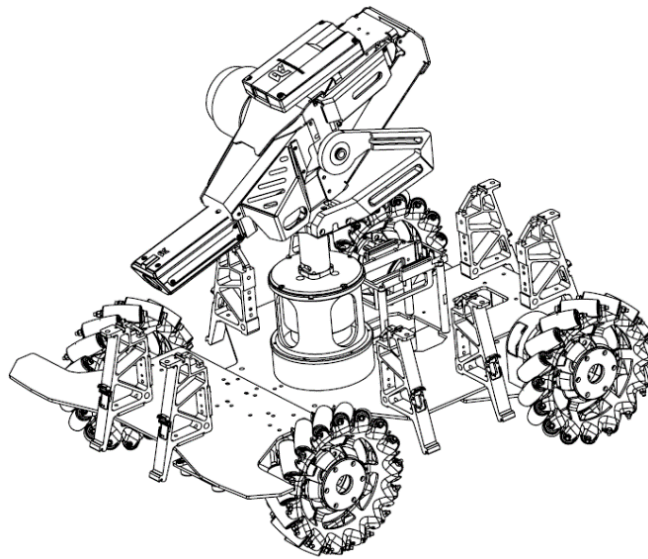


Figure 3-21 Mounting Armor Support Frame

3. Mount the Armor Module on the Armor Support Frame, and secure using M4 screws.
 - 1) Insert the lower slot of the Armor Module into the lower buckle of the Armor Support Frame
 - 2) Insert the upper surface of the Armor Module into the upper buckle of the Armor Support Frame
 - 3) Secure with screws

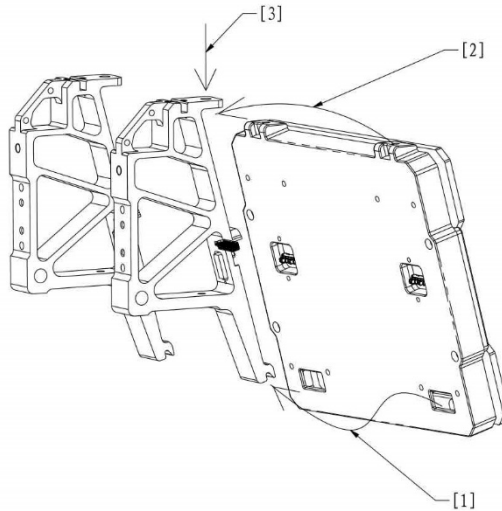
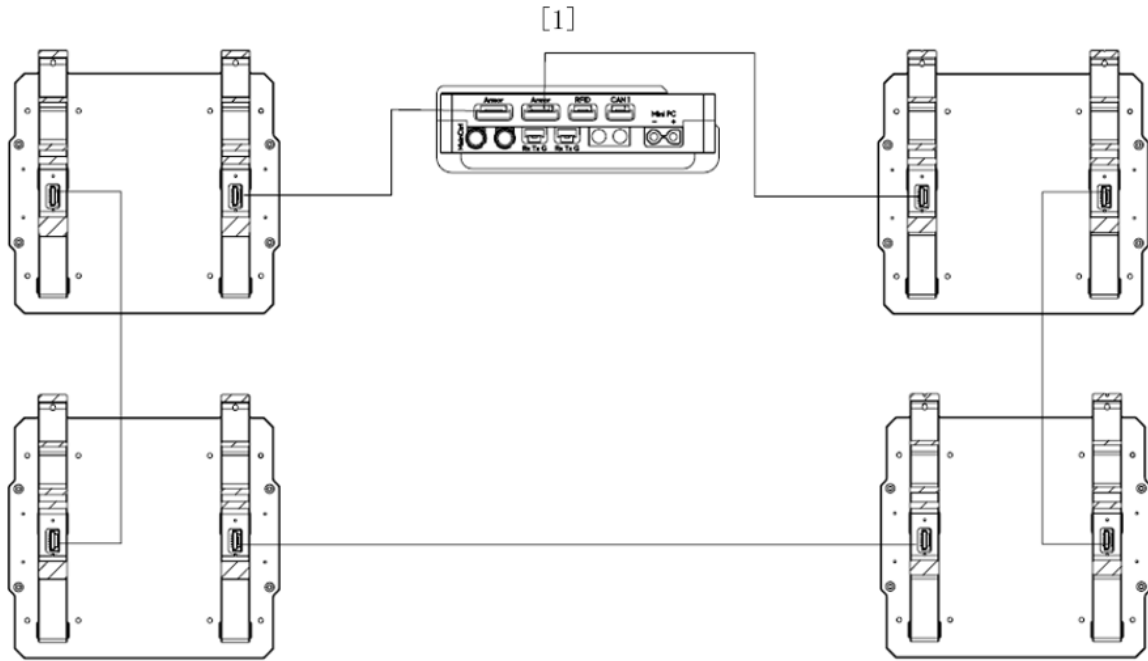


Figure 3-22 Mounting Armor Module

4. Use the 6-pin cables provided in the package to connect the Armor Modules serially to the Armor Module port of the Power Management Module. The two 6-pin ports of the Armor Support Frame are equivalent ports.



- Connect the robots reasonably based on their design and ensure that the cables are connected securely to prevent damage and wear.
- The number of Armor Modules in series on the two 6-pin ports of the Power Management Module should preferably be equally distributed, to divide the current on the ports evenly.



[1] Power Management Module

Figure 3-23 Armor Module Connection

Balancing Standard Robot:

1. As per the dimensions in the drawings below, two sets of built-in holes should be preserved on the chassis, with each corresponding to one Armor Module.

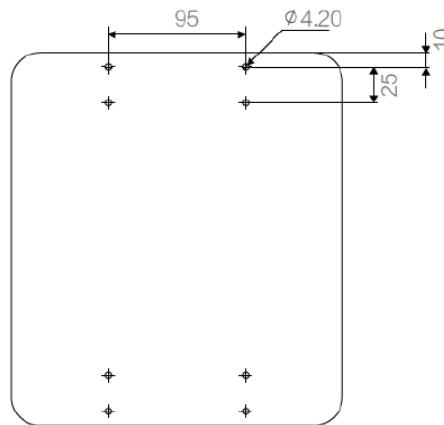


Figure 3-24 Reserved Holes on the Chassis

2. Each Armor Support Frame must be secured to the chassis using two M4 screws. The completed installation should be as shown in the figure below:

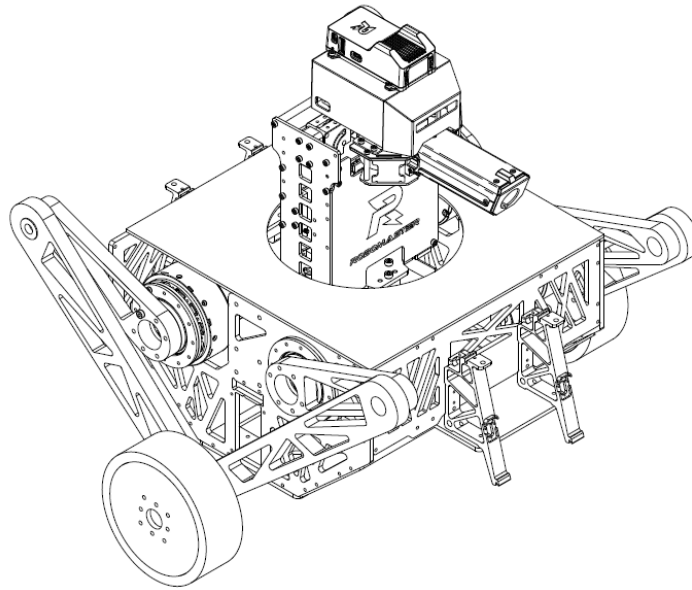


Figure 3-25 Mounting Armor Support Frame

3. Mount the Armor Module on the Armor Support Frame, and secure using M4 screws.
 - 1) Insert the lower slot of the Armor Module into the lower buckle of the Armor Support Frame
 - 2) Insert the upper surface of the Armor Module into the upper buckle of the Armor Support Frame
 - 3) Secure with screws

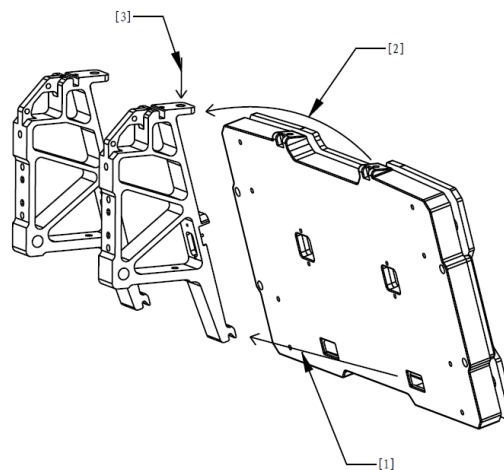
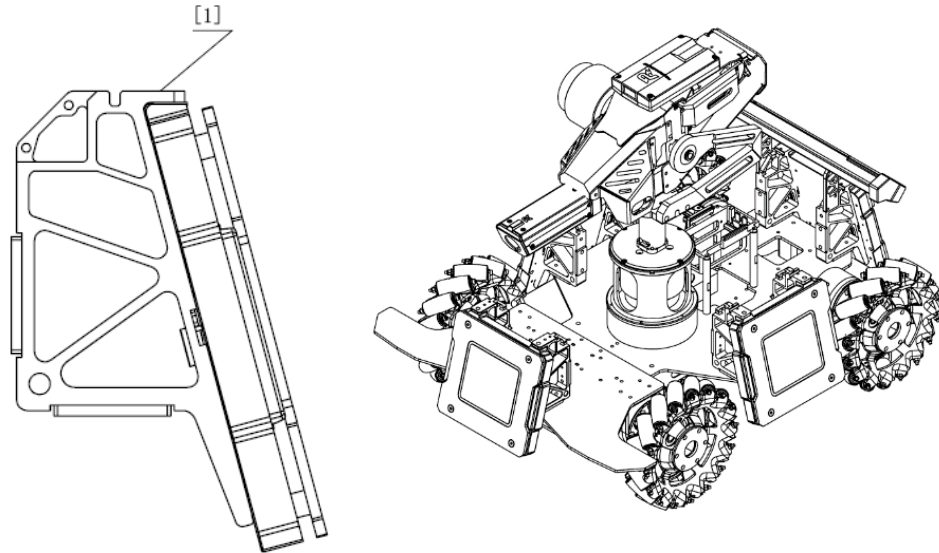


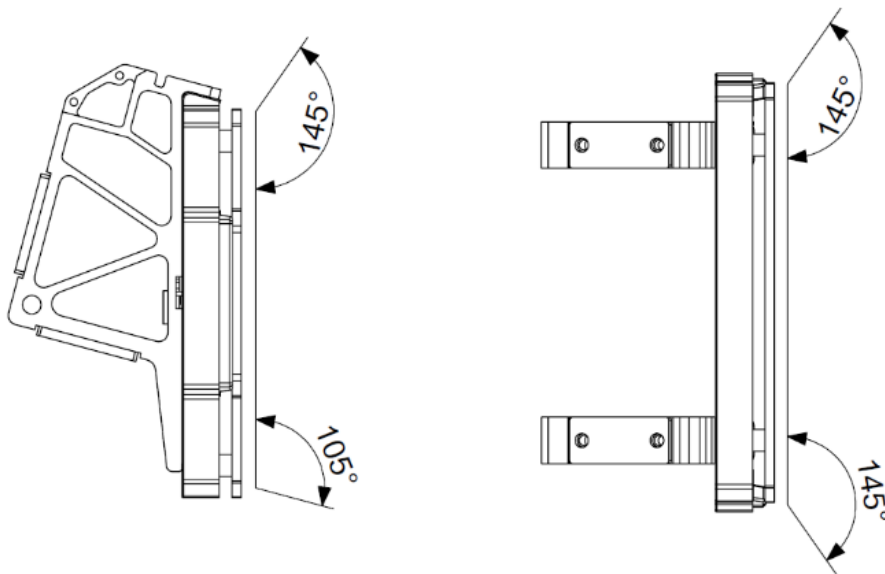
Figure 3-26 Mounting Armor Module

3.6.3 Installation Requirements

S131 The lower 105° area, and the upper, left and right 145° areas of the impact surface on the Armor Modules of Hero, Standard and Sentry Robots must not be blocked.



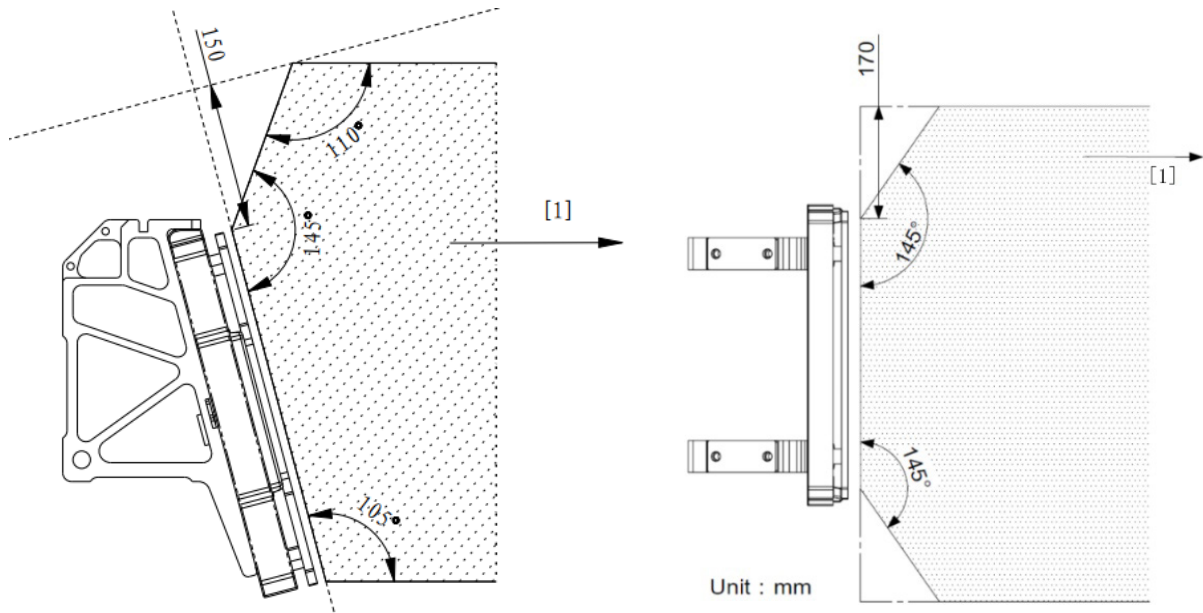
[1] The top fastened with M4 screws



S132 For the Armor Modules of Engineers, the area within 105° of the lower edge of their impact surface must not be blocked. The areas within 145° of the upper, left and right edges of at least three of four Armor Modules must not be blocked. At most one Armor Module is allowed to be blocked in the above-mentioned areas under certain conditions, including: On the plane of the impact surface of the Armor Module, the area beyond 150 mm from the upper edge or the area beyond 170 mm from the left and right edges of the Armor Module can be obstructed, i.e. the grey areas in the following drawings cannot be obstructed.

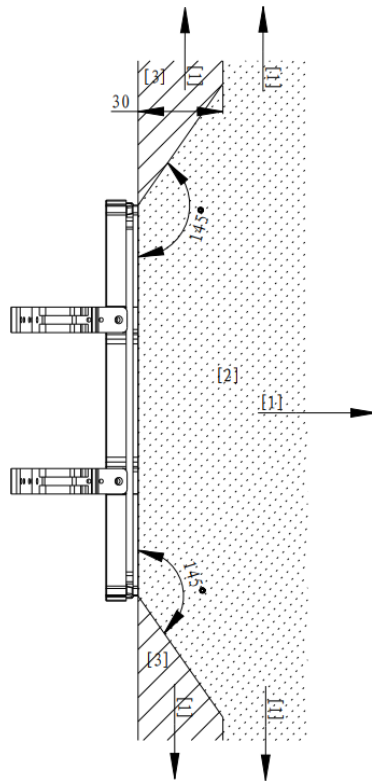


The area not allowed to be blocked, as mentioned in this chapter, extends infinitely within the robot's Maximum Expansion Size.



[1] Unlimited extension

S133 The space extending 30 mm to the left and right of any impact surface on a Balancing Standard Robot's Armor Module must not be blocked, that is, the areas shown in the below image must not be blocked.



[1] Unlimited extension [2] Area not allowed to be blocked [3] Area allowed to be blocked

3.6.4 ID Number Configuration

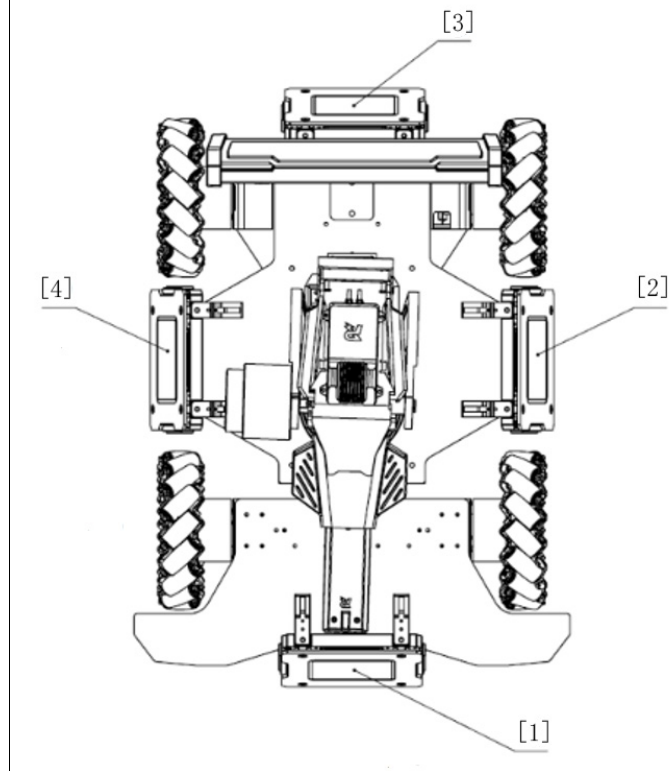
The Armor Module must be configured with the correct ID number before the Inspection. The specific requirements are as follows:

Grounds Robots (excluding Balancing Standard Robots):

S134 According to the Armor Module installation requirements for Ground Robots, after activating the ID setting mode, set any Armor Module as Armor Module 0. Starting from Armor Module 0, tap the rest of the Armor Modules in sequence without repetition to complete the ID setting of all Armor Modules of the robot. After the Armor Module IDs are set, they are shown in the figure below:



The Armor Module IDs will affect the player's client display (data of being hit) and serial data transmission in the Referee system. Participating teams need to confirm the IDs themselves.



- | | | | | | | | |
|-----|-----------------------|-----|-----------------------|-----|-----------------------|-----|-----------------------|
| [1] | Armor Module
No. 0 | [2] | Armor
Module No. 1 | [3] | Armor
Module No. 2 | [4] | Armor
Module No. 3 |
|-----|-----------------------|-----|-----------------------|-----|-----------------------|-----|-----------------------|

Figure 3-27 Ground Robot Armor Module ID Setting

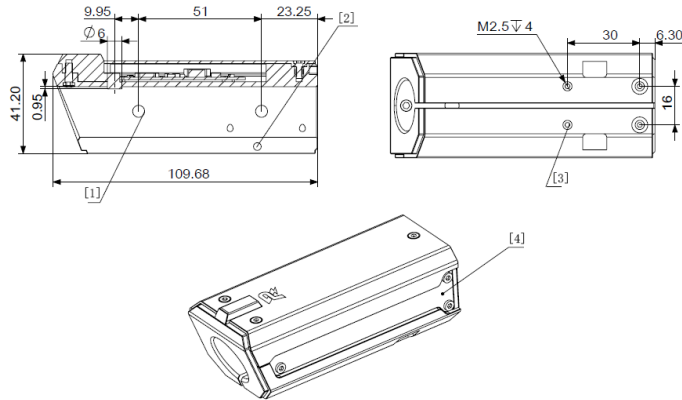
Balancing Standard Robot:

S135 The ID configuration for a Balancing Standard Robot’s Armor in the positive x-axis direction is 0, and the one for the Armor in the negative x-axis direction is 1.

3.7 Mounting Specifications for Speed Monitor Module

Speed Monitor Modules consist of two types: 17 mm and 42 mm.

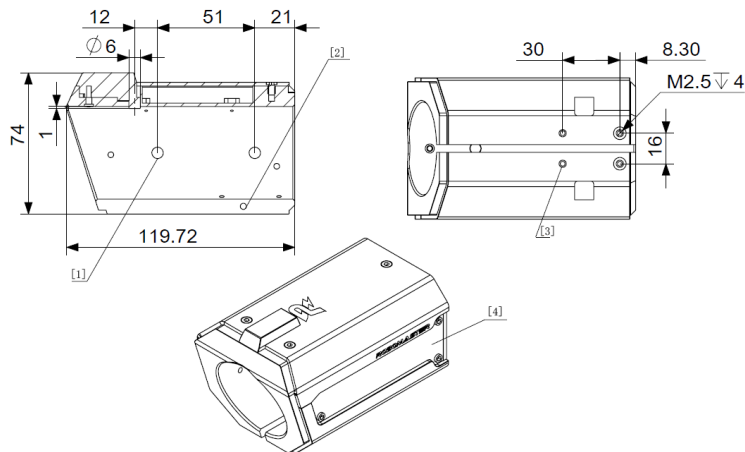
Speed Monitor Module (17 mm projectile):



- [1] Phototube
- [2] Speed Monitor Module's clamping screw hole
- [3] Laser Sight's mounting screw hole
- [4] LED Light Indicator

Figure 3-28 Speed Monitor Module (17 mm Projectile)

Speed Monitor Module (42 mm projectile):



- [1] Phototube
- [2] Speed Monitor Module's clamping screw hole
- [3] Laser Sight's mounting screw hole
- [4] LED Light Indicator

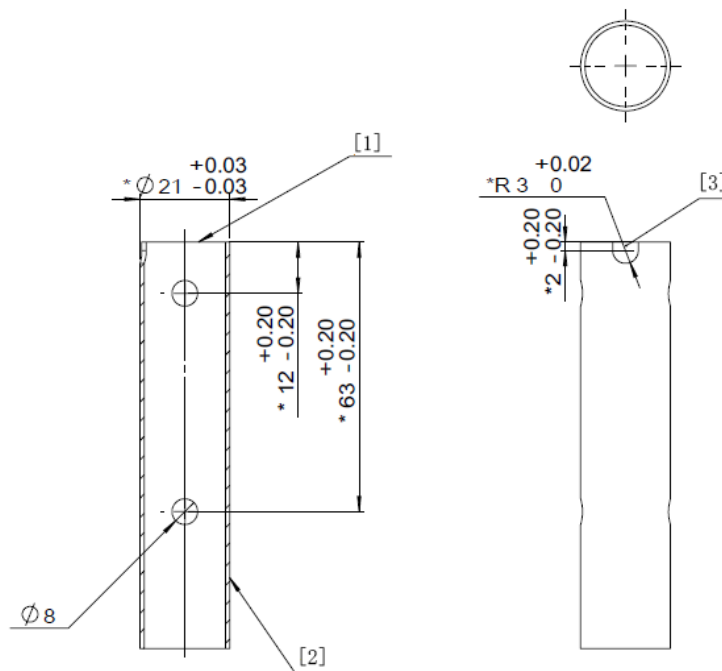
Figure 3-29 Speed Monitor Module (42 mm Projectile)

3.7.1 Installation Steps

Three methods are available for securing the Speed Monitor Module (17 mm projectile). The three securing methods meet the mounting specifications for Speed Monitor Modules (17 mm projectile). Participating teams may choose to adopt any one of the securing methods.

3.7.1.1 Speed Monitor Modules (17 mm projectile) Securing Method 1

17 mm barrel size restrictions (* denotes the key dimensions that teams must adhere to):



- [1] Muzzle
- [2] * Wall thickness must be no less than 1 mm
- [3] The U-shaped groove must face upward after installing the barrel

Figure 3-30 17 mm Barrel

Building requirements for 17 mm barrels:

- S136 The phototube must not be blocked.
- S137 Transparent and luminous materials and the use of infrared ray sensors near the barrel are forbidden.
- S138 The inner wall of a barrel should preferably be given a matte treatment. In the case of any error in recognition by the Speed Monitor Module caused by reflection of light, the consequences shall be borne by the team itself

Mounting Steps for Securing Method 1:

1. Place the Speed Monitor Module on the barrel and ensure that the U-shaped step of barrel is stuck in cylindrical location protrusion within the module inner diameter.
2. Insert M3 screws through the clamping screw holes on the Speed Monitor Module to clamp the barrel.
3. The aviation connector port of the Speed Monitor Module should be connected to the aviation connector port of the Power Management Module using an aviation cable.

The completed mounting is shown in the figure below:

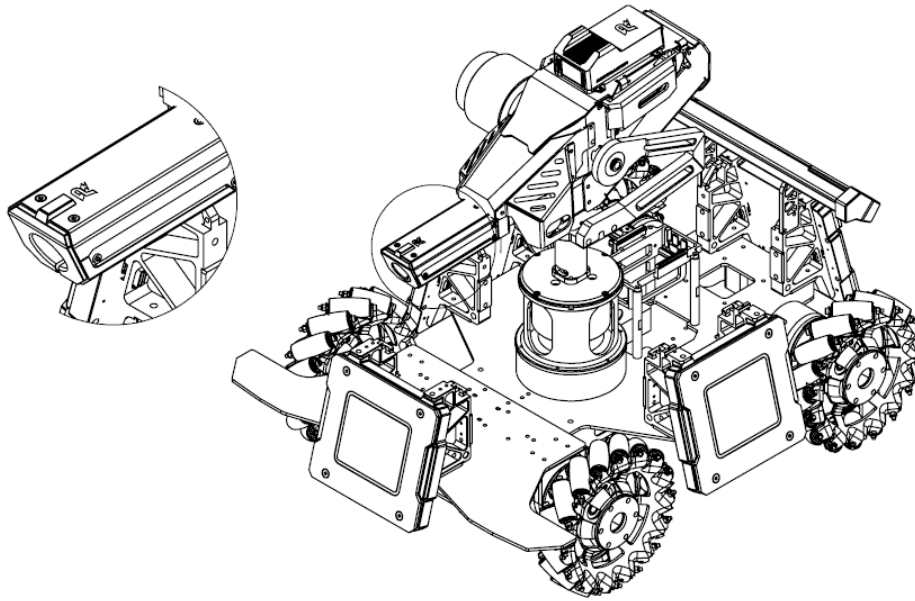


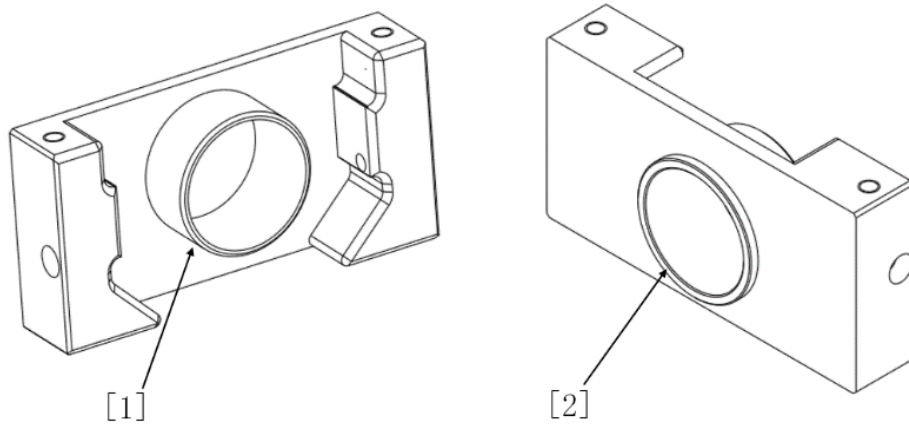
Figure 3-31 Mounting Speed Monitor Module

3.7.1.2 Speed Monitor Modules (17 mm projectile) Securing Method 2

The team designs and develops its own adapter block, to connect the Speed Monitor Module (17 mm projectile) and Launching Mechanism.

See “Appendix 1 - Drawing of Adapter Block for Speed Monitor Module (17 mm projectile)” for the specifications of an adapter block. Its 3D model can be downloaded from the Speed Monitor Module product page on RoboMaster’s official website as a reference.

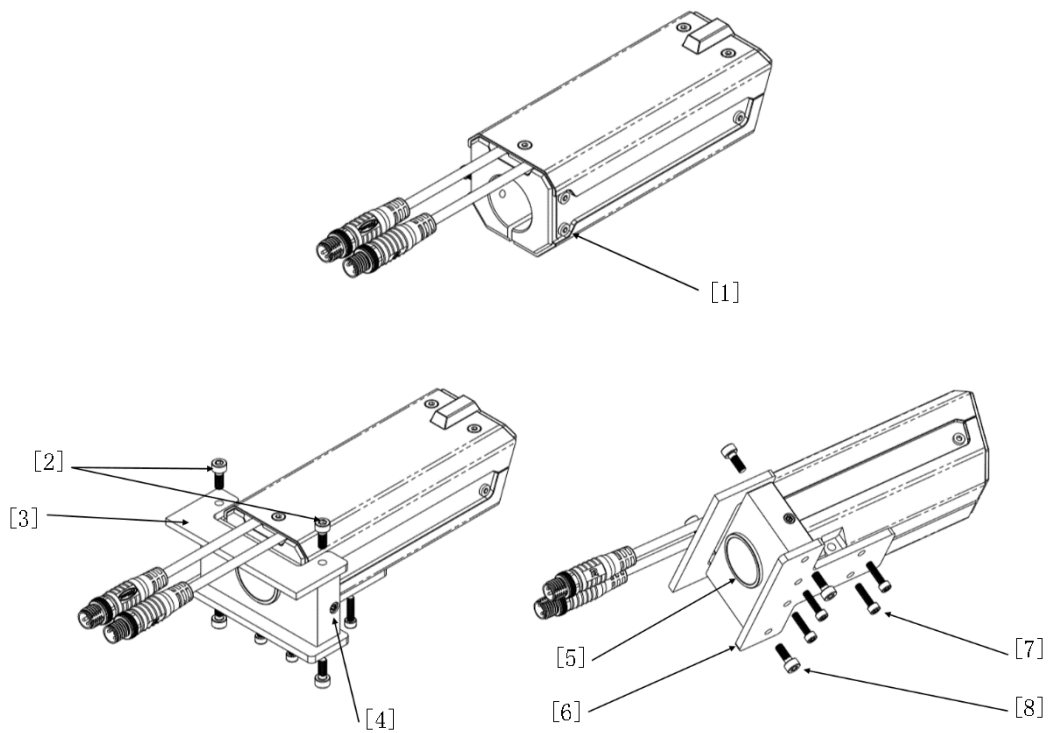
An adapter block is as shown below:



[1] Front Protrusion

[2] Back Protrusion

Figure 3-32 17 mm Adapter Block



- | | | | | | |
|-----|---|-----|-----------------|-----|----------------------|
| [1] | M2.5 securing screw for LED light indicator | [2] | M3 screws | [3] | Self-produced part 1 |
| [4] | Side securing hole | [5] | Back protrusion | [6] | Self-produced part 2 |
| [7] | M2.5 screw | [8] | M3 screws | | |

Figure 3-33 Securing Method for 17 mm Adapter Block

Mounting Steps for Securing Method 2:

1. Remove the M2.5 screws on both left and right of the Speed Monitor Module for securing the LED Light Indicator. The position of one side is as shown in [1] in the figure below.
2. Use two M2.5×14 screws to secure the adapter block on the Speed Monitor Module, through the securing holes on both left and right sides (the position of one side is as shown in [4] in the figure below).
3. Use two M3 screws to secure the robot's original board part 1 on the top of Speed Monitor Module.
4. Use two M3 screws and four M2.5 screws to secure the robot's original board part 2 on the bottom of the Speed Monitor Module.
5. The aviation connector port of the Speed Monitor Module should be connected to the aviation connector port of the Power Management Module using an aviation cable.



Except for the two screws and the cylindrical positioning protrusion which can be removed as in Step 1, the rest of the screws on the Speed Monitor Module must not be removed without permission. Otherwise, it will be deemed as sabotaging the Referee System.

3.7.1.3 Speed Monitor Modules (17 mm projectile) Securing Method 3

The team designs and develops its barrel spare parts, to connect the Speed Monitor Module (17 mm projectile) and Launching Mechanism.

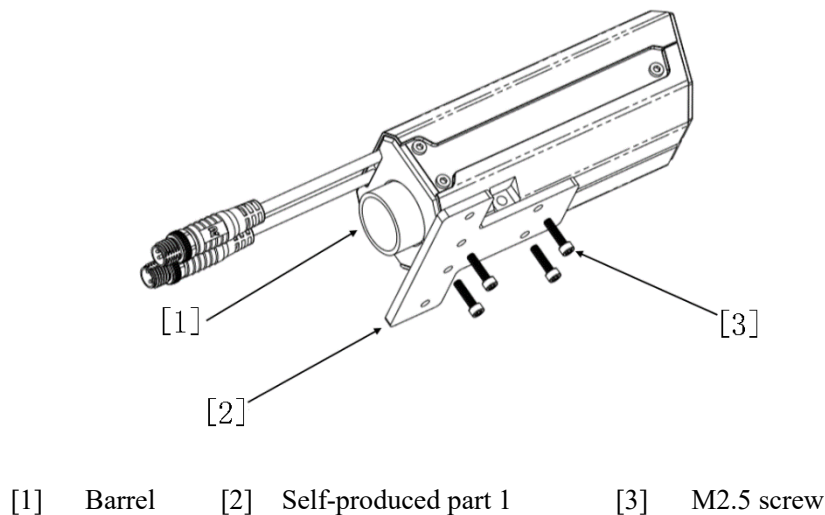


Figure 3-34 Mounting 17 mm Short Barrel

Mounting Steps for Securing Method 3:

1. Insert the Speed Monitor Module into the short barrel.

-
2. Use four M2.5 screws to secure the robot's original board part 1 on the bottom of the Speed Monitor Module.
 3. The aviation connector port of the Speed Monitor Module should be connected to the aviation connector port of the Power Management Module using an aviation cable.
-

- The length of the barrel installed into the Speed Monitor Module must not exceed 23 mm, to avoid obstructing the speed-monitoring phototube.
- The outer diameter of the barrel should preferably be kept within the range of $21 + 0.05$ mm. Insufficient launching mechanism diameter will create a gap between the outer wall of the barrel and the inner wall of the Speed Monitor Module, causing the expansion of the projectile's dispersion area.



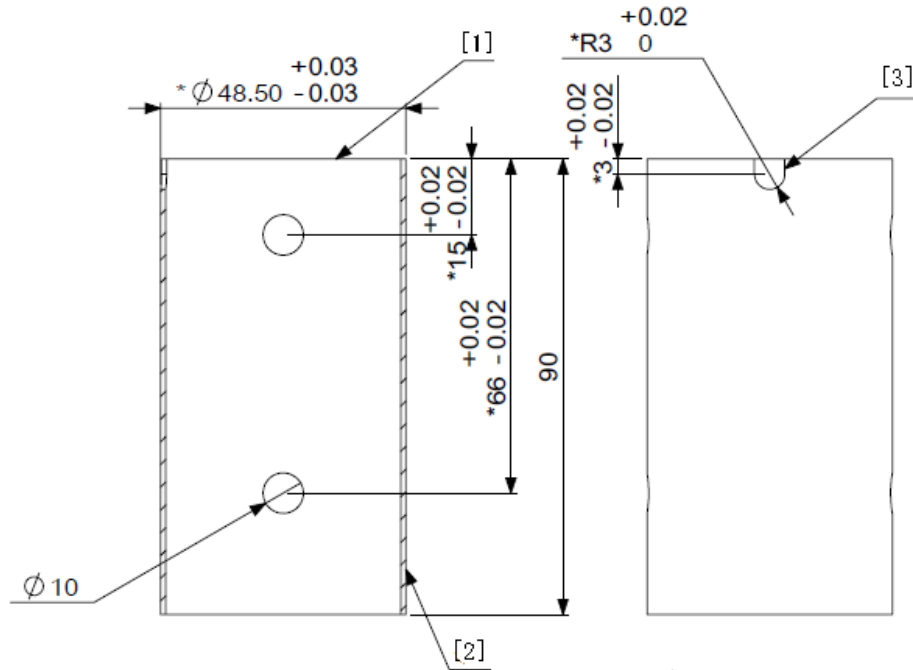
- With this securing method, a lack of mutual positioning between the Speed Monitor Module and parts of the Launching Mechanism may cause the axis of the Speed Monitor Module to not overlap with the axis of a projectile, therefore leading to some projectiles hitting the inner wall of the Speed Monitor Module. Teams may add gaskets between the robot's original board part 1 and the Speed Monitor Module as required, to adjust the mounting angle of the robot's original board part 1 on the Speed Monitor Module.
-

3.7.1.4 Speed Monitor Modules (42 mm projectile) Securing Method



The three securing methods for the Speed Monitor Module (17 mm projectiles) can serve as a reference for the securing method for the Speed Monitor Module (42 mm projectile).

42 mm barrel size restrictions (* denotes the key dimensions that teams must adhere to):



- [1] Muzzle [2]* Wall thickness must be no less than 1 mm [3] The U-shaped groove must face upward after installing the barrel

Figure 3-35 42 mm Barrel

Building requirements for 42 mm barrels:

- S139 The phototube must not be blocked.
- S140 Transparent and luminous materials and the use of infrared ray sensors near the barrel are forbidden.
- S141 The inner wall of a barrel should preferably be given a matte treatment. In the case of any error in recognition by the Speed Monitor Module caused by reflection of light, the consequences shall be borne by the team itself.

Mounting Steps for Securing Method:

1. Place the Speed Monitor Module on the barrel and ensure that the U-shaped step of barrel is stuck in cylindrical location protrusion within the module inner diameter.
2. Insert M3 screws through the clamping screw holes on the Speed Monitor Module to clamp the barrel.
3. The aviation connector port of the Speed Monitor Module should be connected to the aviation connector port of the Power Management Module using an aviation cable.

3.7.2 Installation Requirements

The mounting of a Speed Monitor Module must meet the following requirements:

- S142 A Speed Monitor Module must be installed at the end of the Launching Mechanism to measure the projectile initial speed after it has fully accelerated.
- S143 When performing horizontal calibration on a Speed Monitor Module, its logo should be facing up.
- S144 The Speed Monitor Module should be firmly secured to ensure that the Module and the barrel do not move relative to each other during movements of the robot.



When a robot with two Speed Monitor Modules and a Launching Mechanism translates or rotates its Speed Monitor Modules, and the Speed Monitor Modules are still able to detect the Launching Mechanism, it should not be regarded as relative movement between the Speed Monitor Module and the barrel.

- S145 Each Speed Monitor Module must have at least one light indicator surface, to which the normal line is in the upper hemisphere, and the Pre-Match Inspection personnel must be able to see 80% of the light indicator's surface area when looking directly at the Speed Monitor Module in the direction perpendicular to the light indicator's surface at a distance of 1 m away from the module.
- S146 It is prohibited to use iron barrels or barrels made of materials susceptible to magnetization.
- S147 For ferromagnetic materials or devices that generate strong magnetism during operation, the angle of the magnetic force on the Speed Monitor Module when stationary or during operation must be within 2° (It is not required to follow this specification in RMUL).

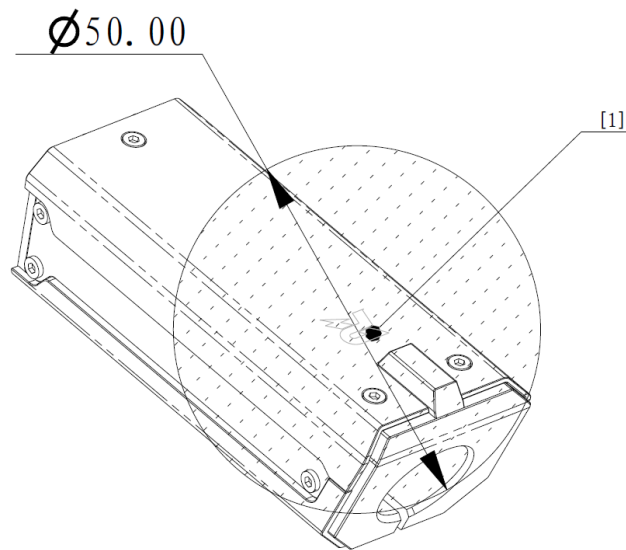


After calibrating the speed monitor module, press OK on the main controller module and then press PgDn. Follow the instructions below to observe the real-time coordinate changes of the main controller module robot (please refer to the Robot Side section in the [Referee System User Manual](#) for details):

- After rotating the gimbal by 90° , 180° and 240° respectively, compare the actual rotation angles to see if the error values are less than 15° .
 - For ferromagnetic materials, after installing them in accordance with the above specifications, observe if the angle of the speed monitor module fluctuates within 2° .
-

- For devices that generate strong magnetism during operation, when the device is powered on and in both stationary and running states (For example, when the friction wheel motor is powered on and in both stationary and rotating states), observe if the angle of the speed monitor module fluctuates within 2°.

S148 As shown in the Mounting Specifications for Speed Monitor Module graph, with the Logo position as the center of the sphere, it is prohibited to use substances that are easily magnetized (products containing iron, cobalt and nickel, the cooling fan at the transmitter of the transmitter module, and industrial camera bodies, etc.) within a diameter of 50 mm. Within a diameter of 100 mm, magnetic materials such as friction wheel motors and gimbal motors (except for video transmitter modules and industrial camera bodies) are not allowed in order to avoid interference with the magnetometer inside the speed monitor module.



[1] Circular center

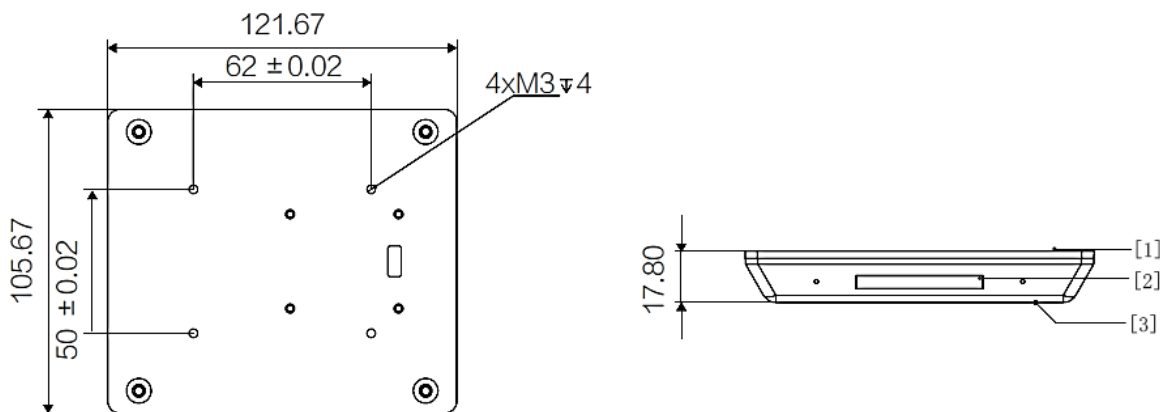
Figure 3-36 Mounting Specifications for Speed Monitor Module



- Four M2.5 threaded holes should be available for installing the RoboMaster Laser Sight or the laser sight prepared by your own team.
- Do not look directly at the laser without eye protection. Goggles are recommended during operation.
- Do not block the phototube holes. Otherwise the initialization of the Speed Monitor Module may fail.
- The aviation connector cable of the Speed Monitor Module is close to the friction wheel. The cable should be protected from wear when used.
- If two Speed Monitor Modules are installed parallel to each other, then one light panel of each module may be blocked.
- It shall be deemed a violation if a mesh-like or other similar structure is used to block more than 1/5 of the surface area of a Speed Monitor Module's light panel.

3.8 Mounting Specifications for RFID Interaction Module

Drill in mounting holes on the robot's chassis according to the size and mounting port of the RFID Interaction Module.



[1] Back [2] LED Light Indicator [3] Front

Figure 3-37 RFID Interaction Module

3.8.1 Installation Steps

1. Connect the RFID Interaction Module to the RFID port on the Power Management Module using the 4-pin cable provided in the package.

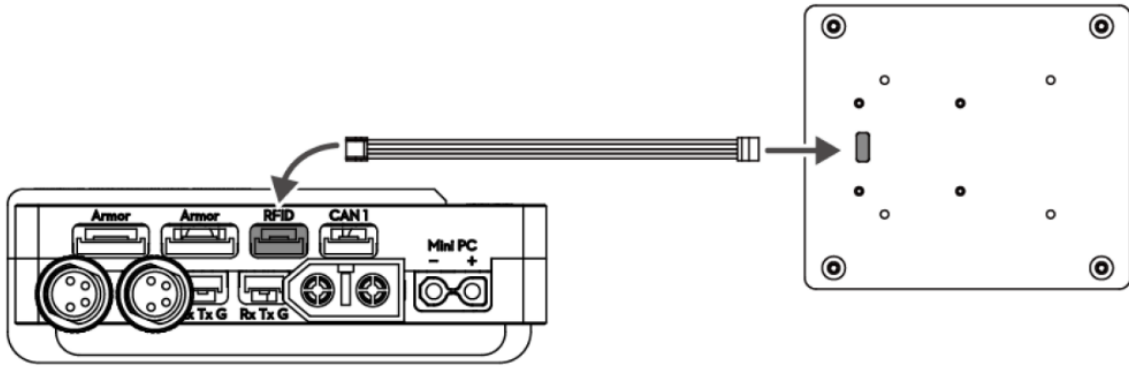


Figure 3-38 RFID Interaction Module Connection

2. Use M3 screws to secure the RFID Interaction Module on the chassis. Do not press the cable during mounting, and make sure to keep the RFID Interaction Module at an appropriate distance from the ground.

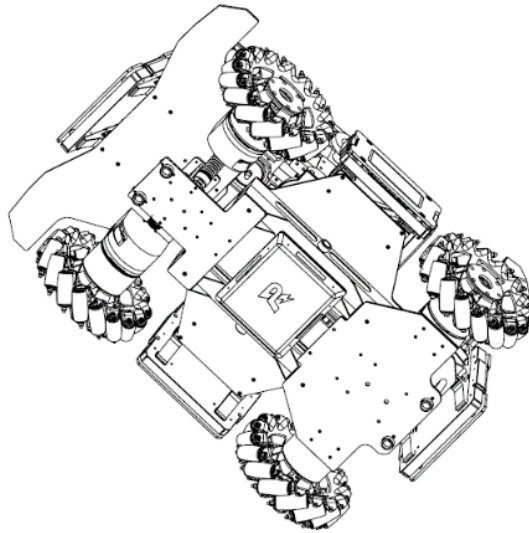



Figure 3-39 Mounting RFID Interaction Module


3.8.2 Installation Requirements

- The effective detection distance of the RFID Interaction Module is 100 mm ($\pm 5\%$). The actual detection distance after mounting is subject to testing. If the effective detection distance is reduced or the Module does not function properly, please check if it was installed correctly. For specific effective detection distance, please refer to the [RFID Interaction Module User Guide](#) and [Power Management Module User Guide](#).
-  The transformation of an RFID Interaction Module must not exceed the maximum expansion size of the robot. An RFID Interaction Module is allowed to extend out of the robot's body when transforming.
- Due to the complex electromagnetic environment in a robot, the testing of the effective detection distance of an RFID Interaction Module must be carried out when all the modules of the robot are working properly (e.g. when the supercapacitor, power motor and wireless charging coil, etc. are in operation). If multiple operation modes are involved with the robot (e.g. the charging or discharge of the capacitor, or the motor at variable or uniform speed), the effective detection distance of the RFID Interaction Module will have to be tested under the different operation modes.

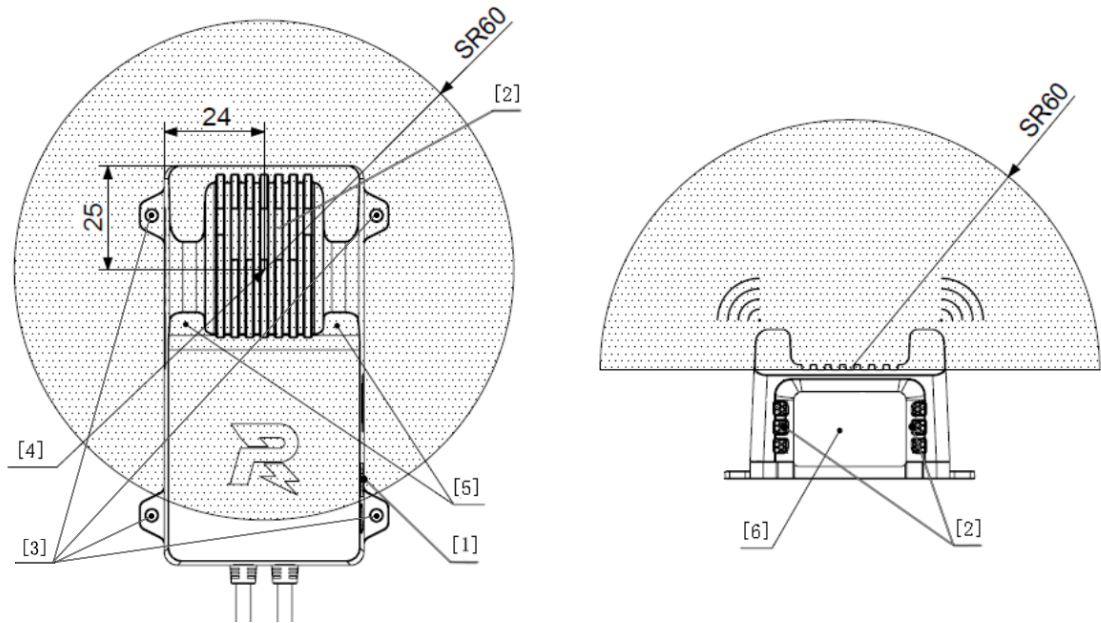
S149 The rear of the RFID Interaction Module should be free of interference from strong currents or high-frequency signals (such as motor cables, RoboMaster Center Board, CAN cables and supercapacitors).

S150 The front and rear of the RFID Interaction Module must not be obstructed by any conductive materials, and the rear surface must be kept at least 30 mm away from conductive materials such as the metal and carbon plates.

3.9 Mounting Specifications for Video Transmitter Module (Transmitter)

- VTM Link data are output from the UART serial port of a Video Transmitter Module (Transmitter).
-  The UART serial port of a Video Transmitter Module (Transmitter) supports the 3.3 V TTL logic level. The UART serial port supports the RX, TX and GND pins. Please do not connect the anode of a power supply to the UART serial port.

Drill in mounting holes at the necessary positions according to the size and mounting port of the Transmitter structure.

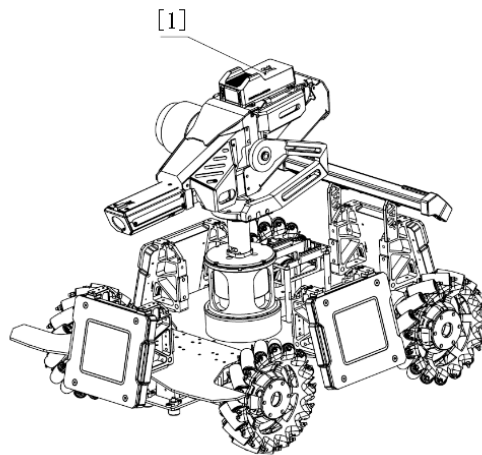


[1] Air Outlet [2] Air Inlet [3] Mounting Hole [4] Circular center [5] Antennas [6] Camera

Figure 3-40 Video Transmitter Module (Transmitter)

3.9.1 Installation Steps

1. Secure the Transmitter on the appropriate position on the robot using four M2.5 screws.



[1] Video Transmitter Module (Transmitter)

Figure 3-41 Mounting Video Transmitter Module (Transmitter)

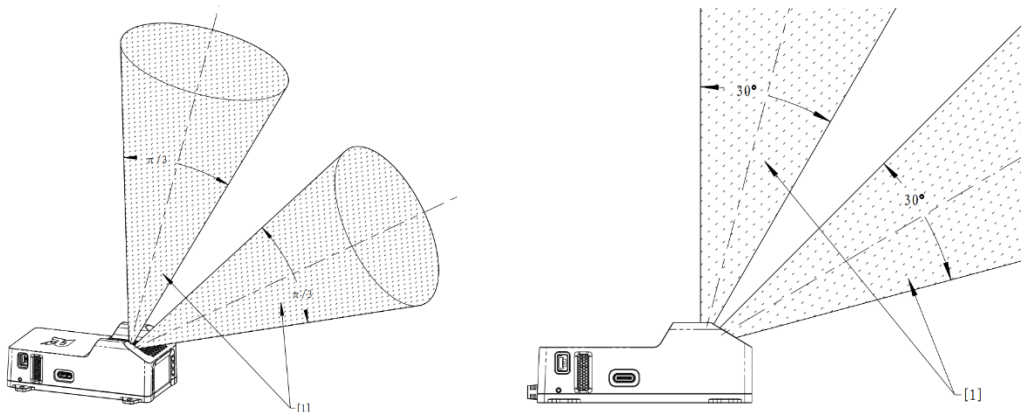
2. The aviation connector port of the Video Transmitter Module (Transmitter) should be connected to the aviation connector port of the Video Transmitter port on the Power Management Module using an aviation cable.

3.9.2 Installation Requirements

The mounting of a Video Transmitter Module (Transmitter) must meet the following requirements. Failure to do so may result in the reduced quality of Video Transmitter Module images, even operational irregularities.

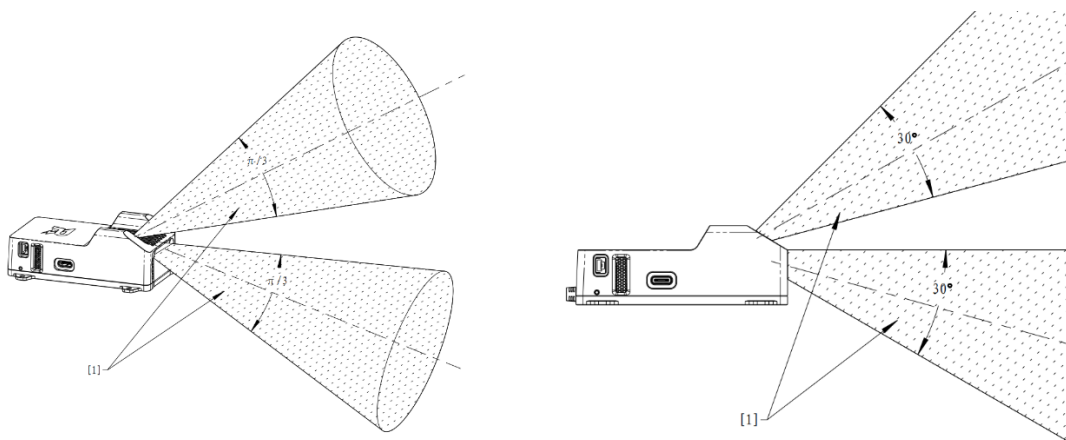
S151 The inlet and outlets of the Transmitter must not be blocked.

S152 Taking the cooling fan of the Transmitter as the vertex and the upper surface of the Transmitter as the plane, and there must be two non-overlapping cones, each with a solid angle of $\pi/3$. The cones should be rotationally symmetrical and areas in the cones must not be blocked by any conductive materials, as shown in the following figure.



[1] Area not allowed to be blocked

For an Aerial Robot, taking the cooling fan of the Transmitter as the vertex, and there should be two non-overlapping cones, each with a solid angle of $\pi/3$. Each cone has a generatrix in its upper hemisphere. The cones should be rotationally symmetrical and areas in the cones must not be blocked by any conductive materials, as shown in the following figure.

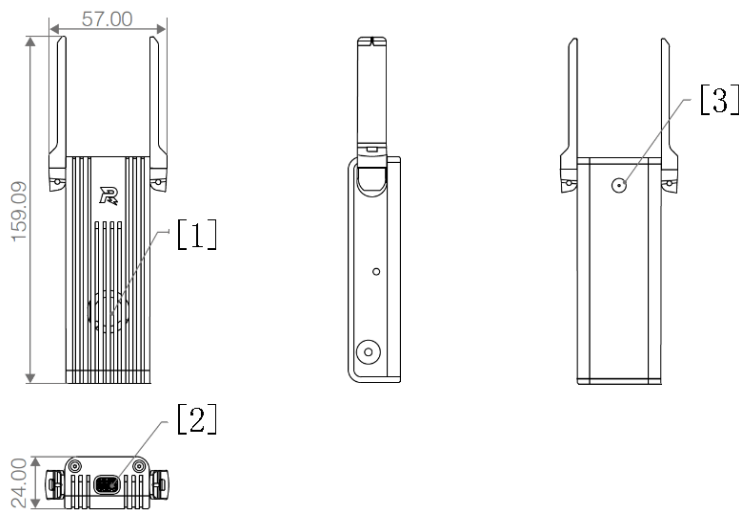


[1] Area not allowed to be blocked (Aerial Robots)

- S153 As shown in “Figure 3-40 Video Transmitter Module (Transmitter)”, set the center of the cooling fan on the Video Transmitter Module (Transmitter) as the circular center, and there should be no blockage by conductive materials in the sphere with a radius of 30 mm.
- S154 As shown in “Figure 3-40 Video Transmitter Module (Transmitter)”, set the center of the cooling fan on the Video Transmitter Module (Transmitter) as the circular center, no motor or electromagnetic device that may interfere with the Module should be within a hemisphere measuring 60 mm from the center, to avoid interfering with Video Transmitter signals.
- S155 If the VTM Link is used, the UART serial port of the Video Transmitter Module (Transmitter) needs to be partially protected, by using protective devices such as foam and non-metallic guards.
- S156 When installing the Video Transmitter Module (Transmitter), if there is a protective device, the device must be easy to open. If it cannot be opened, all ports must be fully exposed to facilitate staff operation.

3.10 Mounting Specifications for Video Transmitter Module (Receiver)

According to the size and mounting port of the Video Transmitter Module (Receiver) structure, the Receiver should be secured using self-purchased mounting clamps. The securing position can be on a monitor or other support structure.



[1] Air Outlet [2] Air Inlet [3] Inch-based Threaded Hole 1/4 20×6

Figure 3-42 Video Transmitter Module (Receiver)

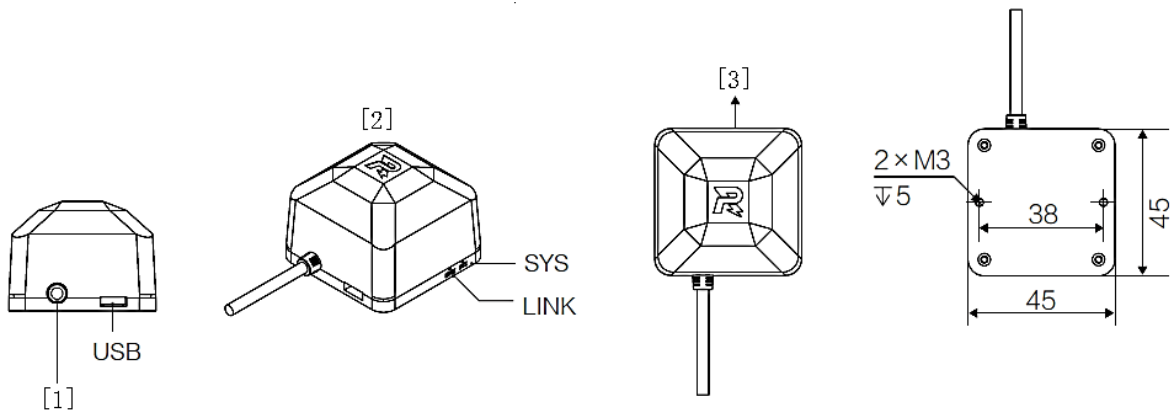
3.10.1 Installation Requirements

The mounting of a Video Transmitter Module (Receiver) must meet the following requirements. Failure to do so may result in the reduced quality of Video Transmitter Module images, even operational irregularities.

- S157 The distance between the fixed position of a Video Transmitter Module (Receiver) and the ground must not be less than 1 m, and it must not be blocked by any metal.
- S158 Ensure that the cooling inlet and outlet [1] and [2] are not blocked.
- S159 The rotation angle for the antenna is 0°-190°. Please fold it gently. The distance to the antenna's center point should preferably be larger than 60 mm.
- S160 The specific mounting position and angles can be adjusted by checking the quality of receiver images.

3.11 Mounting Specifications for Positioning System Module

Drill in mounting holes on specified positions on the robot according to the size of the Positioning System Module.



[1] Referee System Connection Cable [2] Top [3] Front

Figure 3-43 Positioning System Module

3.11.1 Installation Steps

1. Use two M3 screws to secure the Positioning System Module at a specific position. as shown in the figure below:

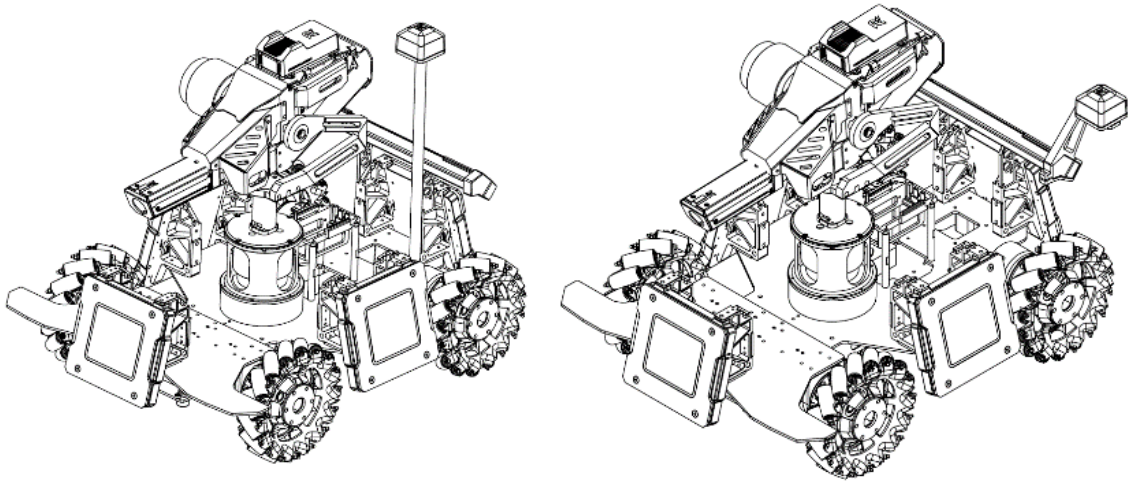


Figure 3-44 Mounting Positioning System Module

2. Use the aviation cable inside the package to connect the Positioning System Module to the aviation connector port with the white metal ring on the Power Management Module.

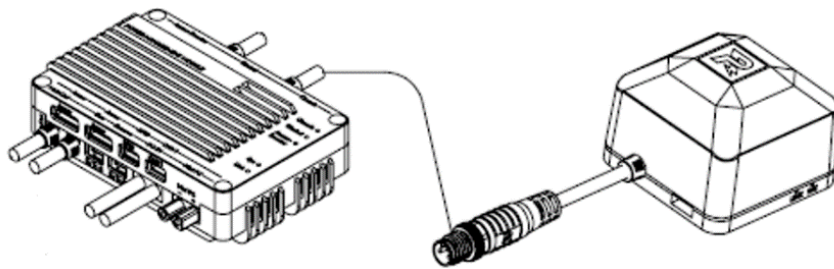


Figure 3-45 Positioning System Module Connection

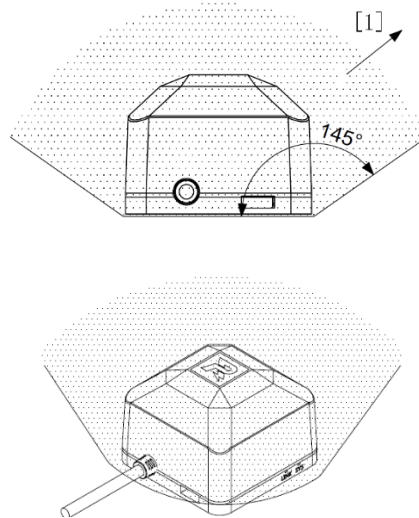
3.11.2 Installation Requirements

The installation of Positioning System Module should meet the following requirements. Otherwise, the position function might not work properly.

- S161 The mounting bracket for the Positioning System Module needs to be rigidly connected to the robot, i.e., when a force of 40 N perpendicular to the bracket is applied at any position on it, there should be no noticeable deformation.
- S162 Positioning System Module should be horizontally installed with the top facing up. The 145° area above the Positioning System Module must not be blocked by any conductor, as shown below:



- According to the above mounting specifications, only one out of the front, back, left and right horizontal directions of an Aerial's Positioning System Module is allowed to be blocked by a conductor at a horizontal distance of 100 mm away.
- Requirements related to Positioning System Module blockage need to be met before, during and after robot transformation.



[1] Unlimited extension

Figure 3-46 Mounting Positioning System Module

S163 The Positioning System Module must always be mounted at least 100 mm away from motors, parts that are magnetic or generate strong magnetic fields during operation, and at least 150 mm away from the Video Transmitter Module. When using a sensor at 200 mm away from the Positioning System Module, tin foil, metal covering, or barriers of other materials shall be used to ensure the sensor does not interfere with the Positioning System Module.

S164 The use of magnets or magnetic materials is prohibited when securing the positioning system module to avoid interfering with the Positioning System Module. It is recommended to use materials that will not be magnetized, such as aluminum products, pure titanium products, or plastic products. Adhesive materials must not be used to secure the Positioning System Module.

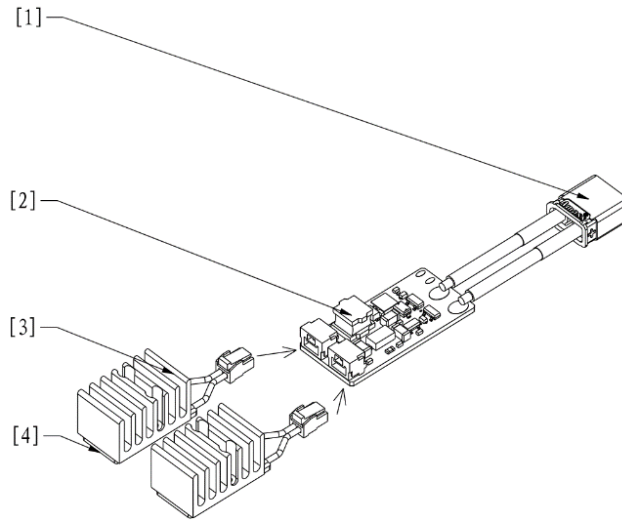
S165 When mounting an infrared laser rangefinder or other sensors, ensure that they do not generate wireless signal interference in the frequency range of 4.2 to 4.8 GHz, and that the maximum noise intensity within the operating frequency range in this band should not continuously exceed -60 dBm. When using a spectrum analyzer, it is recommended to have the robot's full functionality enabled. Measurements using a spectrum analyzer in close proximity to the device may generate wireless signal interference.



It is recommended to take the measurements in an environment with minimal wireless interference.

3.12 Mounting Specifications for 17mm Fluorescent Projectile Energy-Charging Devices

The robot should have built-in holes on specific parts of its body, as per the dimensions of a 17 mm Fluorescent Projectile Energy-Charging Device.



[1] XT30 port [2] LED actuator [3] Heat dissipation panel [4] UV light panel

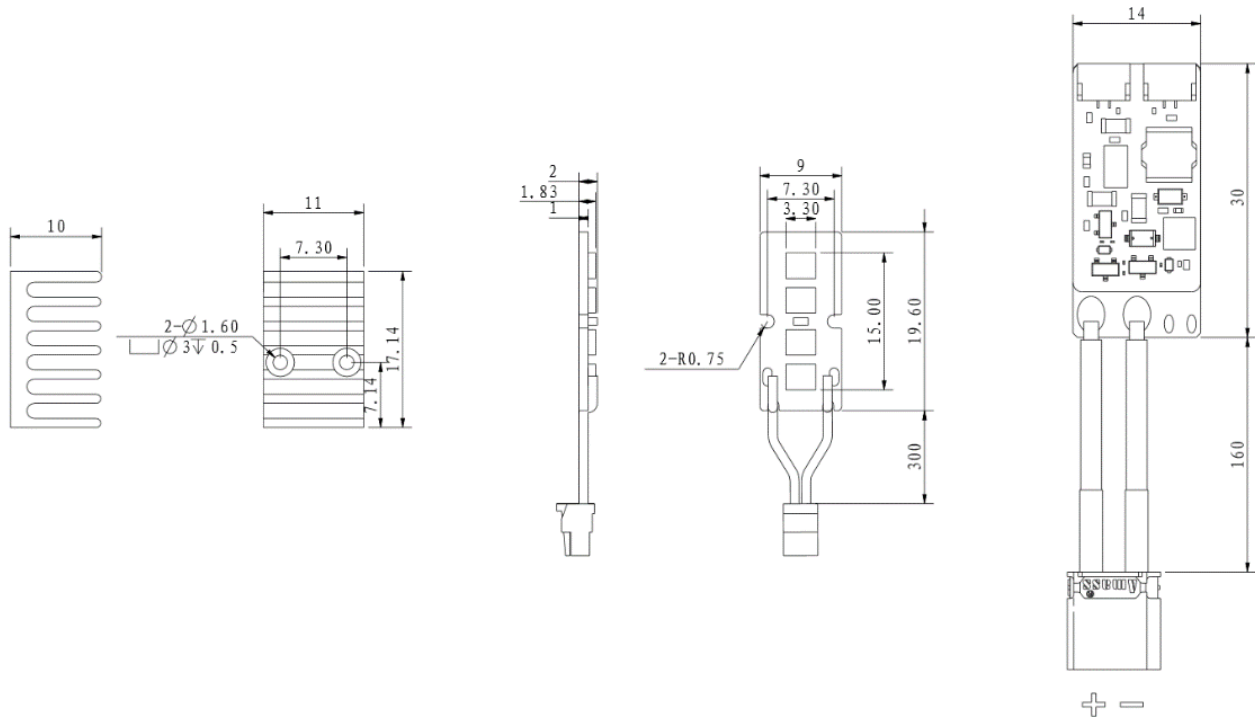


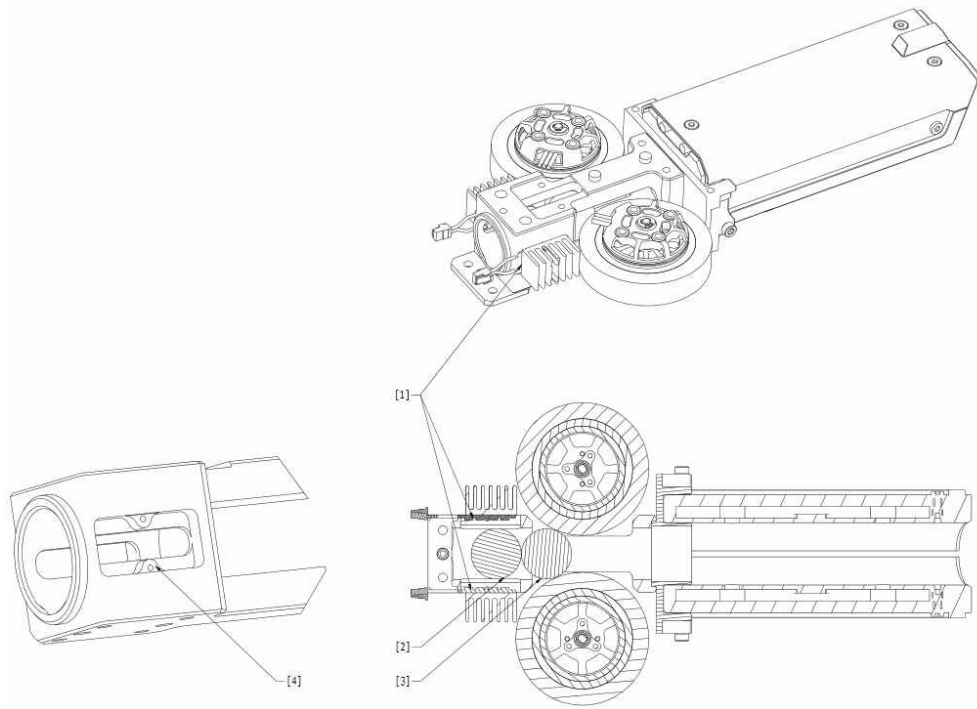
Figure 3-47 17 mm Fluorescent Projectile Energy-Charging Device

3.12.1 Installation Steps



- In RMUL, it is not required to install a fluorescent energy-charging device on the robot.
- UV light panels must be installed in a way that ensures no obvious light leaks to prevent the emission of harmful UV rays.

1. The UV light panel should be installed on a specific part of the robot, and should cover the standby projectile next to the launching projectile, as shown in the drawings below.
2. If the projectile supply tube is metal, its area in contact with the light panel should be maximized as much as possible, and the screw should be tightly fastened for easy conduction. Non-metal projectile supply tubes must be properly mounted with heat dissipation panels.
3. After the wiring for the UV light panel is completed, the XT30 port can be connected to a 12 V or 24 V power supply.



[1] UV light panel [2] Standby projectile [3] Launching projectile [4] Slot

Figure 3-48 Mounting UV Light Panel

3.12.2 Installation Requirements

- S166 The UV light panel must be in close contact with the metal parts, or heat dissipation panels should be installed to extract heat. Heat dissipation panels used can be those provided with the equipment or self-produced.
- S167 The back of the UV light panel or the surface of the heat dissipation panels must not be covered with any material that prevents heat dissipation such as tapes or plastic.
- S168 The UV light panel must cover the standby projectile next to the launching projectile to ensure the proper charging of the projectile. After charging, the brightness of the projectile must be greater than that of the Speed Monitor Module in the “Bullet Test” of the Referee System.

- Steps for entering the “Bullet Test” mode on the Main Controller:
 1. Press and hold OK on the Main Controller module of the Referee System
 2. Select “Debug Settings”
 3. Press OK
 4. Select “Bullet Test” from the list and press OK



- In the subsequent versions of this season, the installation requirements for fluorescent energy-charging devices will remain the same and need to be followed to the letter. For self-testing methods after installation, please refer to:

<https://www.robomaster.com/zh-CN/resource/pages/announcement/1687>

3.12.3 Instructions and Requirements for Production of UV Light Panels

S169 The UV light beads used must be the 390-410 nm variety with a 2835 packaging. The beam angle should be 120°, the power of each bead 0.2 W, and the total power of the light panels no smaller than 1.5 W. Participants should refer to the competition's official design for light panels. Their total length must be at least 19.60 mm which is the official panel length.

S170 Aluminum or copper boards are required to be used for the circuit boards of the light beads for heat conduction. Meanwhile, proper heat dissipation measures should also be used for light panels to avoid overheating and damage to the light beads.



- Light beads or light panels should be heated and dried at 120°C for 2 hours to eliminate humidity, followed by soldering which should be completed within 12 hours after heating.
 - Soldering any light bead with moisture will create water vapor that will damage the packaging structure of the LED and render it unstable.
-

3.13 Mounting Specifications for Supercapacitor Management Module

The Supercapacitor Management Module (hereinafter referred to as the “Capacitor Management Module”) is used to detect the capacitance of the Supercapacitor Module and the energy of the Supercapacitor Module during the

competition. The estimated size of a Capacitor Management Module is 60*30*7.5 mm(L*W*H), and heat-shrink tubing is used as external protection for the module.

The hardware interfaces include one XT30 plug, two XT30 receptacles, and one Capacitor Management Module communication port.



- The model number for the XT30 receptacle is XT30PW-F.
 - The model number for the XT30 plug is XT30PW-M.
-

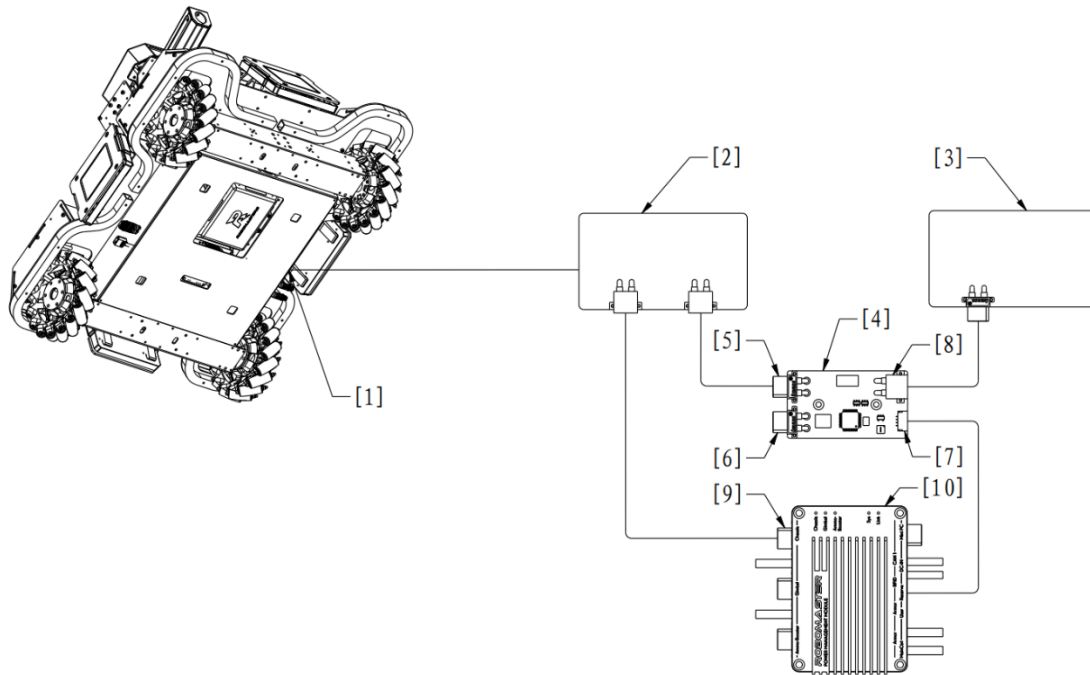
3.13.1 Installation Steps



- The power control panel regulates the output power of the Chassis port of the Power Management Module and the input power and output power of the Supercapacitor Module, to comply with module power limits in the rules. This module should be built by the teams themselves.
 - The XT30 of the Supercapacitor Management Module can withstand a maximum peak current of 30 A and a continuous current of 15 A.
 - For the chassis power source of a robot limited by its power, the maximum total capacity of all capacitors shall be 10 mF, except for the Supercapacitor Module.
-

1. Install the Capacitor Management Module between the output interface of the Supercapacitor Module and the input interface of the power control panel.
2. Connect the Supercapacitor Module and Capacitor Management Module using a XT30-connector cable.
3. Connect the power control panel and Capacitor Management Module using a XT30-connector cable.
4. Connect the communication port of the Capacitor Management Module and the CAN1 port of the Power Management Module using a 4-pin cable.

The connection of the Capacitor Management Module is shown below:



- [1] Robot chassis power supply interface
- [2] Power control panel
- [3] Supercapacitor Module
- [4] Capacitor Management Module
- [5] Capacitor Management Module interface (output, XT30 receptacle) – connecting to power control panel
- [6] Inspection port of Capacitor Management Module (output, XT30 receptacle) – for Pre-Match Inspection only
- [7] Communication port of Capacitor Management Module (CAN, SM04B-GHS-TB interface) – connecting to Power Management Module
- [8] Capacitor Management Module interface (input, XT30 plug) – connecting to Supercapacitor Module
- [9] Chassis output port of Power Management Module
- [10] Power Management Module

Figure 3-49 Capacitor Management Module Connection

3.13.2 Installation Requirements

- The communication port of a Capacitor Management Module must be connected to the CAN1 port of the Power Management Module in order to operate normally.
- During the Inspection, the current load of the Supercapacitor Module is discharged in order to test the capacitance of the Supercapacitor Module. The Inspection steps are as follows:



1. Before Inspection, the team must charge the Supercapacitor Module to its maximum voltage.
2. During the inspection of the supercapacitor, the team must switch the chassis' power supply to the supercapacitor.
3. The inspection staff can measure the energy value of the supercapacitor by connecting an electronic load to the inspection port of the Capacitor Management Module to carry out discharge measurement.

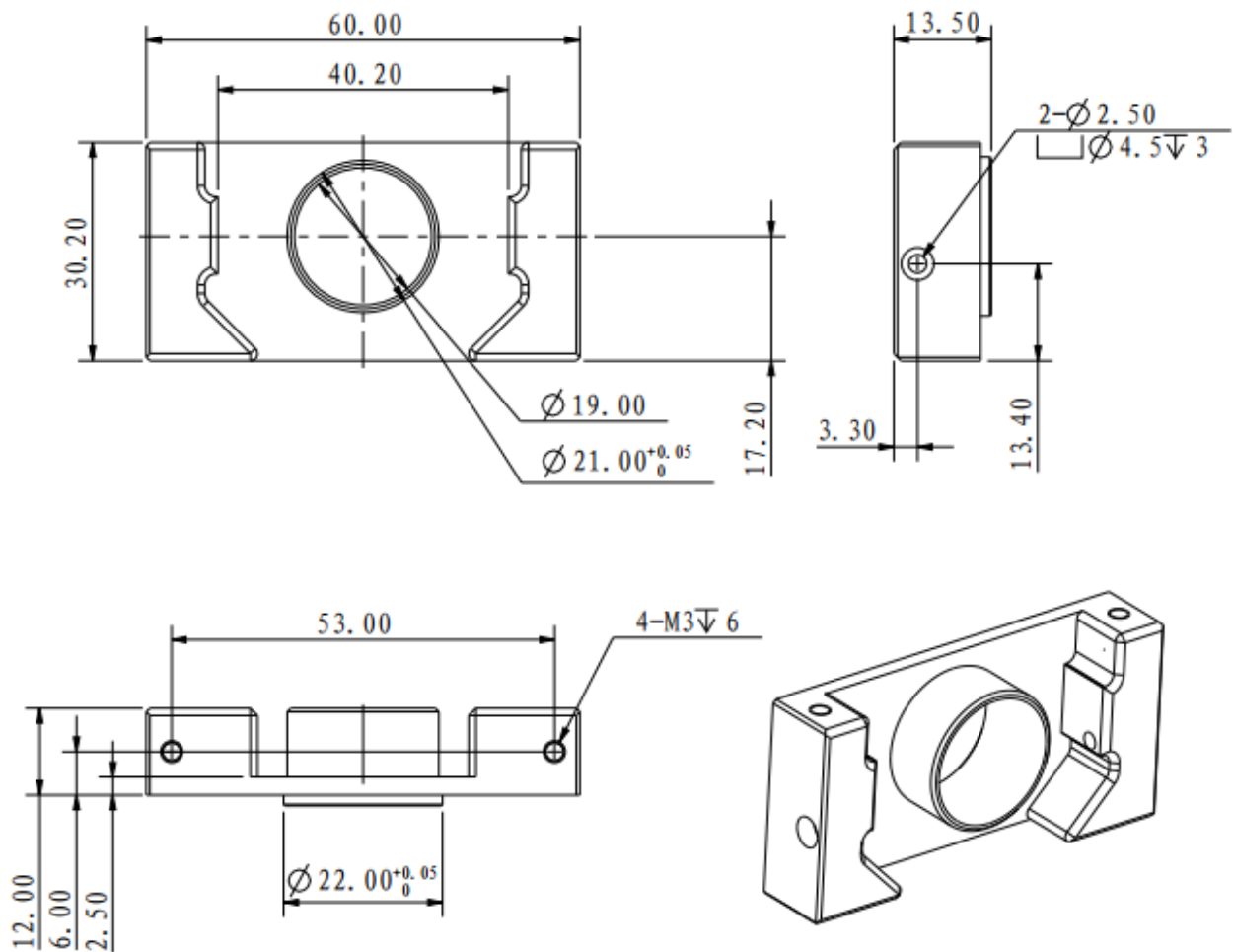
S171 From a fully charged state, the capacitor's voltage needs to drop past 1 V. If the capacitor's voltage drops at an unusually rapid pace, it is deemed to have failed the inspection.

S172 An XT30 receptacle cable that is at least 100 mm long should be attached to the inspection port of the Capacitor Management Module.

S173 Standard, Hero and Sentry Robots must be mounted with Capacitor Management Modules. If a robot does not have a Supercapacitor Module, a Capacitor Management Module can be connected to the Power Management Module using a 4-pin cable.

S174 The Capacitor Management Module must be installed on a place easy for the robot to operate, so that it can be operated during the Inspection.

Appendix 1 Drawing of Adapter Block for Speed Monitor Module (17 mm projectile)



Appendix 2 Reference Drawings



Appendix Figure 1 Hero Armor Sticker - No. 1



Appendix Figure 2 Engineer Armor Sticker - No. 2



Appendix Figure 3 Standard Armor Sticker - No. 3



Appendix Figure 4 Balancing Standard Armor Sticker - No. 3



Appendix Figure 5 Standard Armor Sticker - No. 4



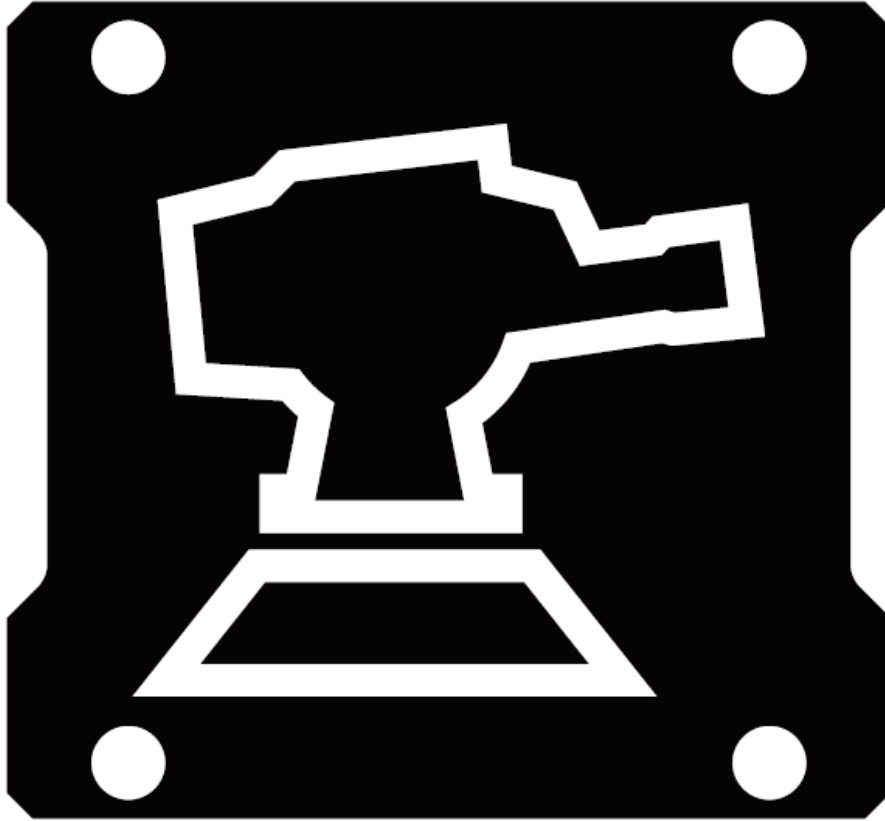
Appendix Figure 6 Balancing Standard Armor Sticker - No. 4



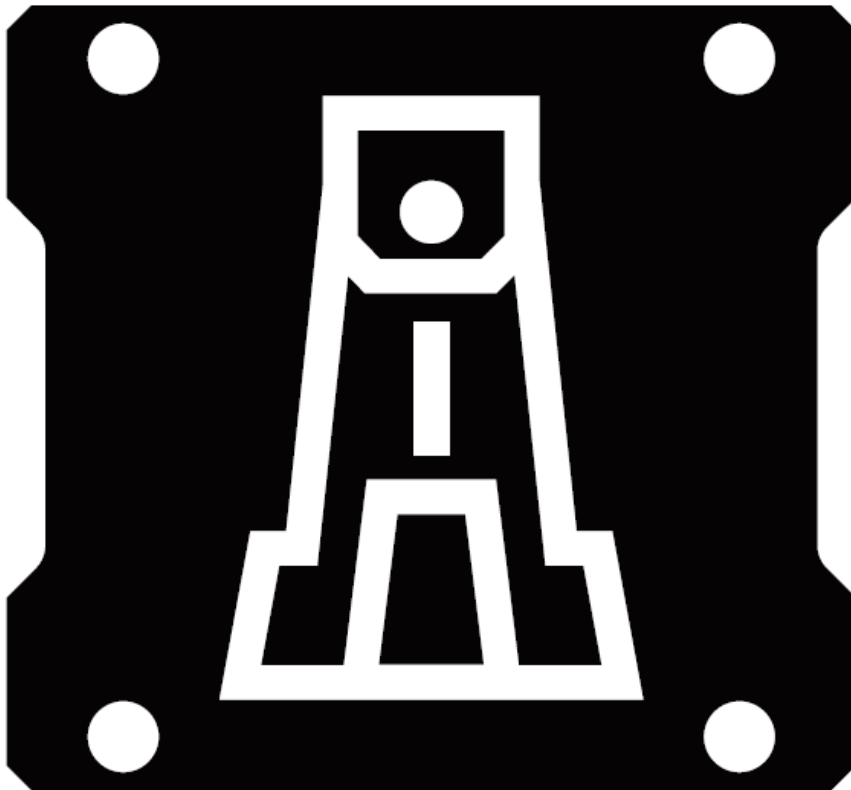
Appendix Figure 7 Standard Armor Sticker - No. 5



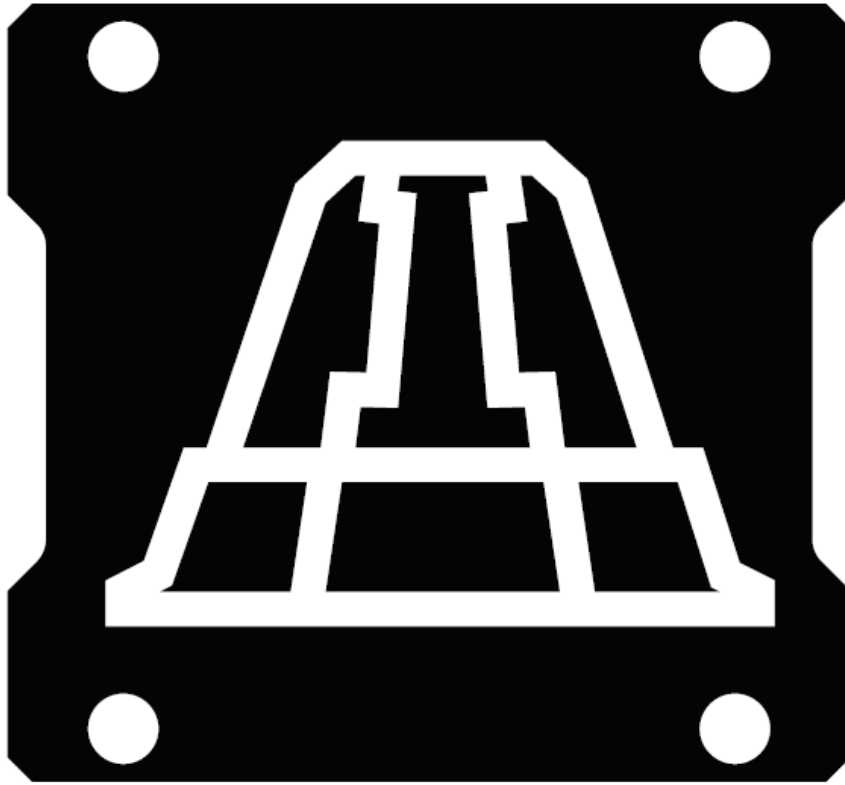
Appendix Figure 8 Balancing Standard Armor Sticker - No. 5



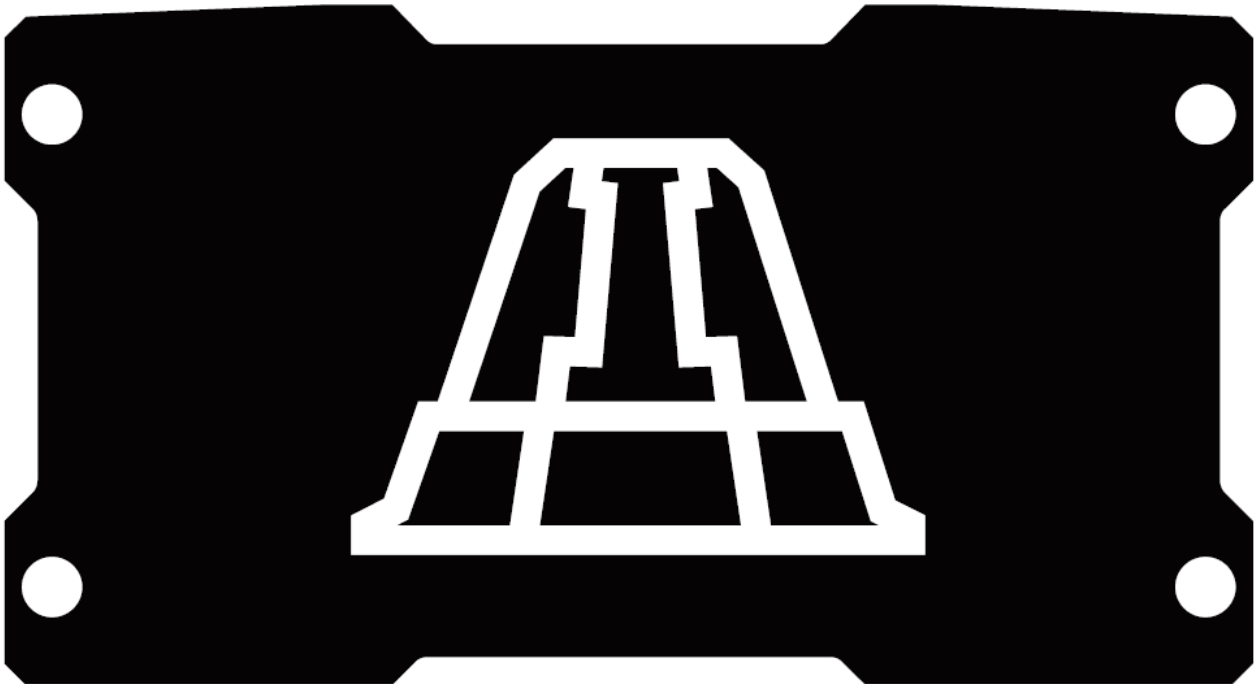
Appendix Figure 9 Sentry Armor Sticker



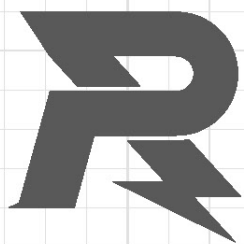
Appendix Figure 10 Outpost Armor Sticker



Appendix Figure 11 Base Small Armor Sticker



Appendix Figure 12 Base Large Armor Sticker



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