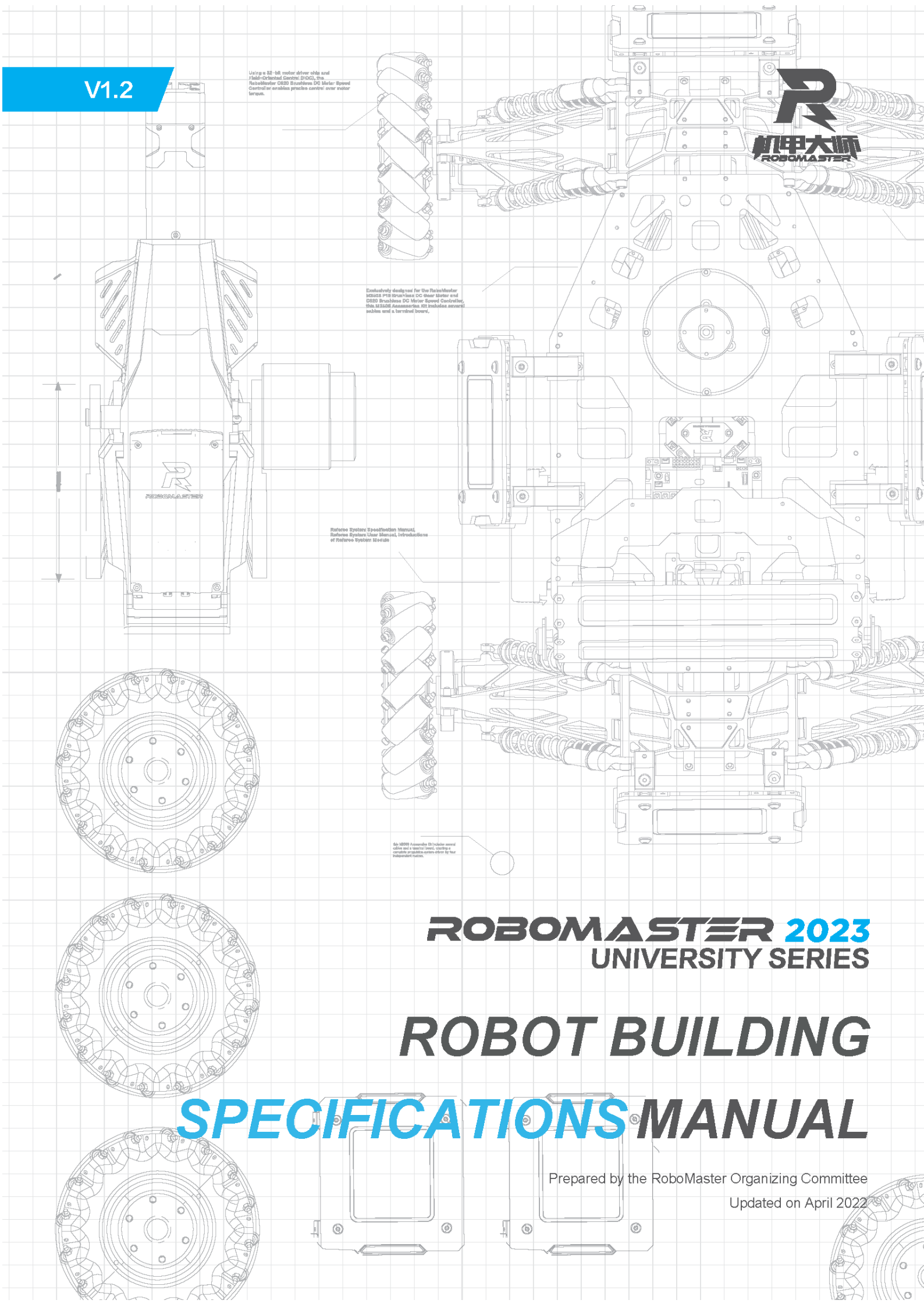
V1.2



ROBOMASTER 2023
UNIVERSITY SERIES

ROBOT BUILDING SPECIFICATIONS MANUAL

Prepared by the RoboMaster Organizing Committee

Updated on April 2022

Using this Manual

Prohibition	Important notes	Hints and tips	Definitions and references

Change Log

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

Date	Version	Release Notes	Effective Date
2023.04.20	V1.2	1. Added new installation rules for robots' Light Indicator Module. 2. Added new definition for robot chassis. 3. Added relevant specifications for cylinders and heat source. 4. Added relevant specifications for Customer Controllers. 5. Added relevant rules for robots' school badges. 6. Modified the relevant descriptions of the batteries. 7. Modified the descriptions of robots' visual feature. 8. Modified the relevant requirements for propulsion with compressed gas of the Launching Mechanism.	2023.04.20
2023.01.13	V1.1	1. Revised part of the General Technical Specifications, mainly including the following: ● Revised the relevant specifications in the “Gas Source” chapter (S7) ● Revised the relevant specifications in the “Communication Equipment” (formerly “Wireless Equipment”) chapter ● Revised the relevant specifications for Launching Mechanism ● Added relevant definitions of third-party finished modules 2. Revised part of the Robot Technical Specifications, mainly including the following: ● Added definitions of robot dimensions	2023.01.13

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Date	Version	Release Notes	Effective Date
		● Revised the relevant specifications for the Mineral-Grabbing Mechanism and Referee System of Engineer Robots ● Revised the relevant specifications for the Referee Systems and Existing Launching Mechanisms Hero and Standard Robots ● Revised the relevant specifications for the propulsion mechanisms of Balancing Standard Robots ● Added relevant specifications for the rigid ring on the protective rod of Aerial Robots ● Revised the relevant specifications for the Existing Launching Mechanism, strength, and Referee System of Sentry Robots ● Revised the descriptions of the Radar computing platform 3. Revised part of the Referee System Mounting Specifications, mainly including the following: ● Added relevant specifications for robot transformation ● Revised the installation requirements for Sentry Armor Modules (S108) 4. Fixed known issues and improved some descriptions	
2022.10.26	V1.0	First Release	2022.10.26

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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 described in this document, or they will not pass the Pre-Match Inspection. If any safety incident has occurred due to a violation of rules, the RoboMaster Organizing Committee ("RMOC") reserves the right to hold the violating party legally responsible. Any dispute arising from this Specification Manual will be settled based on interpretations provided by the Chief Referee or Head Inspector.

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?djifrom=nav

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2. Technical Specifications

2.1 General Technical Specifications

2.1.1 Energy Source

- The use of combustion engines, explosives, and hazardous chemicals is forbidden.
- Participating teams are forbidden from using mains supply in the Competition Area (except for Radars).
- Use of hydraulic or other propulsion methods capable of causing pollution is forbidden.
- For robots limited by their chassis power, the horizontal movements of their chassis can only be propelled by electricity.

S1 Robots can be powered only by electricity and air pressure.

2.1.1.1 Power Supply

S2 Only batteries produced by DJI or other official manufacturers can be used on robots and Customer Controllers, except only for Darts which may use lithium batteries produced by other official manufacturers.

S3 The total nominal energy of the Single Supercapacitor Modules of Standard, Hero and Sentry Robots must not exceed 2000 J, and their actual measured energy must not exceed 2200 J. The nominal energy calculation formula for a single capacitor module is $E = \frac{1}{2} * C * U^2$ (U refers to the withstand voltage value of the capacitor and C refers to capacitance).

S4 Only one set of supercapacitor modules is allowed to be used on each robot.

2.1.1.2 Gas Source

S5 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.

S6 The working gas must be non-flammable, non-toxic and non-polluting, such as air, nitrogen, and carbon dioxide.

S7 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.

S8 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.

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S9 The gas cylinder must have been issued an approval certificate by an officially recognized approving institution in its country of manufacture.

S10 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.

S11 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.

S12 No inflammables are allowed to be within 50mm from the gas cylinder.

S13 All gas pipes and parts must be able to withstand the maximum working pressure of the system. It is recommended for a safety relief valve to be 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 VTM used to transmit robot control-related data. It can replace the DT7 and offer more superior stability.
- For protocols related to the VTM Link, please refer to the Referee System Serial Port Protocol Appendix.

S14 The control methods specified for this competition season are as 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
Serial port of the Referee System	Inter-robot communication, Dart launching command

S15 The remote controllers specified for this competition season are as 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.

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Table 2-2 Summary of Remote Controllers

Name	Image
DT7	
FS-i6X	
WFLY ET08	
WFLY ET16S	

S16 Each remote controller can only be linked to one receiver.

S17 Remote controllers cannot be modified.

S18 Robots are not allowed to carry wireless communication equipment other than the remote controller (RC) and Referee System Module.

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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.

S19 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 one meter must be less than 9 cm).

S20 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.

S21 Besides laser sights, Engineers can also be mounted with a white supplement light and a display screen not larger than 7 inches. The light can only be used for enhancing visual recognition features when the robot is acquiring a mobile component (a mineral or obstacle block). The display screen must not interfere with the robot's visual recognition features. Other robots must not be equipped with other obvious visible light emitting equipment.

S22 The optical equipment used by a robot must not cause any physical harm to any person.

S23 All infrared light sources must conform to the Class I requirements.

2.1.4 Visual Feature

On both sides of the Referee System Armor Module are clear lighting effects to enable robots to develop 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 of the lighting of the venue and other possible interferences around the venue.

The following specifications must be followed when designing a robot's computer visual features:

S24 Armor Modules cannot be blocked.

S25 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.

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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 images of the stickers, please refer to "Appendix 2: Reference Drawings". For robot numberings, please refer to the "Robot Line-up" chapter in the RoboMaster 2023 University Championship Rules Manual.

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

S26 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.

S27 The armor stickers provided by the RMOC can only be attached on 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 on 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:

S28 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.

S29 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.

S30 Fishing net cannot be used as an aesthetic material, but can be used in the protective guard of an Aerial Robot.

S31 Do not design or use sharp structures to avoid causing damage to the battlefield or injury to personnel.

Gloss:

S32 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 100mm 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.

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S33 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.

S34 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 100mm*100mm. 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 30mm. If the exterior of a robot does not meet specifications, an Inspector may require the position or size of a school badge or team badge to be altered.

S35 The inkjet or stickers of the school and team badges must not affect the robot's visual features, and cannot be illuminated.

S36 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:

S37 Inverse colors can be applied for advertising spaces, or their original colors can be retained.

S38 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 30mm.

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

S40 The size of a single robot advertising space shall not be more than 100mm*100mm. 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, an Inspector may require the position or size of an advertising space to be altered.

2.1.7 Launching Mechanism

Launching Mechanism: A mechanism that is able to launch a projectile from a robot along a fixed trajectory to cause damage to another robot (it is not considered a Launching Mechanism if it cannot be powered up).

S41 Robots using compressed gas as the propellant for projectiles must not have an acceleration length exceeding 200mm (the acceleration must be completed before the projectile enters the Speed Monitor Module).

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S42 Except for Aerial Robots, the Launching Mechanisms of robots must be able to stably launch 10 rounds of 17mm projectiles or five rounds of 42mm projectiles.

S43 Each Launching Mechanism must be installed with a Speed Monitor Module in accordance with the rules. 17mm Launching Mechanism must be mounted with a 17mm Fluorescent Projectile Energy-Charging Device according to specifications.

Any robot mounted with an Optional 17mm Launching Mechanism will gain 0.2 kg for its weight in the Referee System.

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, L*W*H

Table 2-3 Description of Custom Controller Production Parameters

Item	Limit	Notes
Target	Each robot may only be equipped with one Custom Controller.	Custom Controllers are not allowed to be used on Sentry Robots.
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage(V)	30	-
Maximum Size (mm, L*W*H)	350*350*350	● Excluding the size of wearable devices such as video glasses (if any) ● Excluding the size of data or power cables of any equipment
Maximum Weight (kg)	10	Including the battery weight
Data Transmission	Serial Port Module	-

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Item	Limit	Notes
Video Transmission	Standard HDMI Type A Plug	The recommended resolution is 1920*1080. Otherwise compression or distortion issues may occur.
Serial Data Transmission	Able to send and receive	The serial port standard is RS232.
Protocol	Refer to the "Appendix to the Referee System Serial Port Protocol"	-

Mounting Requirements:

S44 It is recommended that a non-slip pad is placed under the Custom Controller.

S45 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.

S46 Keep the cables of the Custom Controller neatly stored in the device without being exposed.

S47 The interface between the Custom Controller and the computer in the operation room should strictly comply with the requirements specified in "Table 2-3 Description of Custom Controller production parameters". Unauthorized connection is strictly forbidden.

How to Use:

S48 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.

S49 The Custom Controller must not be equipped with any wireless transmitter or receiver.

S50 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.

S51 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 Customer Controller. No battery is allowed to be mounted in the glasses (excluding commercial video glasses which come with batteries).
- For self-made controllers, only batteries produced by DJI or other official manufacturers can be used. Use of mains electricity (220V) is strictly forbidden.

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2.1.9 Other

S52 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.

S53 Robots are not allowed to grab the Referee System Module of any robot.

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

- Only teams that did not qualify for the offline competitions of the RoboMaster 2022 University Series (except for the RoboMaster 2022 University AI Challenge) 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 abovementioned 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 abovementioned 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

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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.

S54 Before a robot is inspected, the team is required to submit its photographs to the Inspection Area clearly showing the primary structures of the robot. Any protective shell must be removed to capture the robot's main body in the photographs.

S55 Any team using a redesigned fully assembled robot or open-source robot must submit descriptions of the relevant modifications to the Inspection Area.

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 projectile containers. For example: Fixed linkage between projectile containers 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.

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3. **Executive mechanisms**

- 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 executive mechanisms. 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 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.

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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

- L*W*H: Length*Width*Height
- Maximum Initial Size: A robot's maximum size before transformation.
- Maximum Expansion Size: A robot's maximum size at any time, and is the maximum size the robot's mechanisms can possibly expand to.

2.3.1 Hero Robot

The production parameters for Hero Robots are as follows:

Table 2-4 Hero Production Parameters

Item	Limit	Notes
Operating Mode	There is no limit. 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	● A Fixed 42mm Launching Mechanism ● The Optional 17mm Launching Mechanism can be mounted.	-

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Item	Limit	Notes
Maximum Weight (kg)	35	Includes battery weight, but not the weight of the Referee System
Maximum Initial Size (mm, L*W*H)	800*800*800	Its orthographic projection on the ground should not exceed a 800*800 square
Maximum Expansion Size (mm, L*W*H)	1200*1200*1200	Its orthographic projection on the ground should not exceed a 1200*1200 square
Referee System	● Large Armor Module ● Speed Monitor Module (42mm Projectile) ● VTM Transmitter ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module ● Light Indicator Module ● Supercapacitor Management Module	Weight is 4.21kg

2.3.2 Engineer Robot

The production parameters for Engineer Robots are as follows:

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Table 2-5 Hero Robot Production Parameters

Item	Limit	Notes
Operating Mode	There is no limit. One remote control and one Custom Controller can be configured at most	-
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage（V）	30	-
Mineral-grabbing Mechanism	● Any mechanism that can come into contact with minerals in the Large Resource Island is considered a Mineral-grabbing Mechanism. ● No adhesive materials can be used. ● When extending to the front, a Mineral-grabbing Mechanism must not reach farther than 500mm from the robot's body and beyond the central line of the Large Resource Island.	-
Launching Mechanism	No Launching Mechanism is allowed to be installed	-
Maximum Weight (kg)	35	Includes battery weight, but not the weight of the Referee System
Maximum Initial Size (mm, L*W*H)	600*600*600	Its orthographic projection on the ground should not exceed a 600*600 square
Maximum Expansion Size (mm, L*W*H)	1200*1200*1000	● Its orthographic projection on the ground should not exceed a 1200*1200 square

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Item	Limit	Notes
		● All components of an Engineer cannot exceed their Maximum Expansion Size during its transformation.
Referee System	● Small Armor Module ● VTM Transmitter ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module ● Light Indicator Module	Weight is 3.04kg

2.3.3 Standard Robot

The production parameters for Standard Robots are as follows:

Table 2-6 Standard Production Parameters

Item	Limit	Notes
Operating Mode	There is no limit. 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	-

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Item	Limit	Notes
	damage to any part of the body	
Launching Mechanism	● A Fixed 17mm Launching Mechanism ● The Optional 17mm Launching Mechanism can be mounted.	-
Maximum Weight (kg)	25	Includes battery weight, but not the weight of the Referee System
Maximum Initial Size (mm, L*W*H)	600*600*500	Its orthographic projection on the ground should not exceed a 600*600 square
Maximum Expansion Size (mm, L*W*H)	800*800*800	Its orthographic projection on the ground should not exceed a 800*800 square
Referee System	● Small Armor Module (Balancing Standard Robots shall be installed with Large Armor Modules) ● Speed Monitor Module (17mm Projectile) ● VTM Transmitter ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module ● Light Indicator Module ● 17mm Fluorescent Projectile Energy-Charging Device	The Referee System of a Balancing Standard Robot weighs 2.60 kg, while those of Regular Standard Robots weigh 3.25 kg.

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Item	Limit	Notes
	● Supercapacitor Management Module	

The definition of Standard Balancing Robots:

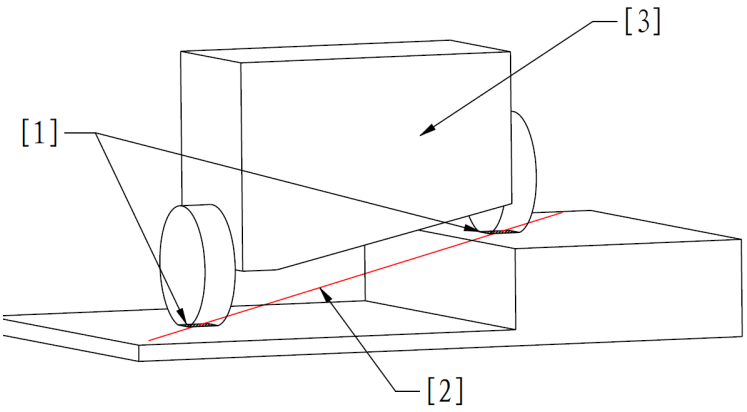
A robot's contact surface shall be any bordered battlefield surface that it has contact with. Any robot that meets all the following criteria is deemed a Balancing Standard Robot:

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 200mm height difference in between. A 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.

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2.3.4 Aerial Robot

The production parameters for Aerial Robots are as follows:

Table 2-7 Aerial Robot Production Parameters

Item	Limit	Notes
Operating Mode	There is no limit. Only a maximum of two remote controls and one Custom Controller can be configured.	-
Maximum Total Power Supply Capacity (Wh)	800	-
Maximum Supply Voltage (V)	48	-
Launching Mechanism	The Optional 17mm Launching Mechanism can be mounted.	-
Maximum Weight (kg)	15	Includes battery weight, but not the weight of the Referee System
Maximum Size (mm, L*W*H)	1700*1700*800	Its orthographic projection on the ground should not exceed a 1700*1700 square (not including the size of the vertical rigid safety rod)
Referee System	● VTM Transmitter ● Positioning System Module ● Main Controller Module ● Power Management Module	Weight is 0.64 kg

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

S56 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

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significant damage.

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

S57 While the fully enclosed propeller cage is being shot by a 42mm projectile at the speed of 12m/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 42mm projectile cannot penetrate the mesh of the propeller cage, which should not have a surface area bigger than 9 cm^2.

S58 If 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.

S59 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 protective rod that is 350±5mm 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 protective 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 protective 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 50mm, 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 road can be joined normally with the Aerial Safety Rope hook. The dimensions of the Aerial Safety Rope hook are as follows:

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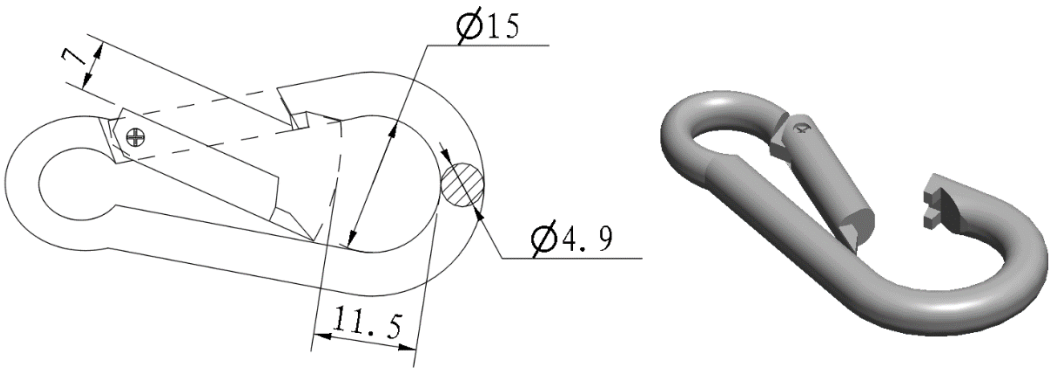

S60 Teams should reasonably evaluate and fully test whether the propulsion system and power supply system of Aerial can meet the requirements of loading and combat, to prevent safety incidents or accidents during the competition.

S61 Teams can mount light indicators on Aerials to indicate their current flight status. Light indicators shall not be installed in more than six places. The max illuminance of each light at 100mm away must not exceed 3,500 Lux. Light indicators shall not disturb the match in 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 3,200 Lux at a distance of 100mm.

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S62 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 180mm 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.

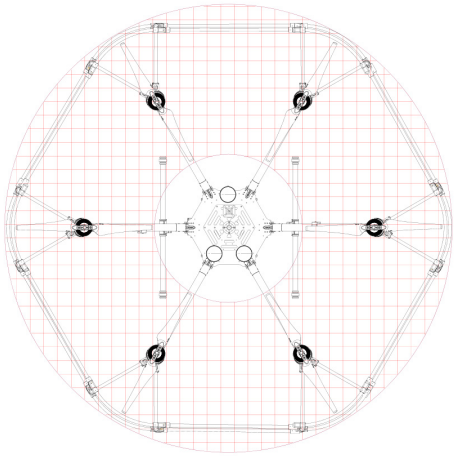

Figure 2-2 Effective Area of the External Navigation Lights

S63 A single area of external navigation light of Aerial must have an illuminance at 100mm away ranging between 500 - 2,000 Lux.

S64 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.

S65 If the Aerial Robot is mounted with a Optional 17mm Launch Mechanism, it must have a corresponding structure that holds the projectiles in place in the magazine. No projectiles should fall from the projectile magazine during the robot's flight.

S66 The Remote Controller used by an Aerial must have a propeller stopping function, to ensure the Aerial Robot is able to stop its propellers instantly through the Remote Controller in an emergency.

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2.3.5 Sentry Robot

The production parameters for Sentry Robots are as follows:

Table 2-8 Sentry Production Parameters

Item	Limit	Notes
Operating Mode	Fully automatic, with no more than one remote controller for debugging	-
Maximum Power Supply Capacity (Wh)	265	-
Maximum Power Supply Voltage（V）	30	-
Launching Mechanism	Maximum two Fixed 17mm Launching Mechanisms	Two Speed Monitor Modules (17mm projectile) must be installed
Maximum Weight (kg)	25	Includes battery weight, but not the weight of the Referee System
Maximum Initial Size (mm, L*W*H)	700 x 700 x 700	Its orthographic projection on the ground should not exceed a 700*700 square area
Maximum Expansion Size (mm, L*W*H)	800*800*800	Its orthographic projection on the ground should not exceed a 800*800 square
Referee System	● Small Armor Module ● Speed Monitor Module (17mm Projectile) ● RFID Interaction Module ● Positioning System Module ● Main Controller Module ● Power Management Module	Weight is 3.32kg

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Item	Limit	Notes
	● Light Indicator Module ● 17mm fluorescent projectile energy-charging device ● Supercapacitor Management Module	

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.

S67 A Dart uses its own Visionary Intelligence 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.

S68 A Dart Launcher must be mounted with a Referee System, where the Aerial Gimbal Operator can control the client interface and transmit data through the Referee System port or Remote Controller to control the Dart Launcher.

S69 Dart Trigger Device 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 should incorporate buffer and strength designs to avoid damage to their Darts.
- A Dart Trigger Device will enter normal work mode after being powered on for 3 seconds or going through Pre-Match Inspection setup. A Dart Trigger Device will emit a light of the corresponding team's color after being subject to an acceleration of 2 g. Each trigger lasts for 5 seconds, at the end of which the light will turn off. If the acceleration of 2g occurs again during the trigger period, the trigger time will be refreshed.
- If the Dart Trigger Device 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 are unable to detect Dart hits. Please replace with a backup Dart Trigger Device, otherwise all resulting losses shall be borne by the team.

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The use of compressed air is prohibited in propelling a Dart.

The production parameters for a Dart is as follows:

Table 2-9 Dart Production Parameters

Item	Limit	Notes
Maximum Power Supply Capacity (Wh)	4	-
Maximum Power Supply Voltage（V）	8.4	-
Maximum Weight (kg)	0.22	Not including the Dart Trigger Device (0.02 kg)
Maximum Size (mm, L*W*H)	250*150*150	● The flight length of a Dart is no longer than 250 ● The wingspan of a Dart is no longer than 150

S70 Dart can only be in the ready-to-launch state during the 7-minute match.

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

The production parameters for Dart Launcher are as follows:

Table 2-10 Dart Launcher Production Parameters

Item	Limit	Notes
Operating Mode	There is no restrictions. One remote control and one Custom Controller can be configured at most	Use of the Referee System Serial Port is recommended.
sf	● Yaw angle: No restrictions ● Pitch angle: 25-45	-
Maximum Total Power Supply Capacity (Wh)	265	-

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Item	Limit	Notes
Maximum Power Supply Voltage（V）	30	-
Maximum Chassis Power Consumption (W)	No restrictions	-
Maximum Dart Load	4	-
Maximum Weight (kg)	25	Includes battery weight, but not the weight of the Referee System
Maximum Size (mm, L*W*H)	1000*600*1000	The orthographic projection of the Dart Launcher on the ground must not under any circumstances exceed the plane on which the Dart Launcher is placed.
Referee System	Main Controller Module and Power Management Module	Weight is 0.22kg

2.3.6.1 Mounting Specifications

Dart must be mounted with Dart Trigger Device provided by the RMOC. A Dart Trigger Device 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 Device.

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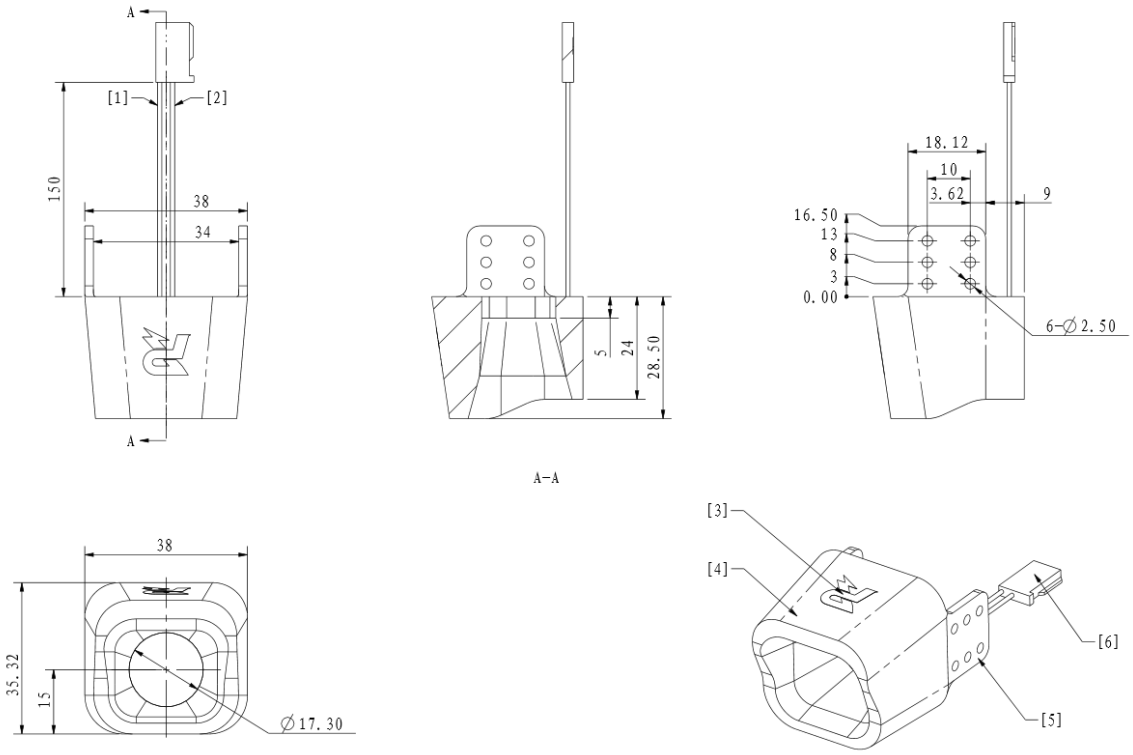

[1] GND Cable [2] +5V Cable [3] Logo

[4] Dart Trigger Device [5] Installation Lug [6] 3P 2.54mm cable

Figure 2-3 Dart Trigger Device

2.3.6.1.1 Installation Steps

1. Secure the Dart Trigger Device 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 Device with 5V power supply.

2.3.6.1.2 Installation Requirements

S71 After mounting Dart Trigger Device, its up and down, left and right sides must not be blokced by the Dart structure, as shown below.

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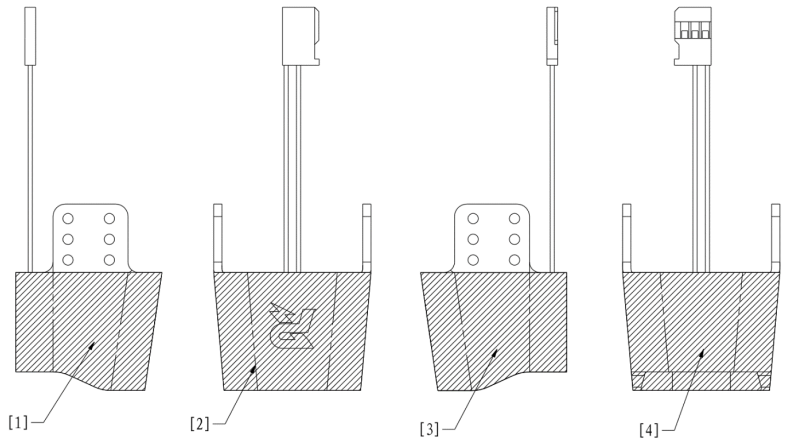
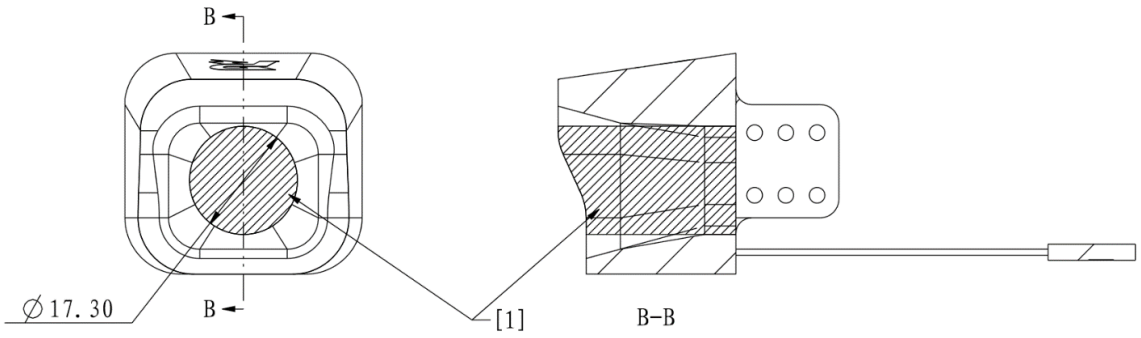


[1] Left side [2] Upward side [3] Right side [4] Downward side

Figure 2-4 Areas Not Allowed to Be Blocked on A Dart Trigger Device

S72 Dart camera or other devices can be mounted in the internal cavity of Dart Trigger Device. The mounting area must not exceed the shadow area as shown below.



[1] Shadow Area

Figure 2-5 Dart Trigger Device Internal Cavity

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 2023 University Championship Rules Manual.

2.3.6.3 Dart Launching Station

A Dart Launcher is considered official battlefield component. The gate of a Dart Launcher 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 description of the Dart Launching Station in the RoboMaster 2023 University Championship Rules Manual.

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2.3.7 Radar

A Radar consists of two components: the computing platform and the sensor. Both ends need to be connected by an electric cable.

The production parameters for a Radar Computing Platform are as follows:

Table 2-11 Radar Computing Platform Production Parameters

Item	Limit	Notes
Operating Mode	Fully automatic, with no more than one remote controller for debugging	-
Vx	750	-
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.
Vx	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	Its orthographic projection on the ground should not exceed a 600*350 rectangular area.
Referee System	● Main Controller Module ● Power Management Module	Weight is 0.22kg

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The parameters for a Radar Sensor are as follows:

Table 2-12 Radar Sensor Parameters

Item	Limit	Notes
Maximum Weight (kg)	30	-
Maximum Expansion Size (mm, L*W*H)	1200*1200*1500	● Its orthographic projection on the ground should not exceed a 1200*1200 rectangular ● The recommended height for the mounting bracket of Radar sensor is at least 1.2m.

2.3.7.1 Mounting Specifications

- The surface of the Radar Base 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 Base.
- 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 3m.

2.3.7.2 Computing Platform

During the 3-minute Setup Period, teams shall place their computing platforms on a designated surface near the Radar Base. The surface should provide at least two 10A 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.

S73 The Referee System of a Radar can only be mounted on the Computing Platform.

S74 No wireless receiving device can be used on computing equipment. If a receiving device cannot be removed, it must be set as disabled in the operating system.

S75 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 220V 50Hz, and the power outlets are based on the 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 Base and the HDMI cable provided by the RMOC. Teams must resolve connection issues on their own.

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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.

S76 Sensors must be fixed on the Radar sensor mounting bracket and placed on the Radar base.

S77 Teams must design their own Radar sensor mounting bracket to increase the elevation for the installation of sensors.

S78 The size of the Radar sensor mounting bracket should allow for proper installation on the surface of the Radar base and be able to be lifted with one arm. The specifications of the Radar Base should follow the relevant description of the Radar Base in the RoboMaster 2023 University Championship Rules Manual. The signal transmission and power supply of the sensor must be handled by the teams themselves.

S79 In the case of an emergency such as a short circuit or fire in the Radar area, the referee may power it off or perform other necessary operations.

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3. Referee System Mounting Specifications

3.1 Introduction

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 Consumption: The power propulsion system that enables a robot to move horizontally, 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 executive mechanism 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).

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: control the chassis, gimbal, and power supply for the Launching Mechanism of a robot; transmit data; detect chassis power; etc.

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Module	Introduction
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 Module and Large Armor Module.
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 (17mm projectile) and Speed Monitor Module (42mm 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 monitor in the Operator Room.
Positioning System Module	A Positioning System Module can detect a robot's location on the Battlefield.
17mm Fluorescent Projectile Energy-Charging Device	The 17mm fluorescent projectile energy-charging device provides light energy to 17mm fluorescent projectiles.

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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.

3.2 Configuration of Robot Referee System

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

Table 3-2 Configuration of Robot Referee System Modules

Quantity \ Robot Type	Hero Robots	Engineer Robots	Standard Robots	Balancing Standard Robots	Aerial Robots	Sentry Robots	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 (Transmitter)	1	1	1	1	1	0	0	0
RFID Interaction Module	1	1	1	1	0	1	0	0
Speed Monitoring (17mm) Module	0	0	1	1	0	2	0	0

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Robot Type / Quantity	Hero Robots	Engineer Robots	Standard Robots	Balancing Standard Robots	Aerial Robots	Sentry Robots	Dart System	Radar
Speed Monitoring Module (42mm) 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

- The table above does not include the Optional 17mm Launching Mechanism. If the robot is mounted with one, please refer to "2.1.7 – Launching Mechanism" for the installation requirements.
- Positioning System Modules do not have to be mounted on robots in the RoboMaster University League.

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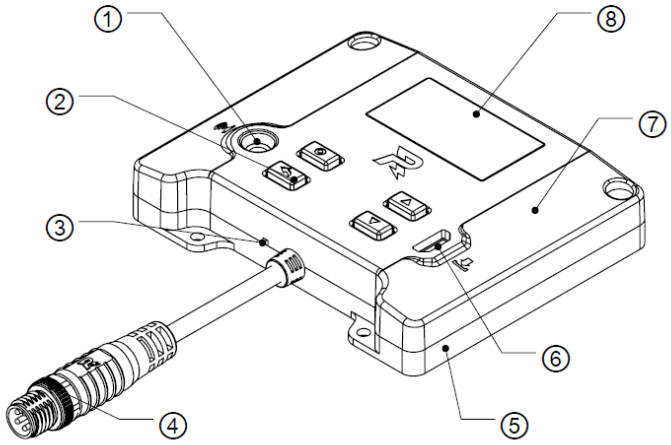
3.3 Specifications for Mounting Main Controller Module

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

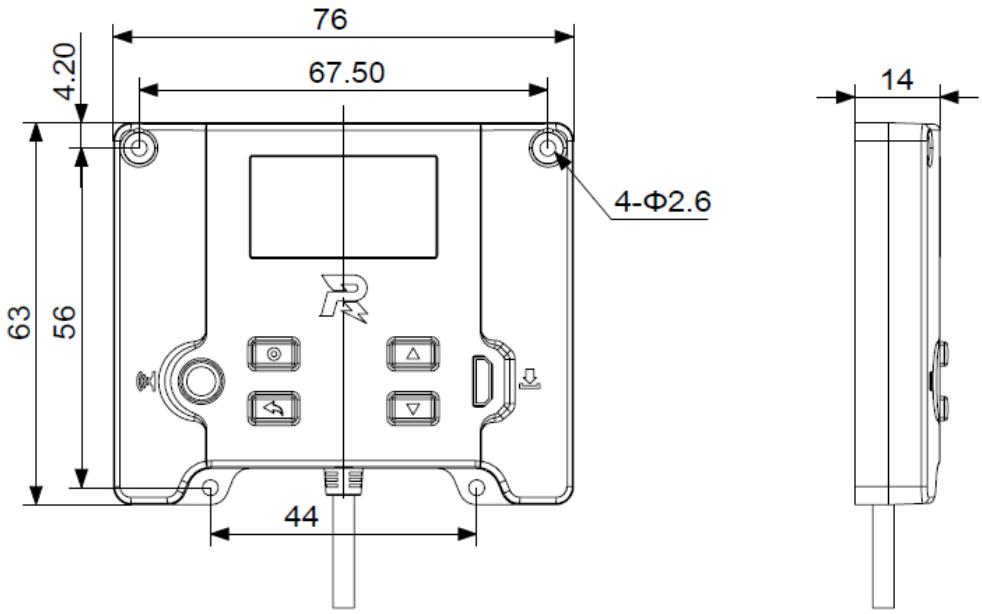


Figure 3-1 Main Controller Module

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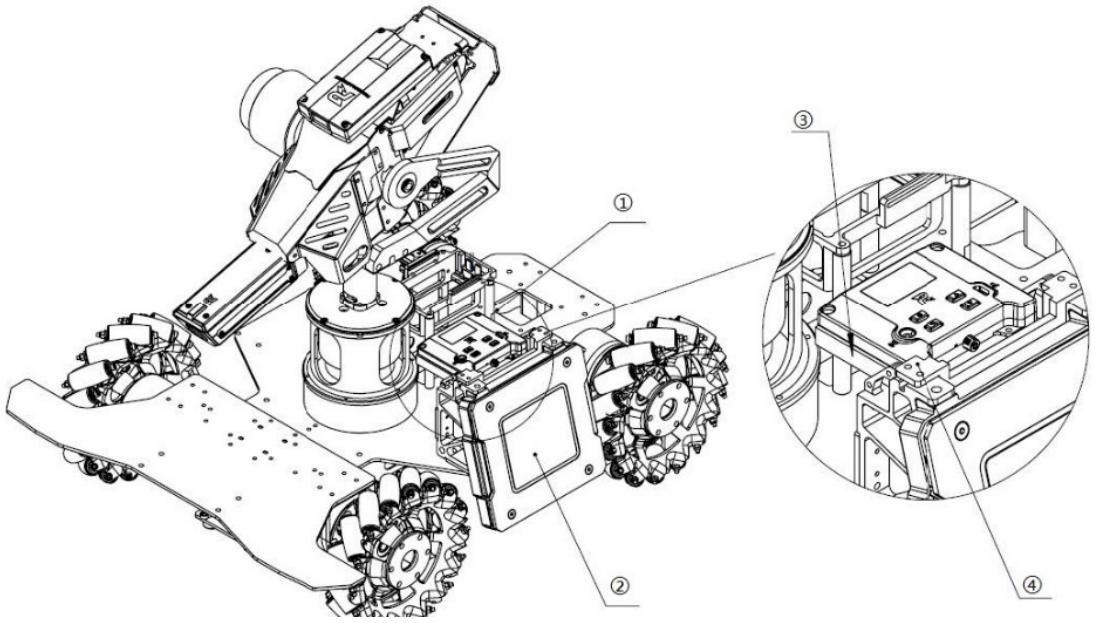
3.3.1 Installation Steps

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

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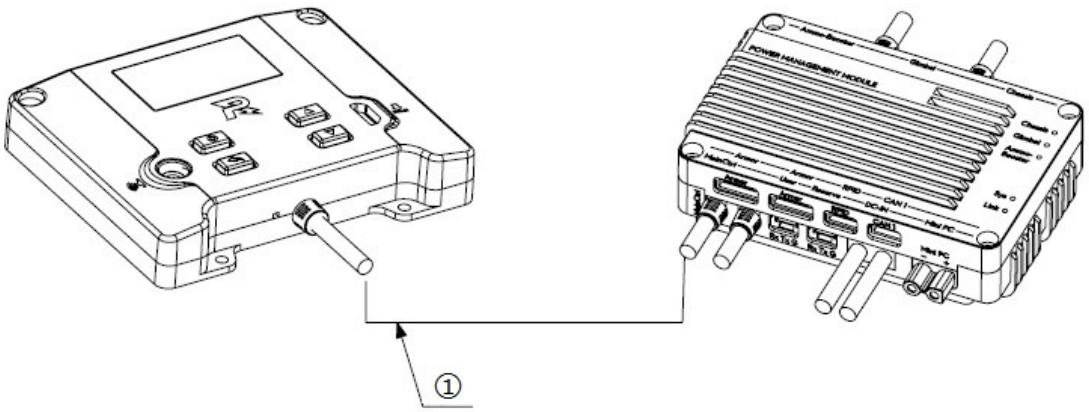


[1] Aviation Connector Cable

Figure 3-3 Main Controller Module Connection

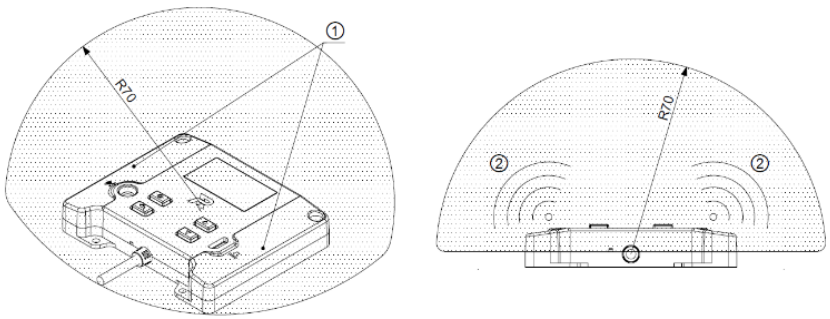
3.3.2 Installation Requirements

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

S80 Ensure the top surface of the Main Controller Module of a robot faces up horizontally when it is in working condition.

S81 The space above the interface of the Main Controller Module screen, keys, ports, and infrared receiver must not be obstructed, and if any protective device is mounted (e.g. foam or fiberglass sheets), it must be easy to open for staff to operate the buttons, check screen information, and upgrade the firmware.

S82 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 70mm radius, with the center being 14.5mm directly below the center point of the logo.



[1] Antenna Position [2] Signal Direction

Figure 3-4 Graph of Main Controller Module Mounting Position

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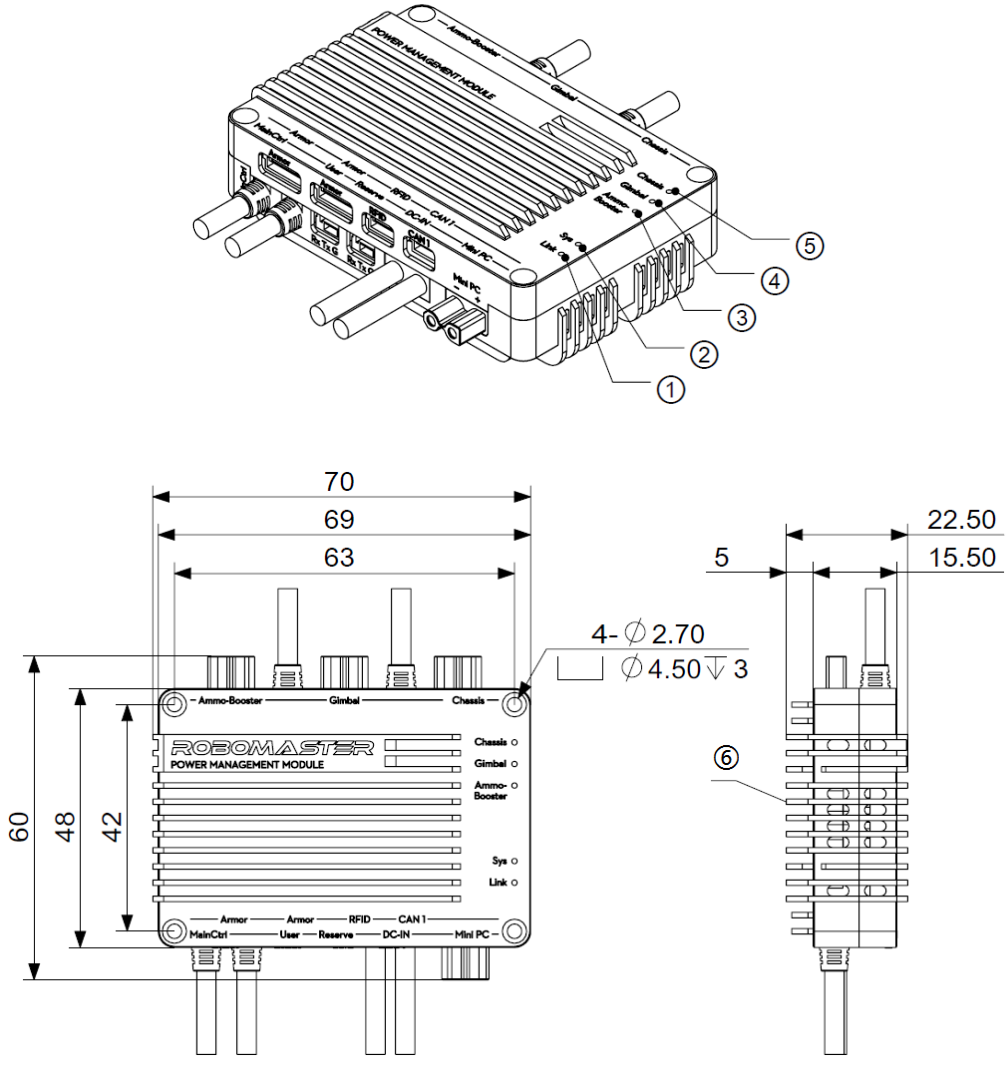
S83 During a match, participants must use the Main Controller Module installed by the RMOC on the site for their Dart Systems and Radars.

During a match, participants must use the Main Controller Module installed by the RMOC on the site for their Dart Systems and Radars. When designing the Main Controller Module, teams do not have to mount it according to the above requirements.

3.4 Mounting 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

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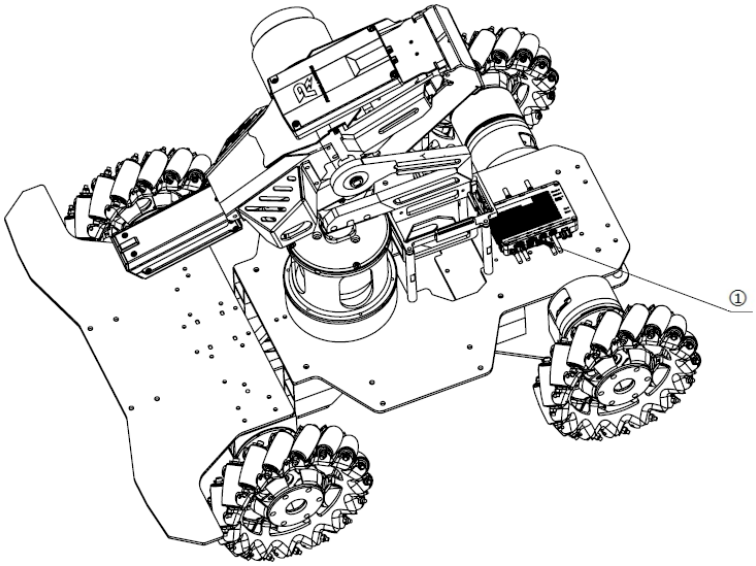
3.4.1 Installation Steps

The aviation connector port of the Light Indicator Module, VTM 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 Power Management Module Mounting Graph

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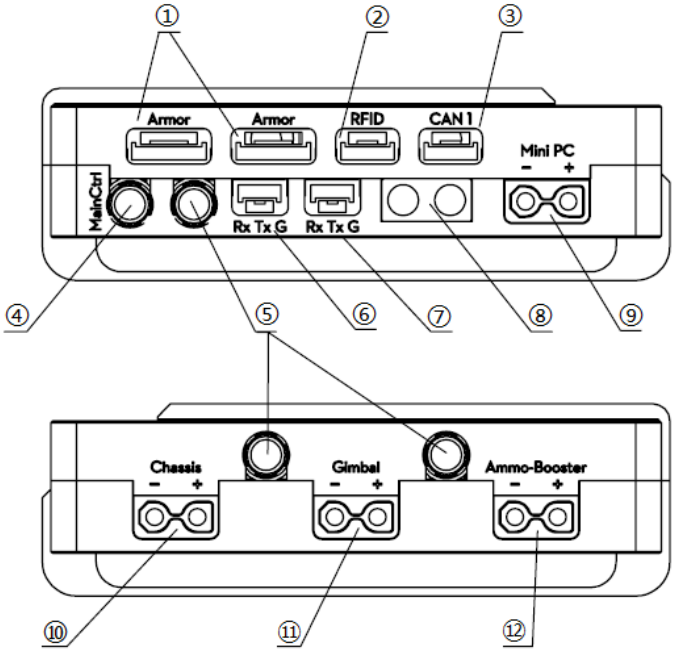

[1] Armor Module SM06B-GHS-TB Port

[2] RFID Interaction Module SM04B-GHS-TB Port

[3] Capacitor Management Module SM04B-GHS-TB Port

[4] Main Control 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) - connects to the chassis

[11] Referee System Power Supply XT30 Port (output) - connects to the gimbal

[12] Referee System Power Supply XT30 Port (output) - connects to the Launching Mechanism

Figure 3-7 Power Management Module Port

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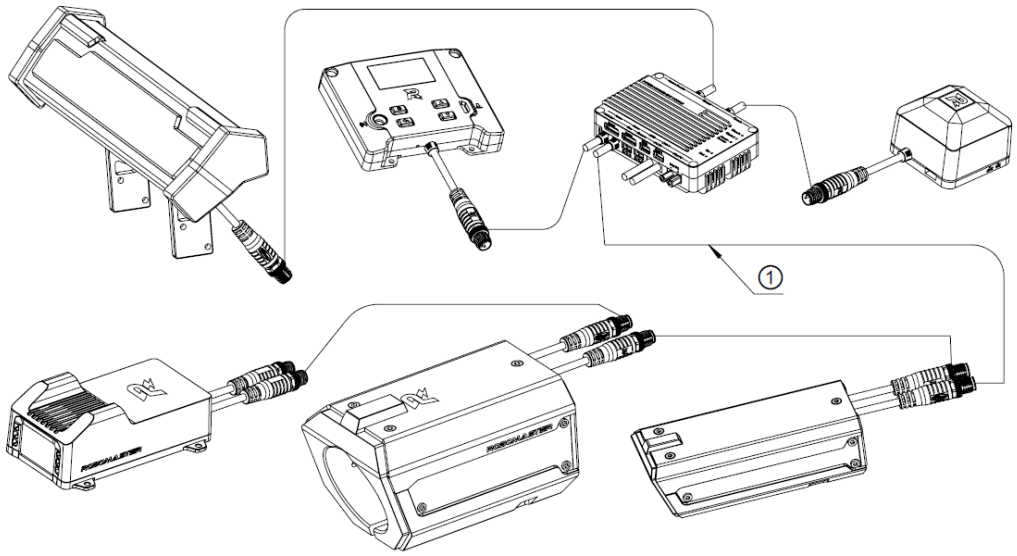

[1] Aviation Connector Cable

Figure 3-8 Power Management Module Connection

3.4.2 Installation Requirements

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

S84 The status indicators of the Power Management Module are not blocked.

S85 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.

S86 Do not use glue such as 3M glue to secure the Power Management Module.

S87 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.

S88 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.
- Have the Power Management Module installed close to the portal of the Dart Launching Station when designing the Dart System.

S89 Carefully differentiate between the ports on the Power Management Module to ensure correct cabling.

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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 42mm 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).

- If a Hero Robot is not installed with a 17mm Launching Mechanism, the Gimbal interface will not receive any power supply, meaning the robot's gimbal power supply will have to be connected to the Chassis interface of the Power Management Module.
- If the Radar or Dart Launcher requires a 24V power interface, it can be powered directly through the "Mini PC" interface of the Power Supply Module or the battery.
- The symbol "-" in the table signifies a non-power supply interface.

Table 3-3 Descriptions of Power Management Module ports

Robot Type/Power Supply	Chassis Power Supply	Gimbal Power Supply	17mm Launching Mechanism Power Supply	42mm Launching Mechanism Power Supply
Hero Robot	Chassis	Chassis	Gimbal	Ammo-Booster
Hero Robot	Chassis	Chassis or Gimbal	-	-
Standard Robot	Chassis	Gimbal	Ammo-Booster	-
Aerial Robot	-	Gimbal	Ammo-Booster	-
Sentry Robot	Chassis	Gimbal	Ammo-Booster	-
Dart Launcher	-	-	-	-
Radar	-	-	-	-

S90 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.

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- 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 24AWG or smaller, and can only be used for communication, with the total current flow equal to or smaller than 50mA.

  - Input voltage requirements for a Power Management Module: 22V-26V. Power output ports No. 10, 11 and 12 in the graph can be connected and disconnected by the Referee System. The highest single-channel load of No. 10 "Chassis" and No. 11 "Gimbal" ports is 10A, and the longest duration for its peak value of 30A is 500ms. As for No.12 "Ammo-Booster" port, the maximum continuous payload for a single circuit is 8A, and the longest duration for its peak value of 20A is 500ms. The total maximum continuous payload for ports No. 10, 11 and 12 is 20A. The maximum continuous payload for a single circuit connected to power output port No. 9 in the graph is 6A.
  - For power out ports No. 10-12 on the Power Management Module, overload protection will be triggered when a single circuit payload reaches the hardware maximum, causing the Power Management Module to disconnect power output. Reasonable payload distribution must be considered when designing circuits.
  - 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.

    - Actual test results for reference: When a continuous current of 20A has been running for a working period of 30 minutes, the temperature of the outer casing is around 70°.
    - A Launching Mechanism Power Supply refers to the power supply for launching projectiles. If only a friction wheel power supply is connected to the "Ammo-Booster" port of the Power Management Module, care should be taken to avoid the situation where the loading mechanism continues running after the friction wheel has powered off, which may lead to projectiles becoming stuck and damaging the loading mechanism.

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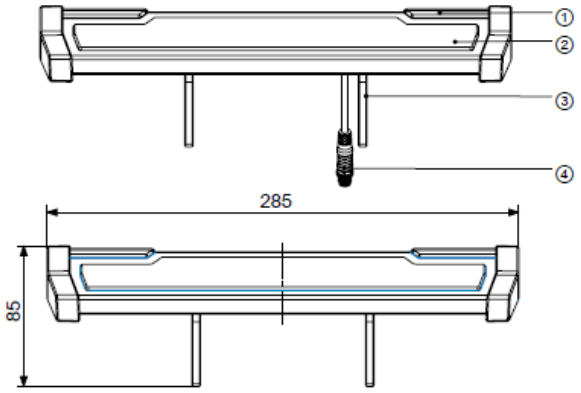
3.5 Mounting Light Indicator Module

Mount the Light Indicator Module on the robot using a mounting bracket according to the size of the module.

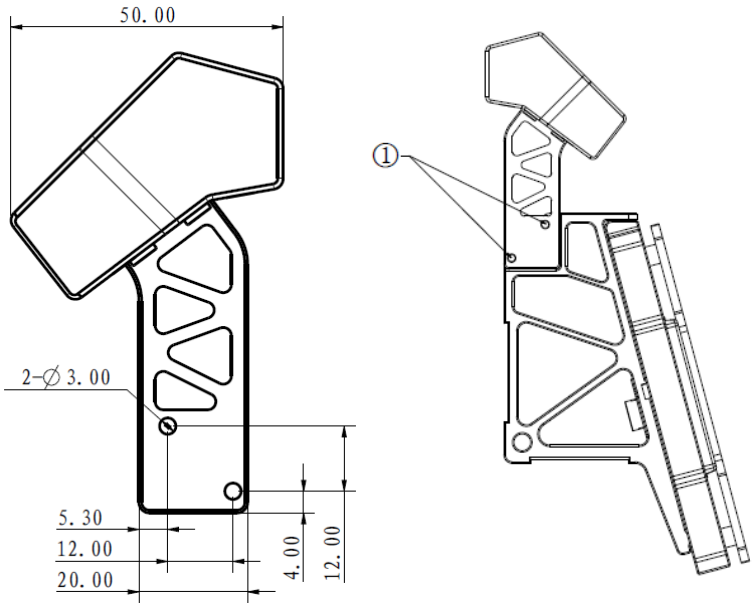


[1]	Auxiliary Light Indicator	[2]	Main Light Indicator	[3]	Mounting bracket	[4]	Aviation connector port

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

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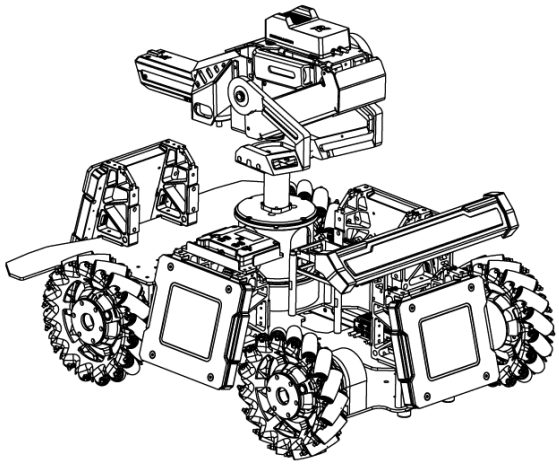


Figure 3-10 Mounting Light Indicator Module

2. 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.

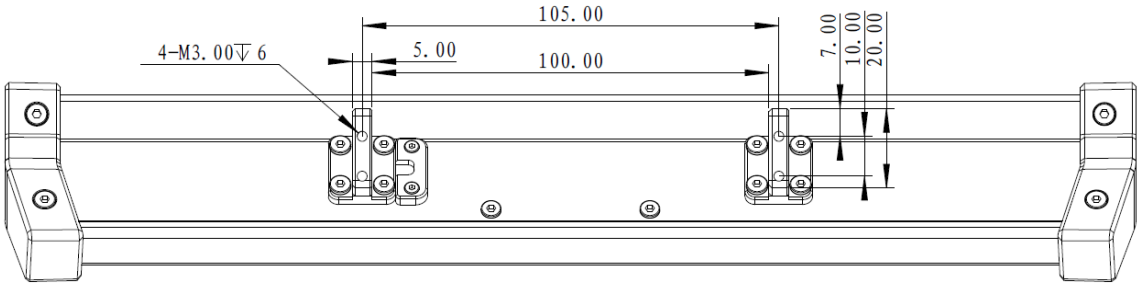
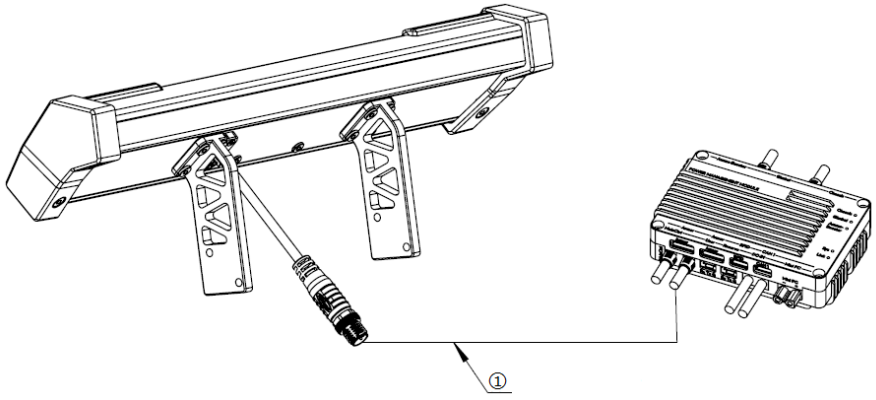


Figure 3-11 Bottom of Light Indicator Module

3. Use the aviation connector 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 Connector Cable

Figure 3-12 Light Indicator Module Cable Connection

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3.5.2 Installation Requirements

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

S91 The connection cables of the left and right auxiliary Light Indicators are parallel to the ground.

S92 The main and auxiliary Light Indicators should be fully visible from at least one horizontal viewing angle.

S93 Except for Sentry and Engineer Robots, the Light Indicator Module must be installed firmly on the robot chassis mechanism.

S94 When mounting Light Indicator Modules on a Ground Robot, the illuminant part must be at least 200mm from the ground.

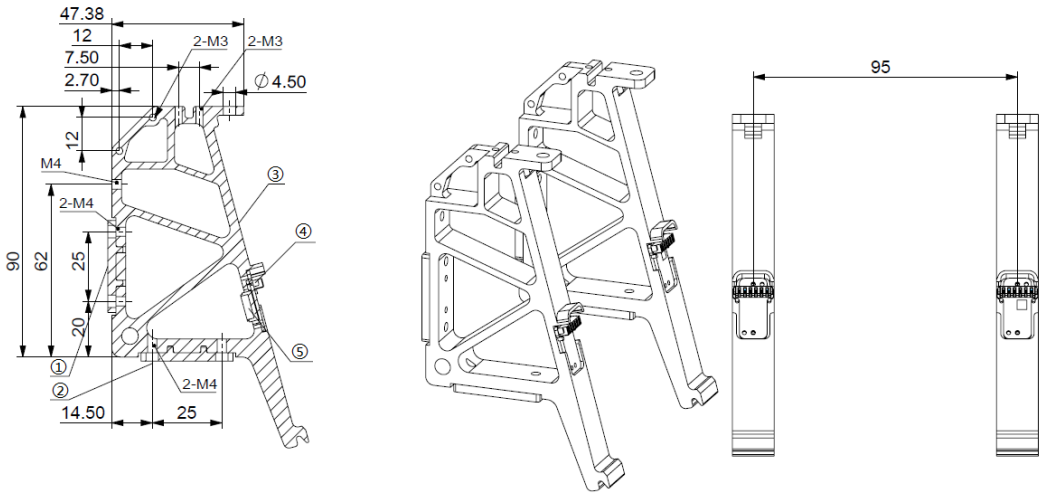
S95 When mounting Light Indicator Modules on a Sentry, the modules are always situated at the highest point of the robot (except for the Positioning System Module and its mounting bracket), and at least 80% of their illuminant part must be exposed when viewed from the the top of the robot.

3.6 Armor Module Mounting Specifications

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 17mm 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 Frame

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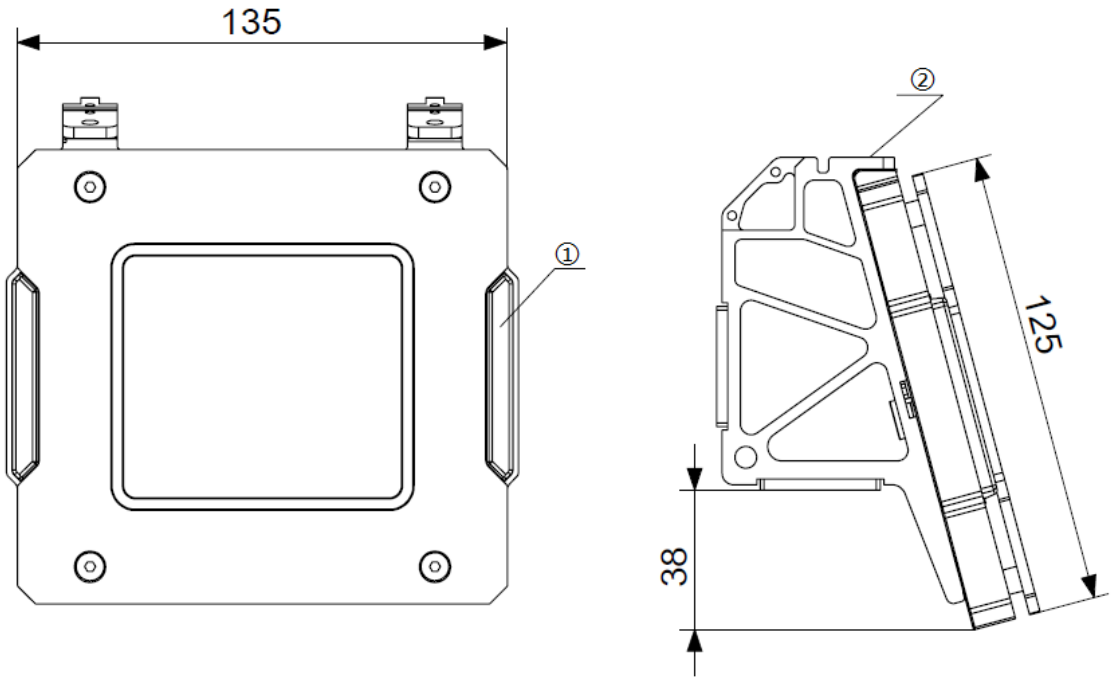
S96 The Armor Module can only be mounted on an Armor Support Frame provided by the RMOC. The Armor Support Frame must not be tampered with or damaged.

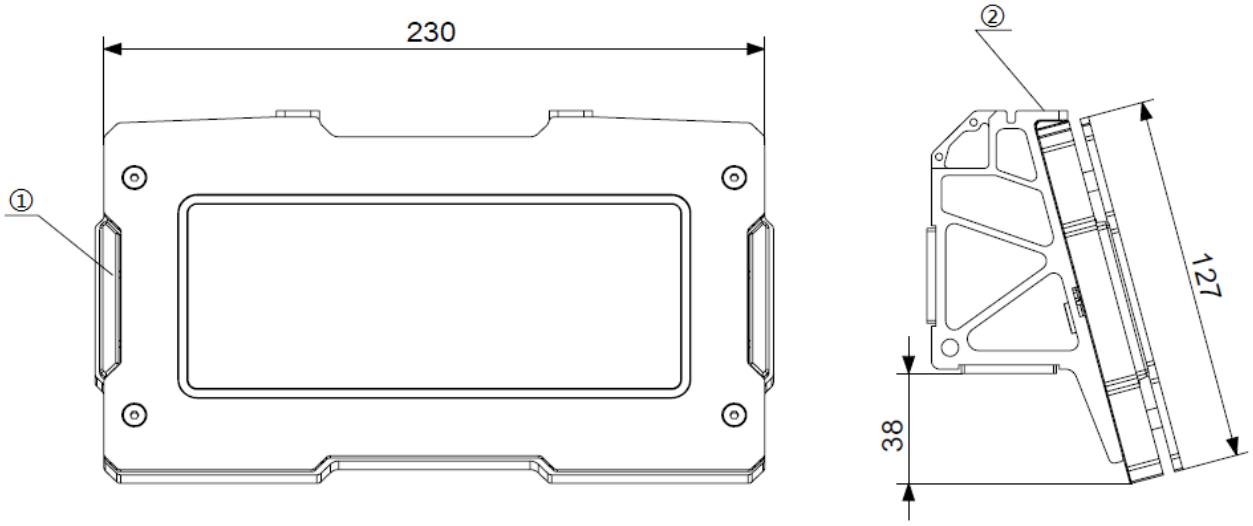
Below shows the small armor support frame:



[1] Side Light Indicator [2] The top fastened with M4 screws

Figure 3-14 Small Armor Module Graph

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 Module

S97 Do not modify or decorate the Armor Modules.

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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:

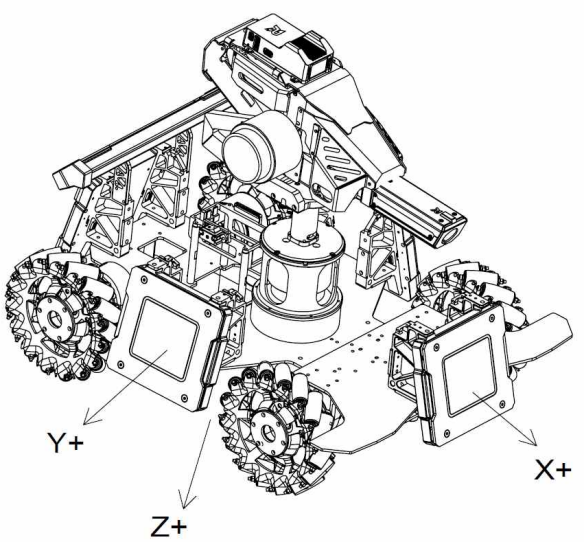

Figure 3-16 Robot Coordinate System

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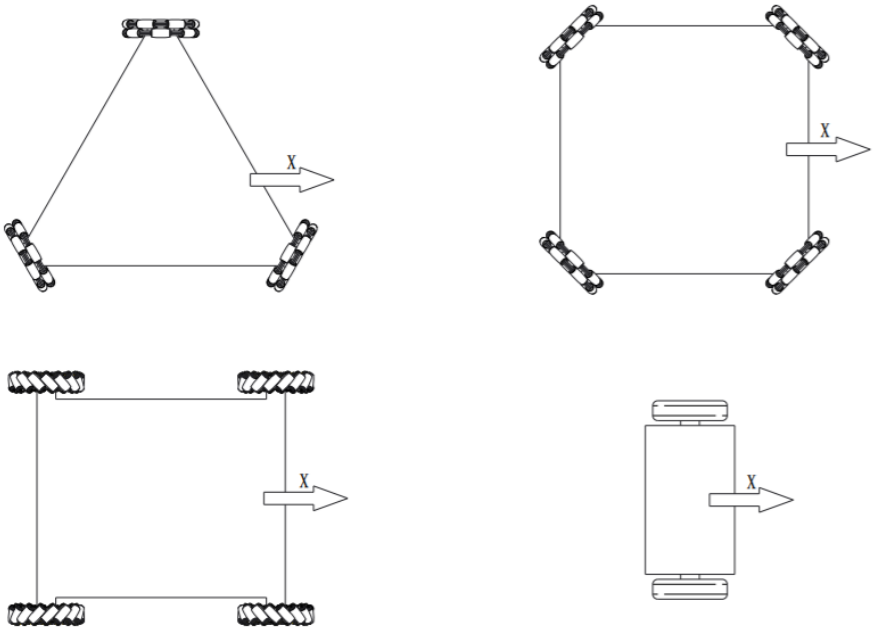

Figure 3-17 The X-axes of Different Robot Chassis Structures

3.6.1.1 Mounting the Armor Module

S98 When an Armor Module is mounted on a robot, the Armor Module and the Armor Module 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°.

S99 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 orkinematic characteristics. The geometric center point line of the Armor Modules mounted on the X-axis and thegeometric 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 50mm on the X or Y axis.

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3.6.1.2 Rigid Connection

S100 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 60N 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°.

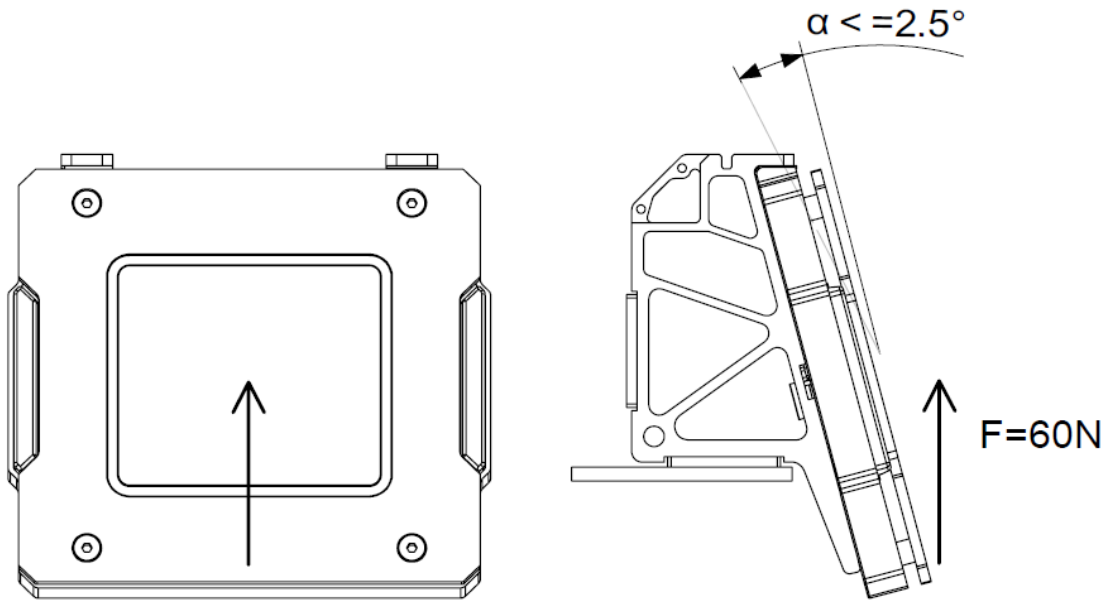

Figure 3-18 Application of Force on Armor Module

3.6.1.3 Robot Transformation

S101 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 fastly is the movement speed exceeding 0.5 m/s.

S102 For Hero, Engineer and Balancing Standard Robots, the altitude difference between the lower edges of any two Armor Modules must not exceed 100mm.

S103 For Standard and Sentry Robots, the altitude of the lower edge of their Armor Module from the ground before and after transformation must be within the range of 60 - 150mm.

S104 For a Balancing Standard Robot, the altitude of the lower edge of its Armor Module from the ground before and after transformation must be within the range of 60mm - 400mm.

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S105 For an Engineer 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 - 400mm.

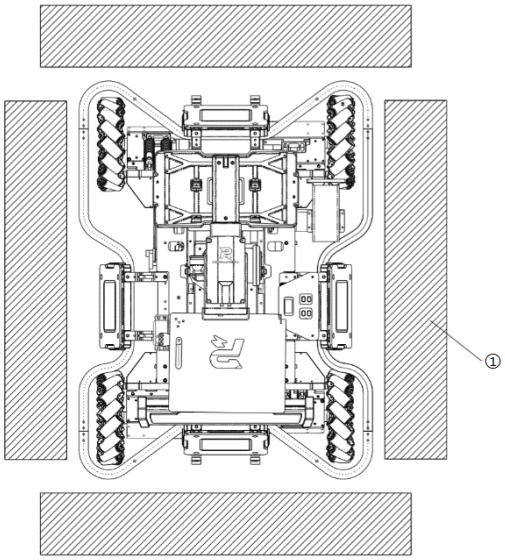
S106 For a Hero Robot, the altitude of the lower edge of its Armor Module from the ground before and after transformation must be within the range of 60 - 200mm.

- When the plane that supports the robot body is no longer be 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

S107 Teams should design bumpers for ground robots to reduce any damage caused by collision of Armor Modules.

S108 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

S109 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.

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1. As per the dimensions in the drawings below, four sets of built-in holes shall 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.

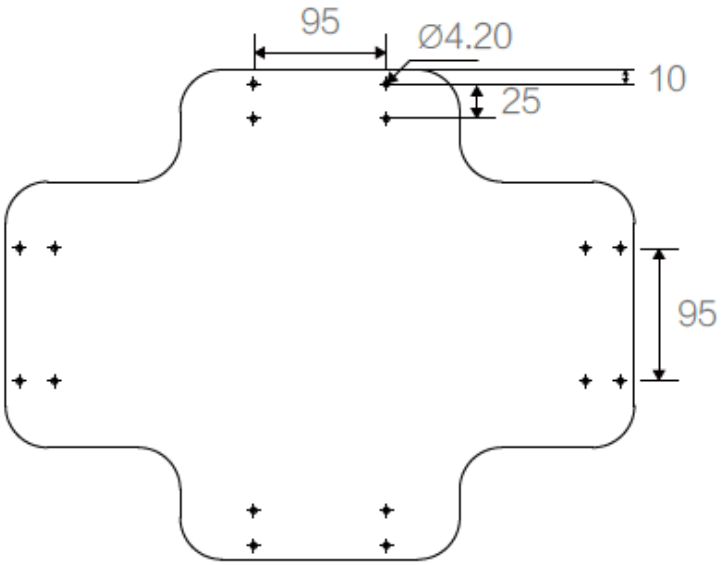

Figure 3-20 Reserved Holes on the Chassis

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.

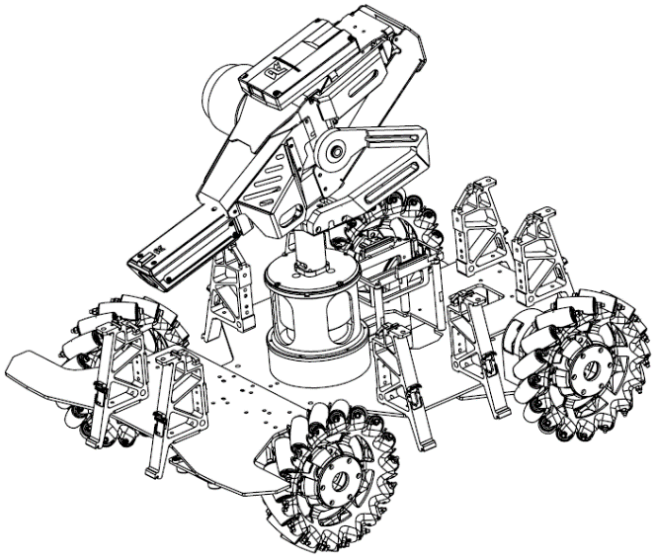

Figure 3-21 Mounting Armor Support Frame

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

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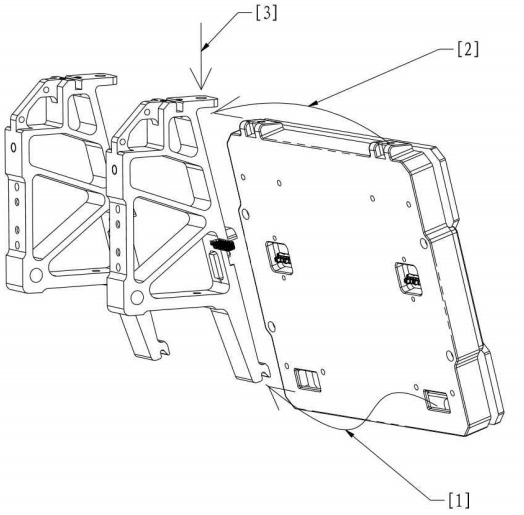
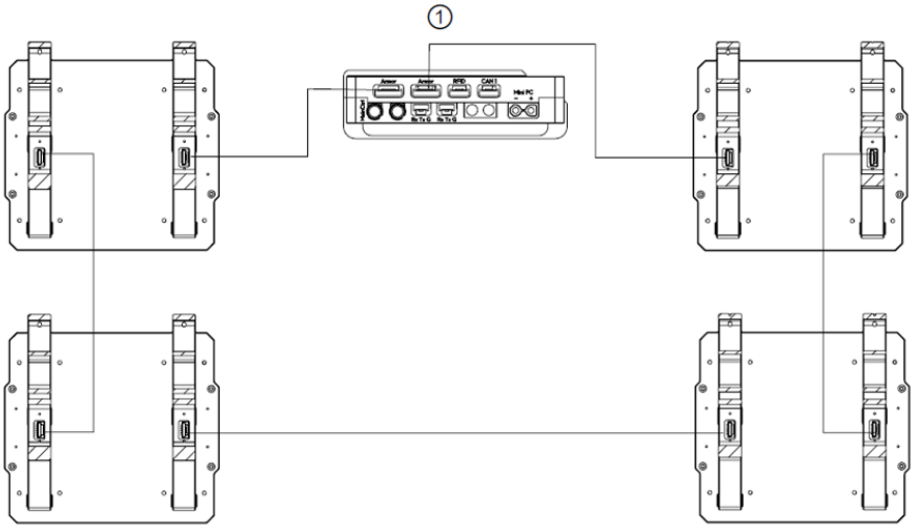


Figure 3-22 Armor Module Mounting Diagram

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 Cabling Diagram

Balancing Standard Robot:

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

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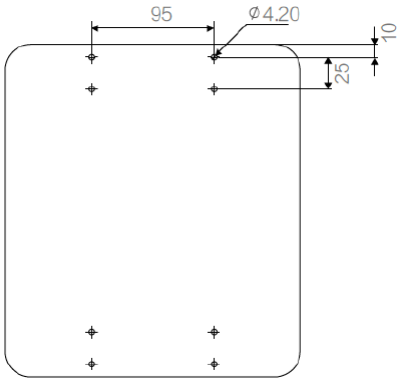

Figure 3-24 Reserved Mounting Holes on Chassis

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:

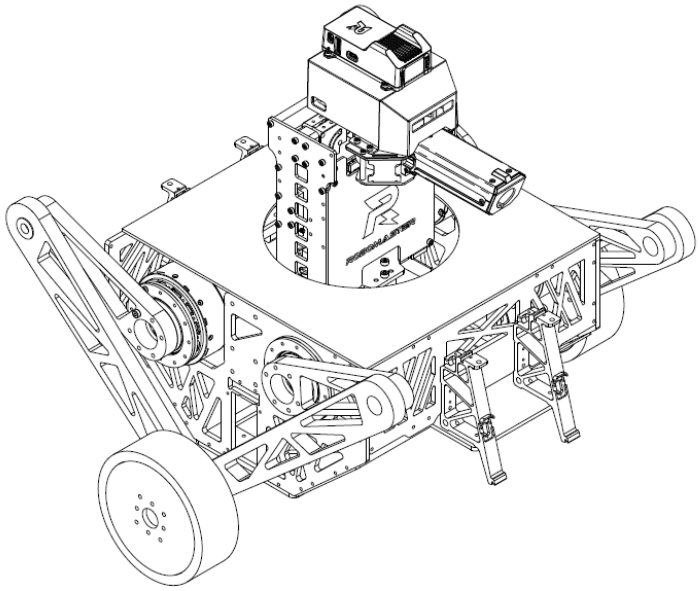

Figure 3-25 Mounting Armor Support Frame

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

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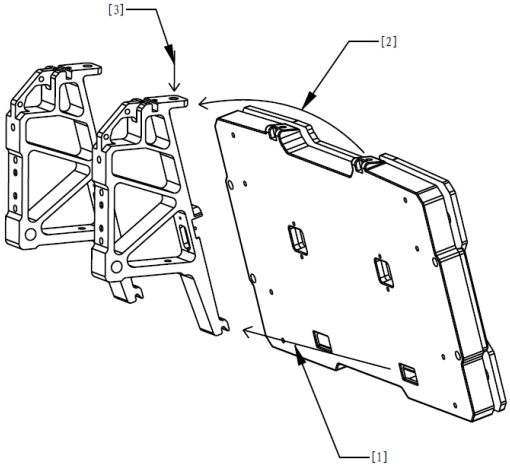
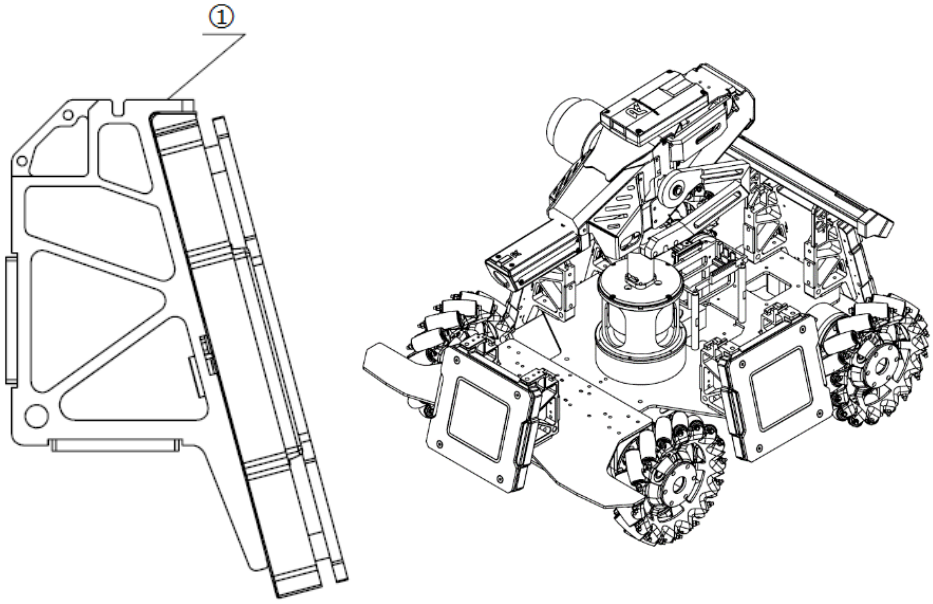


Figure 3-26 Armor Module Mounting Diagram

3.6.3 Installation Requirements

S110 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

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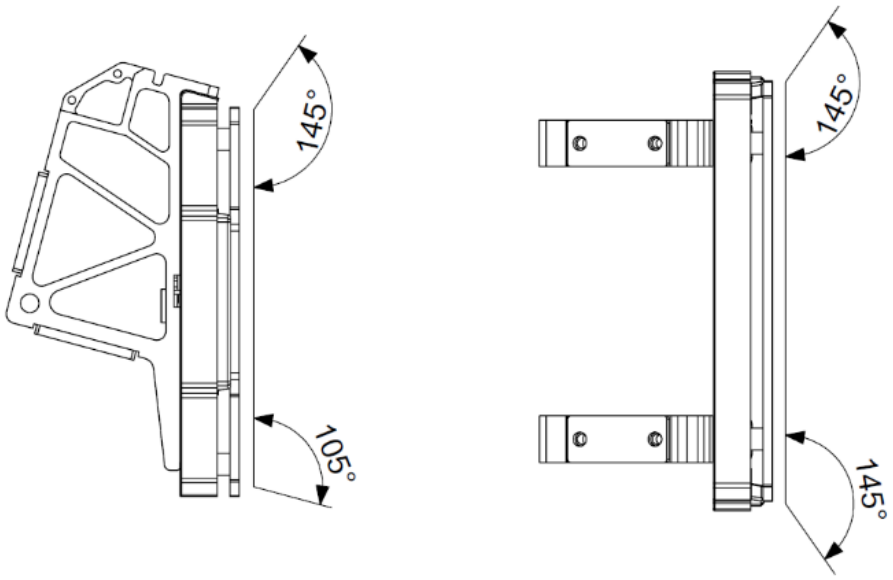
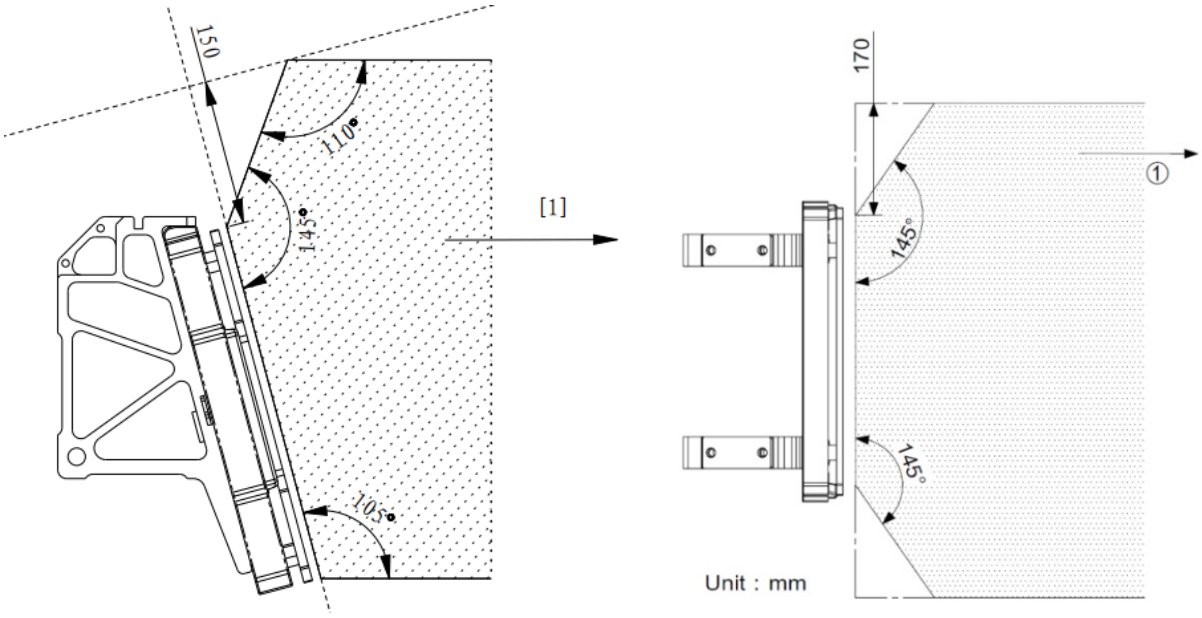


S111 For the armor modules of Engineers, the area within 105° of the lower edge of their impact surface must not be blocked. The vertical distance between the outer edge of a robot below its armor module and the lower edge of the module must be smaller than 100mm. The areas within 145° of the upper, 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 150mm from the upper edge or the area beyond 170mm 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.



[1] Unlimited extension

S112 The space extending 30mm 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.

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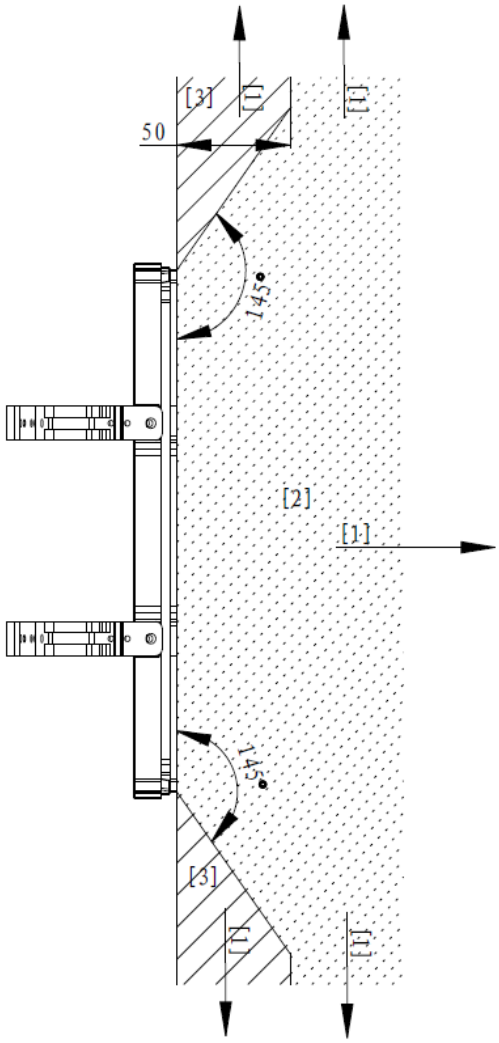

[1] Unlimited extension [2] Area not allowed to be blocked [3] Area allowed to be blocked

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):

S113 According to the armor module installation requirements for Ground Robots, after activating the ID setting mode, the Armor Module facing the VTM transmitter) of a robot at the beginning of a match shall be Armor 0. Armors 0, 1, 2 and 3 should be tapped sequentially in the counterclockwise direction as viewed from the top, to complete the ID setting for all the robot's Armor Modules. Armor Modules with correct ID setting should appear as shown in the drawings:

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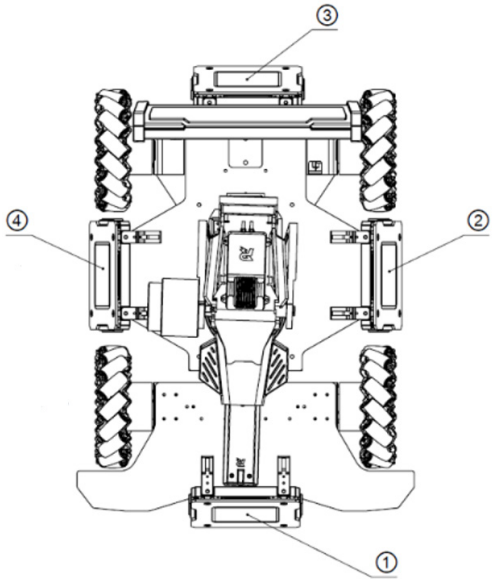


[1] Armor Module No. 0 [2] Armor Module No. 1 [3] Armor Module No. 2 [4] Armor Module No. 3

Figure 3-27 Ground Robot Armor Module ID Setting

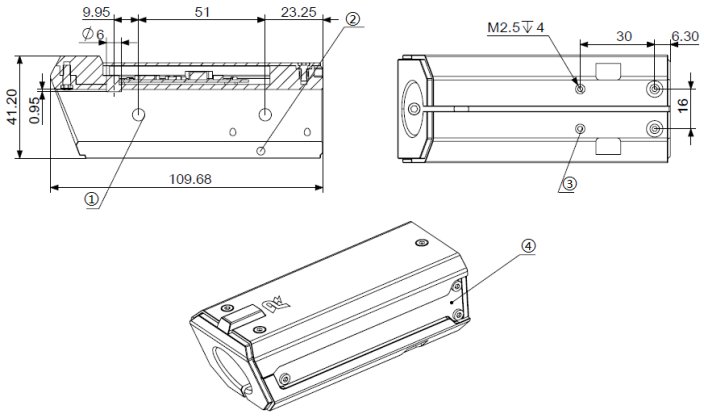
Balancing Standard Robot:

S114 The ID configuration for a Balance 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 Speed Monitor Module

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

Speed Monitor Module (17mm 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 17mm Speed Monitor Module

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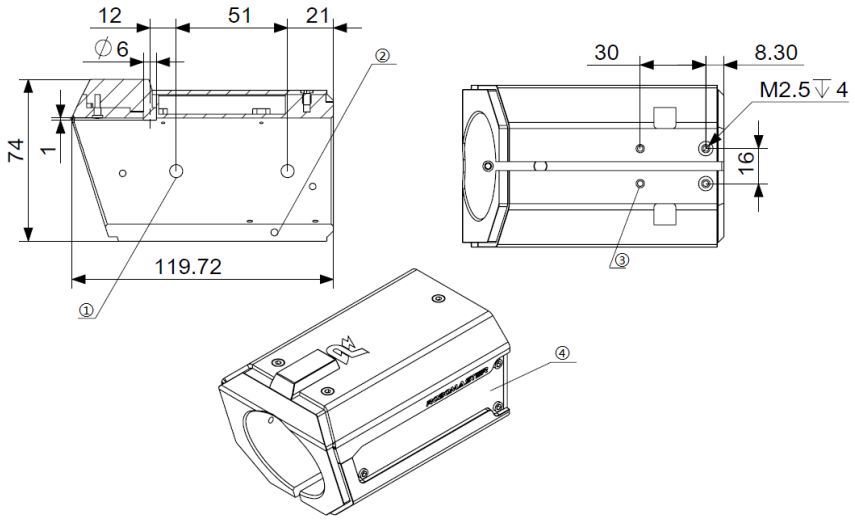
Speed Monitor Module (42mm projectile):



[1] Phototube

[2] Speed Monitor Module's clamping screw hole

[3] Laser Sight's mounting screw hole

[4] LED Light Indicator

Figure 3-29 42mm Speed Monitor Module

3.7.1 Installation Steps

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

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

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

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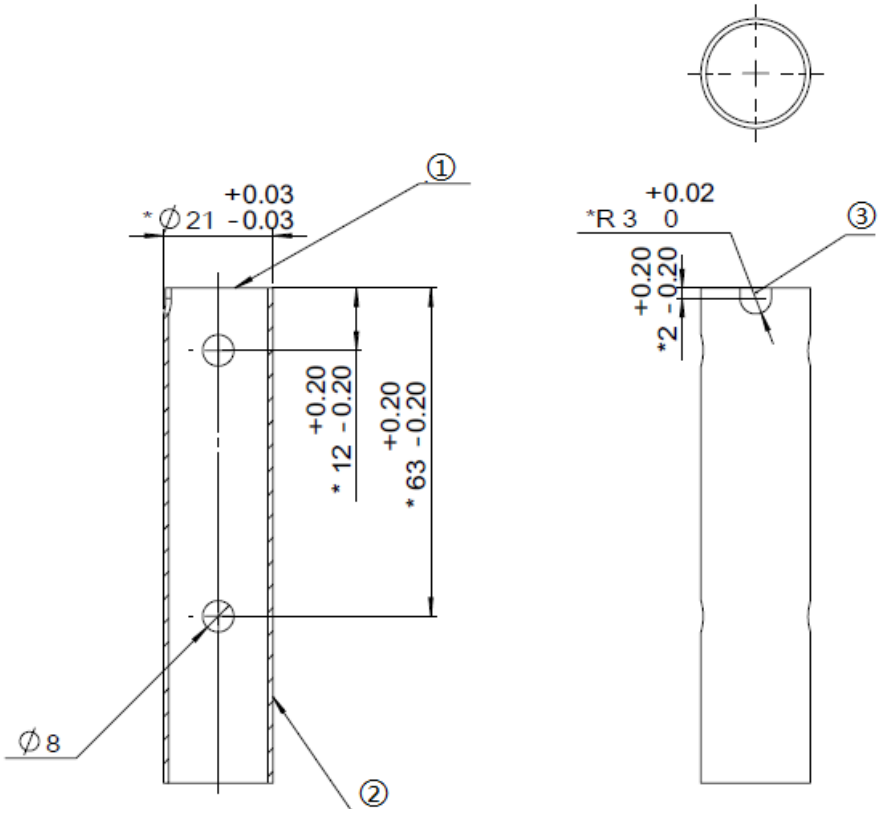

[1] Muzzle [2] * Wall thickness must be no less than 1mm [3] The U-shaped groove must face upward after installing the barrel

Figure 3-30 17mm Barrel

Production requirements for 17mm barrel:

S115 The phototube must not be blocked.

S116 Transparent and luminous materials and use of infrared ray sensors near the barrel are forbidden.

S117 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 the launching mechanism is on the cylindrical positioning boss within the module's 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 connector cable.

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The completed mounting is shown in the figure below:

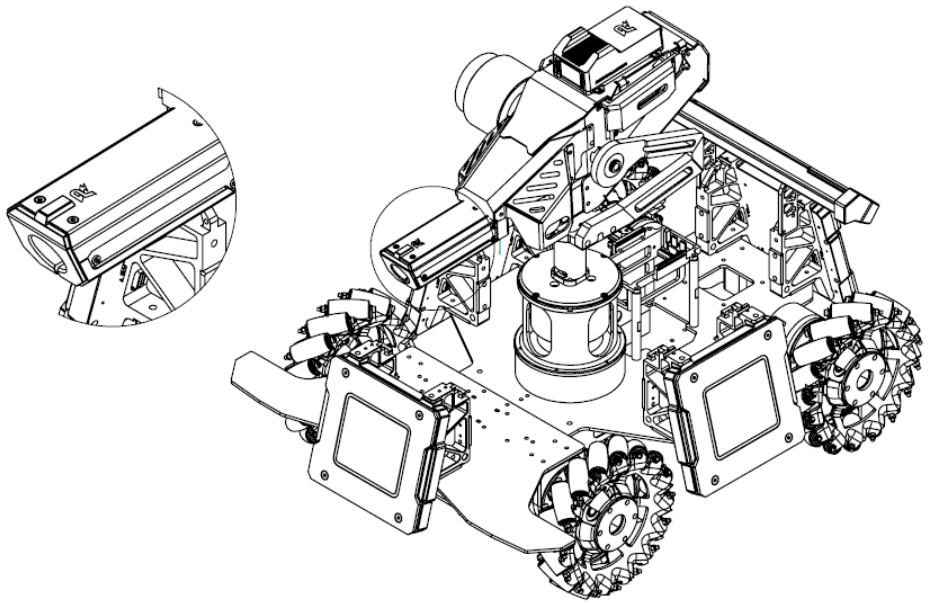


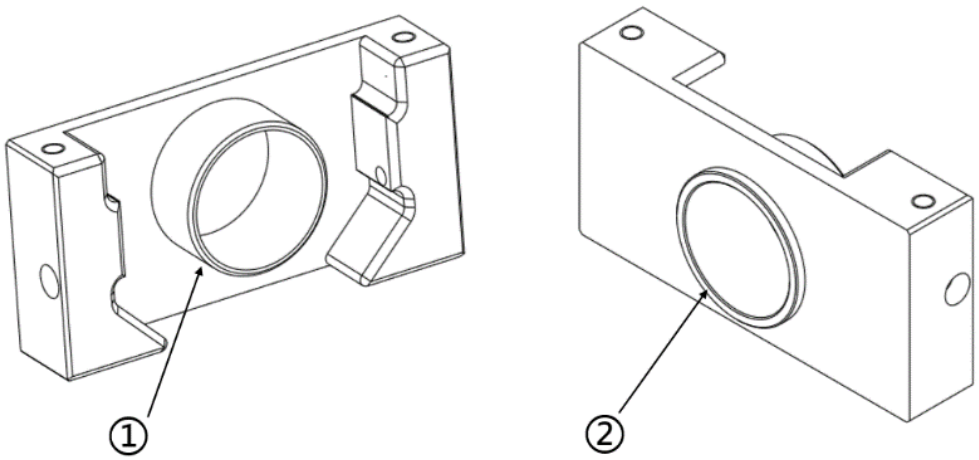
Figure 3-31 Mounting Speed Monitor Module

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

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

See “Appendix 1 - Drawing of Adapter Block for Speed Monitor Module (17mm 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 17mm Adapter Block

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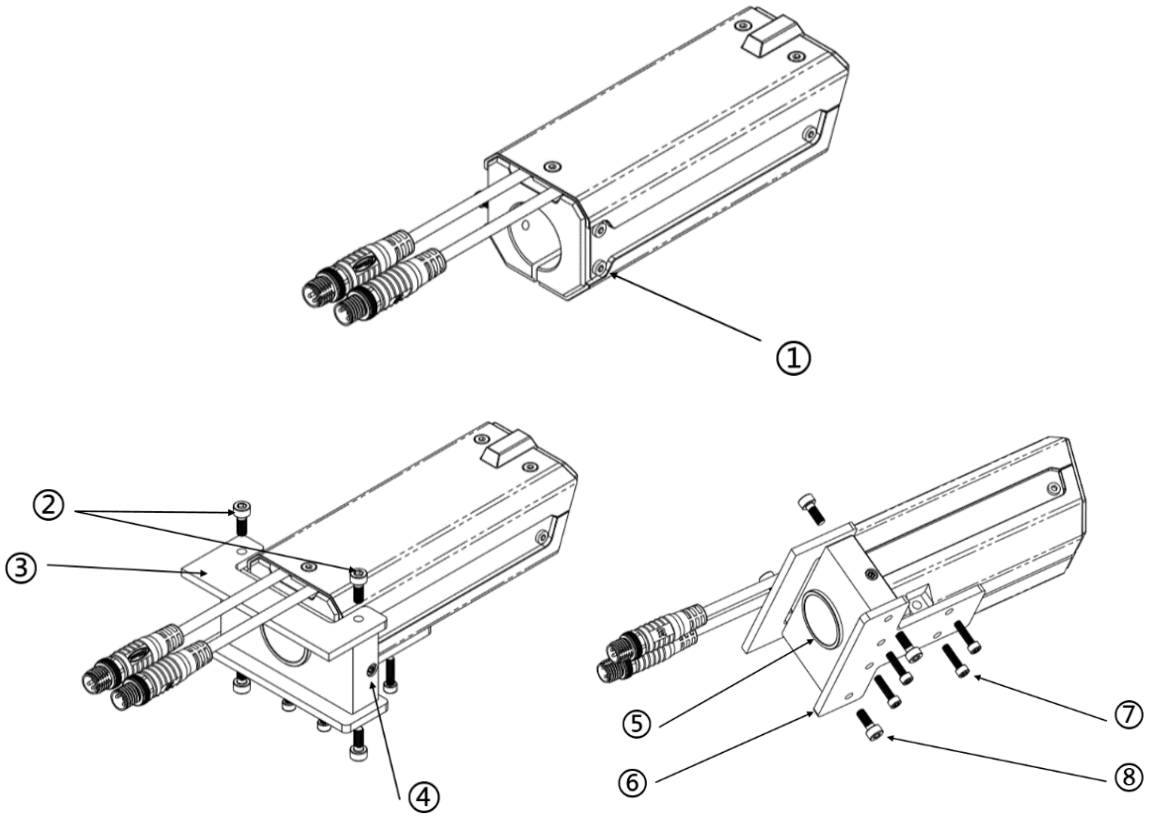

[1]	M2.5 Securing Screw for LED Light Indicator	[2]	M3 Screws	[3]	Self-produced Part 1
[4]	Side Securing Hole	[5]	Back Protrusion	[6]	Self-produced Part 2
[7]	M2.5 Screw	[8]	M3 Screws		

Figure 3-33 Securing Method for 17mm Adapter Block

Mounting Steps for Securing Method 2:

1. Remove the M2.5 screw 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 M2.5x14 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 adapter cable.

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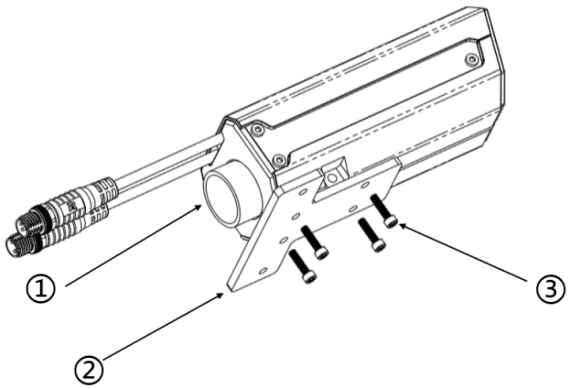
Except for the two screws and the cylindrical positioning protrusion which can be removed as in Step 1, the rest of the screws on the Speed Monitor Module must not be removed without permission. Otherwise, it will be deemed as sabotaging the Referee System.

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

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



[1] Barrel [2] Self-produced Part 1 [3] M2.5 Screw

Figure 3-34 Mounting 17mm 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 connector cable.

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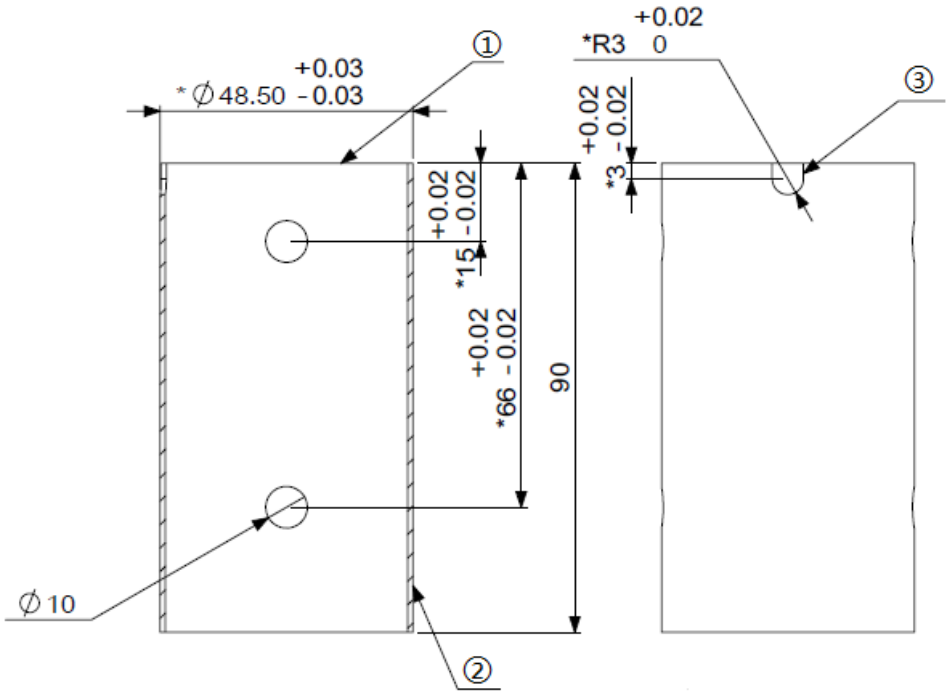
- The length of the barrel installed into the Speed Monitor Module must not exceed 23mm, to avoid obstructing the speed-monitoring phototube.
- The outer diameter of the barrel should preferably be kept within the range of 21+0.05mm. Insufficient launching mechanism diameter will create a gap between 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 (42mm projectile) Securing Method

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

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



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

Figure 3-35 42mm Barrel

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Production requirements for 42mm barrels:

S118 The phototube must not be blocked.

S119 Transparent and luminous materials and use of infrared ray sensors near the barrel are forbidden.

S120 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 connector cable.

3.7.2 Installation Requirements

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

S121 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.

S122 When performing horizontal calibration on a Speed Monitor Module, its logo should be facing up.

S123 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.

S124 Except for the two Speed Monitor Modules blocking one another, the inspection personnel must be able to see at least 80% of the light indicator's surface area when looking at the side of the Speed Monitor Modules from above at a 45° angle, at a distance of 1m from the Modules.

S125 As shown in the installation drawing for the Speed Monitor Modules, no large magnetic conductive materials (such as iron barrels, cooling fans on the VTM Transmitter or friction wheel motors) should be placed within an area of 50mm in diameter with the logo as the center, to avoid any interference with the magnetometer inside the Speed Monitor Module.

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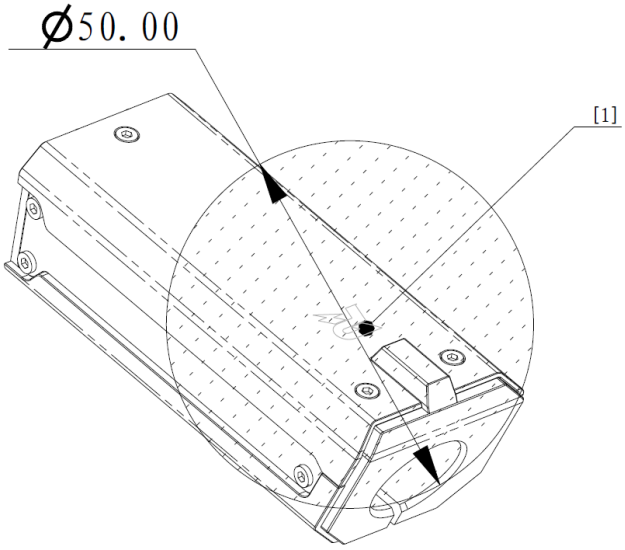

[1] Circular center

Figure 3-36 Speed Monitor Module Mounting Specification

- Four M2.5 screw 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 RFID Interaction Module

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

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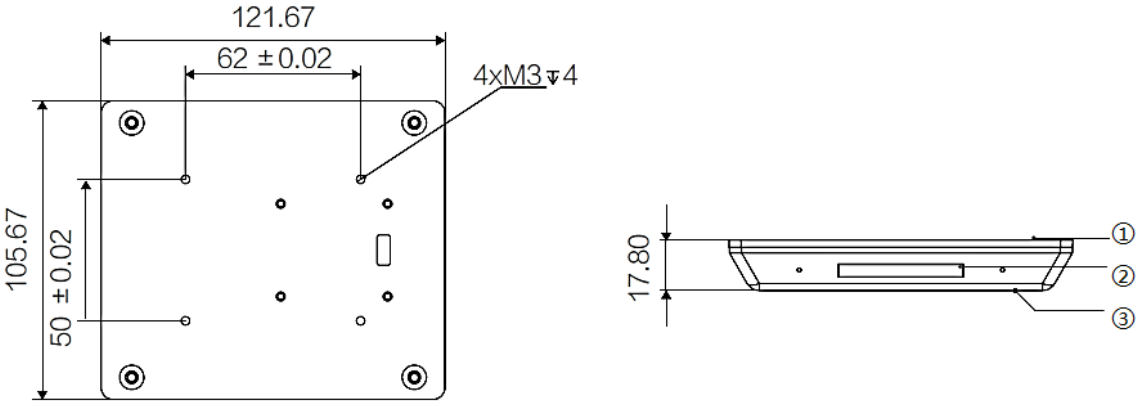

[1] Back [2] LED Light Indicator [3] Front

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.

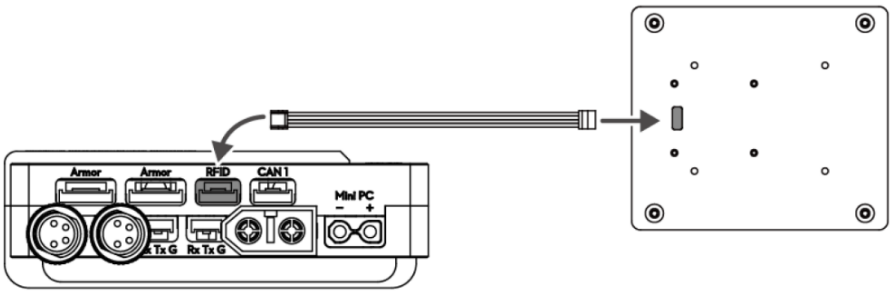

Figure 3-38 RFID Interaction Module Cable Connection

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.

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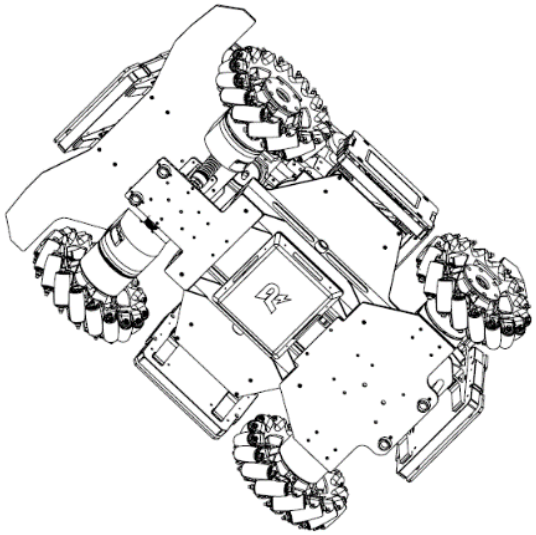

Figure 3-39 Mounting RFID Interaction Module

3.8.2 Installation Requirements

- The effective detection range of the RFID Interaction Module is 100mm (±5%). The actual detection range after mounting is subject to testing. If the effective detection range is reduced or the Module does not function properly, please check if it was installed correctly.
- 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 range 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 range of the RFID Interaction Module will have to be tested under the different operation modes.

S126 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).

S127 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 30mm away from conductive materials such as the metal and carbon plates.

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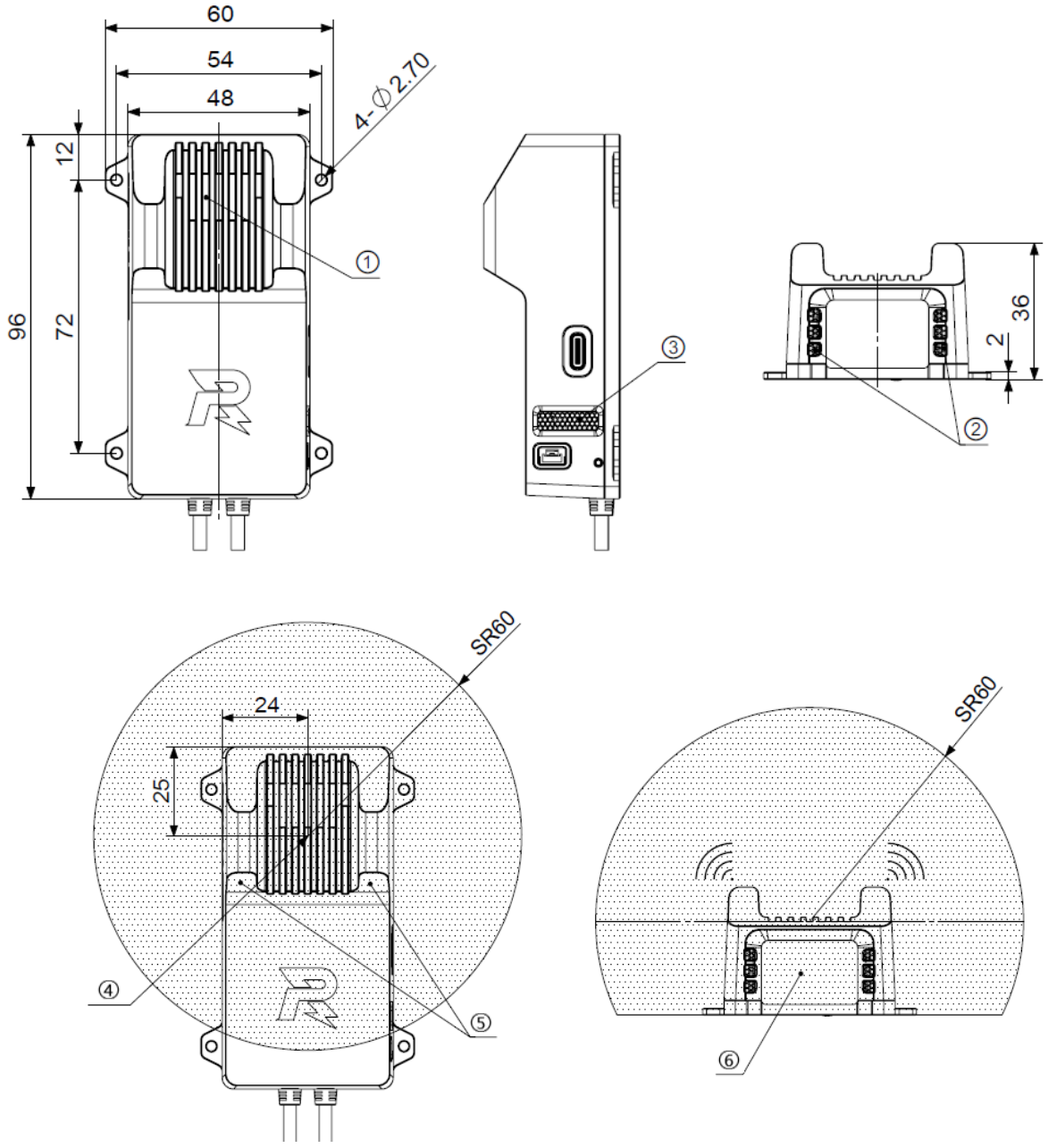
3.9 Mounting VTM Transmitter

- VTM Link data are output from the UART serial port of a VTM Transmitter.
- The UART serial interface of a VTM Transmitter supports the 3.3V 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 Inlet [2] Air Inlet [3] Air Outlet [4] Circular center [5] Antenna [6] Camera

Figure 3-40 VTM Transmitter

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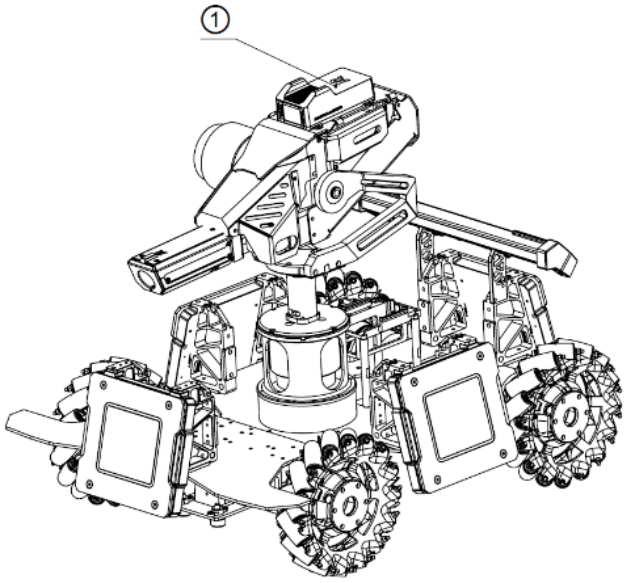
3.9.1 Installation Steps

1. Use four M2.5 screws to secure the Transmitter at the appropriate position on the robot.



[1] VTM Transmitter

Figure 3-41 Mounting VTM Transmitter

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

3.9.2 Installation Requirements

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

S128 The inlet and outlets of the Transmitter must not be blocked.

S129 As the Transmitter's antenna is located at the top of the Module, the top should not be blocked by any metal.

S130 As shown in the VTM Transmitter drawing, set the center of the VTM Transmitter be the circular center, no motor or electromagnetic device that may interfere with the Module should be within a hemisphere measuring 60mm from the center, to avoid interfering with Video Transmitter signals.

S131 If the VTM Link is used, the UART serial interface of the VTM Transmitter needs to be partially protected, by using protective devices such as foam and non-metallic guards.

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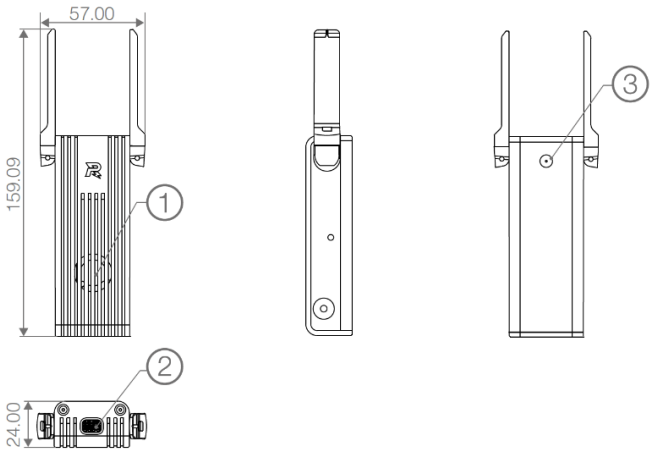
3.10 Mounting Video Transmitter Module (Receiver)

According to the size and mounting port of the Video Transmitter Module 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 VTM Transmitter Graph

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.

S132 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.

S133 Ensure that the cooling inlet and outlet ①② are not blocked.

S134 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 60mm.

S135 The specific mounting position and angles can be adjusted by checking the quality of receiver images.

3.11 Mounting Positioning System Module

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

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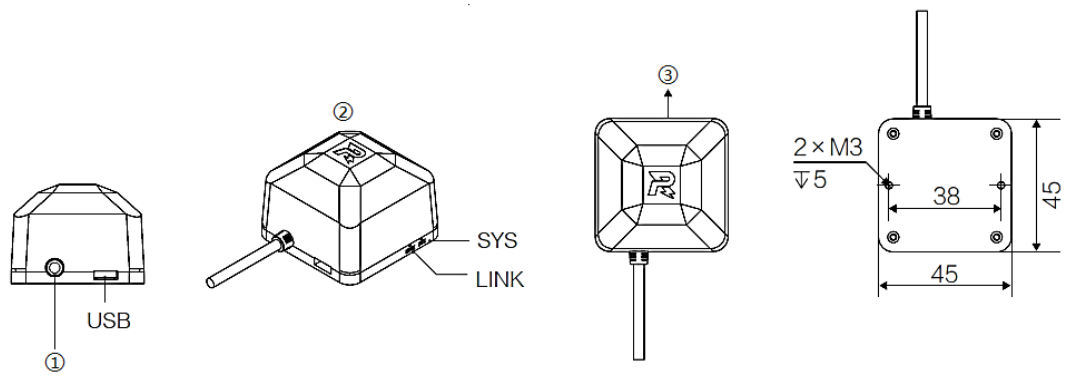

[1] Referee System Connection Cable [2] Top [3] Front

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 below:

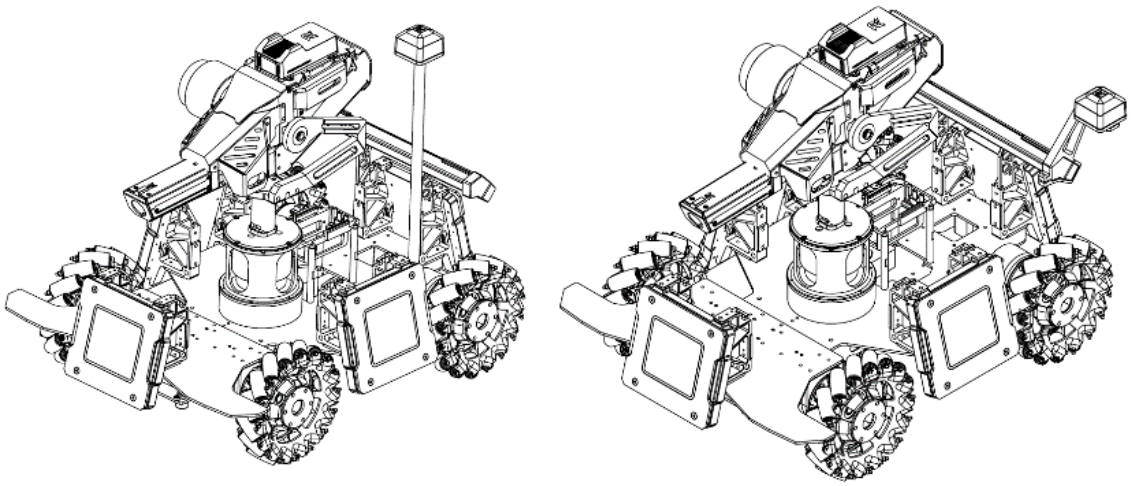

Figure 3-44 Positioning System Module

2. Use the aviation connector 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.

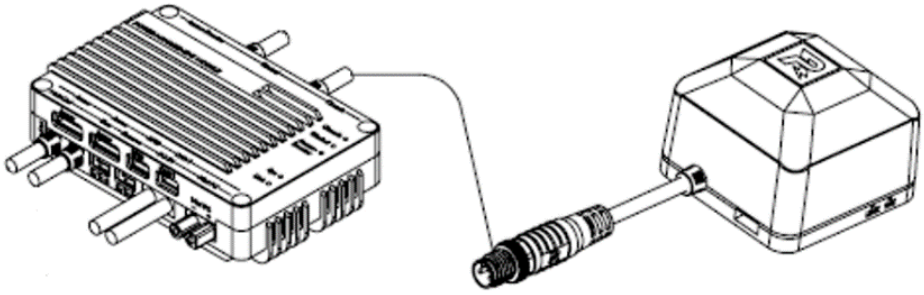

Figure 3-45 Positioning System Module Cable Connection

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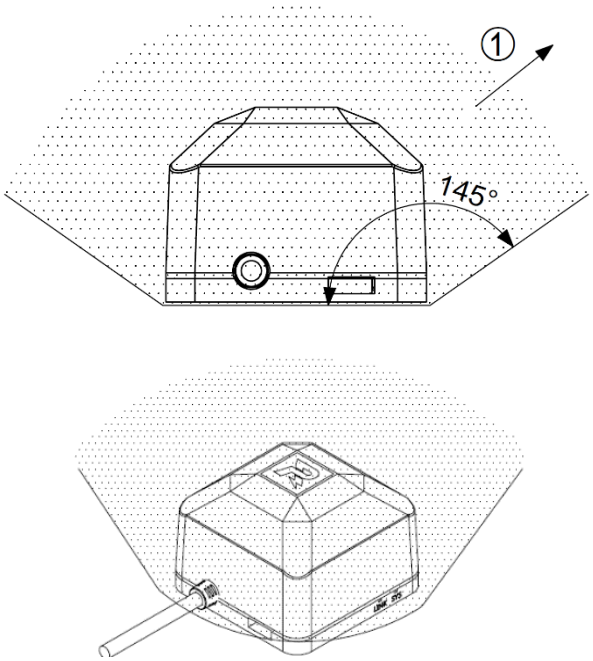
3.11.2 Installation Requirements

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

S136 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 100mm away.



[1] Unlimited extension

Figure 3-46 Positioning System Module

S137 The Positioning System Module must be at a distance of at least 100mm from any motor, Video Transmitter Module or parts that are magnetic or create a magnetic field when operating. Such parts should preferably be installed at a distance of at least 200mm away.

3.12 Installation 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 17mm Fluorescent Projectile Energy-Charging Device.

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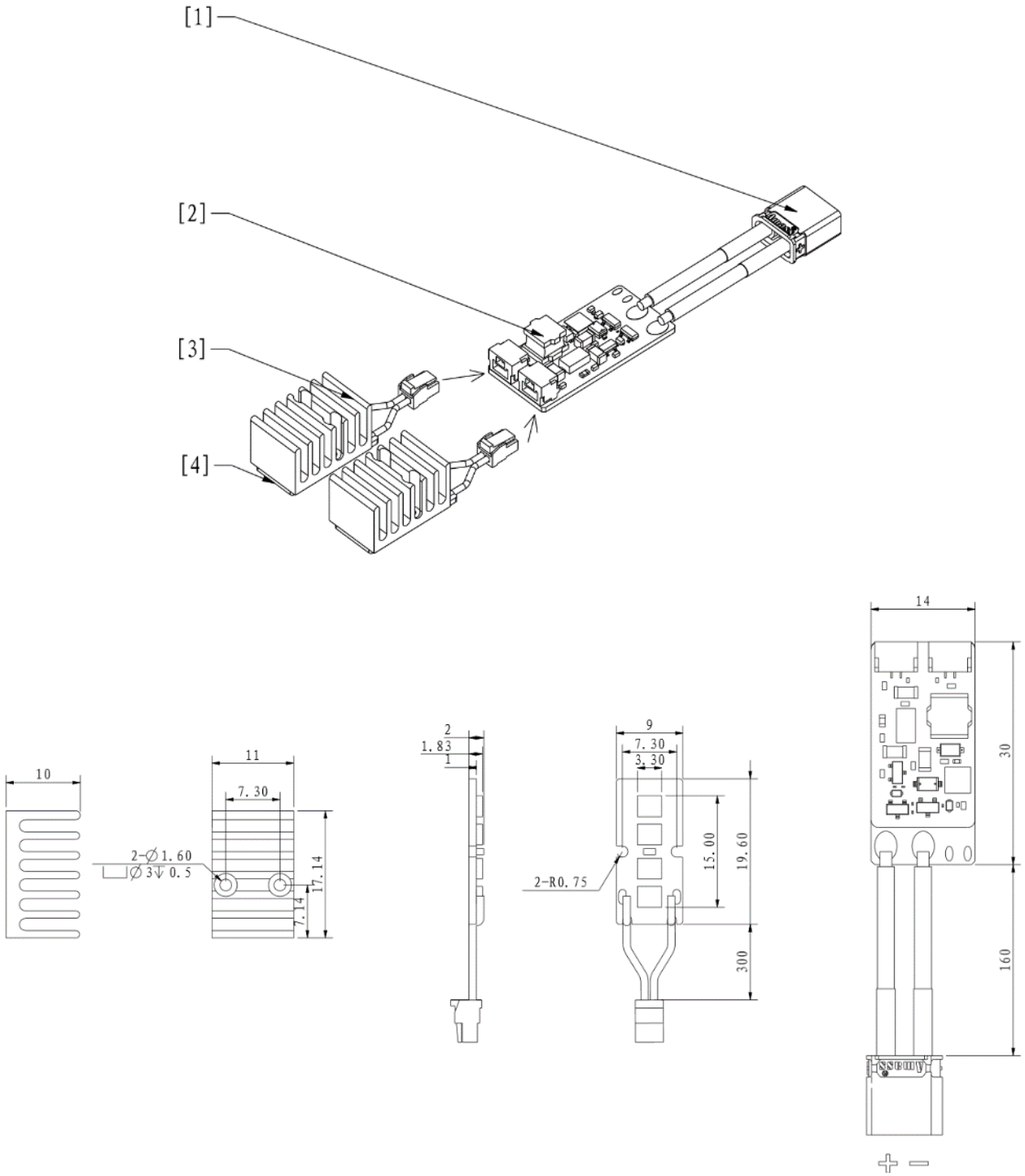

[1] XT30 port [2] LED actuator [3] Heat dissipation panel [4] UV light panel

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

3.12.1 Installation Steps

⚠ UV light panels must be light-tight to prevent the emission of harmful UV rays.

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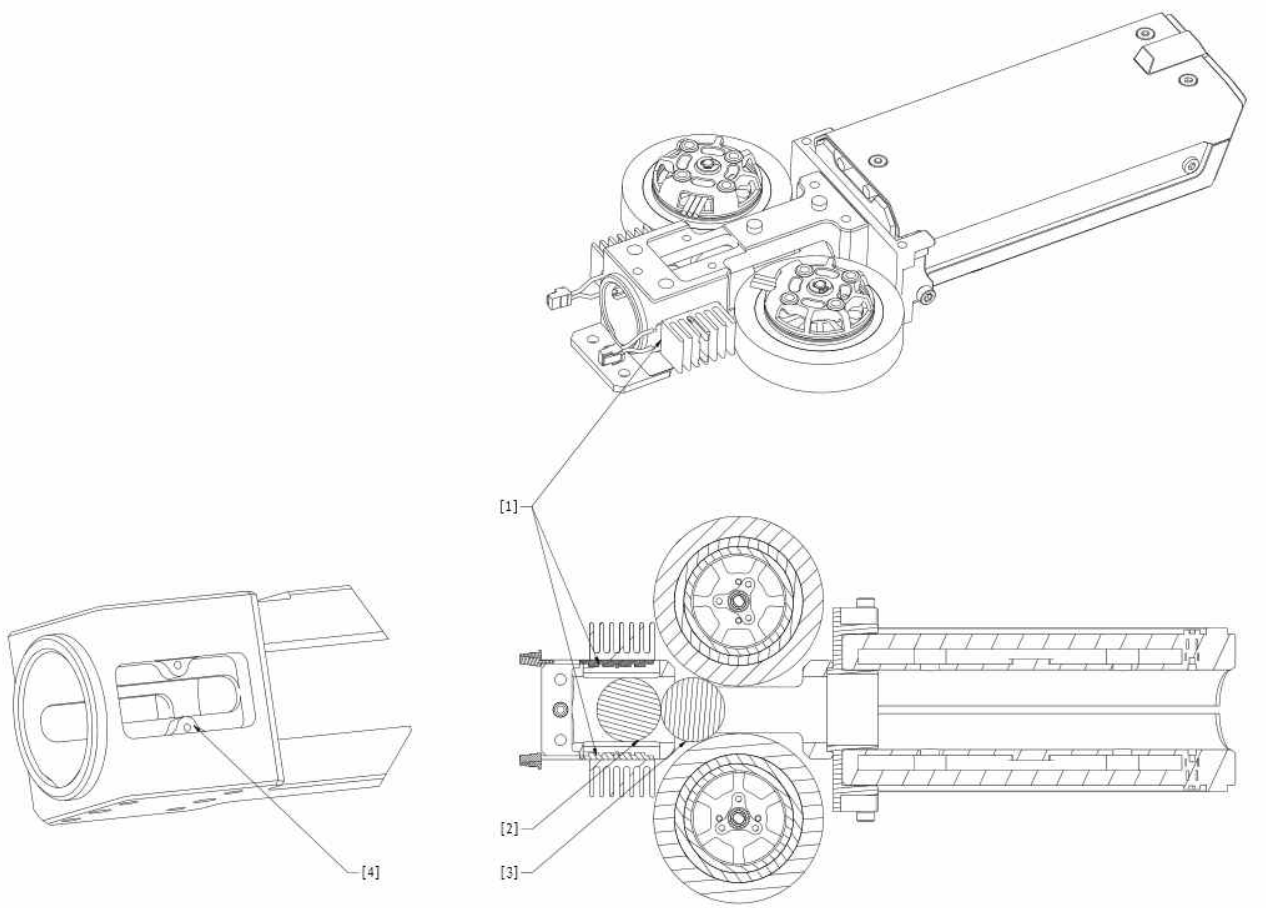
1. The UV light panel should be installed on a specific part of the robot, and should cover the standby projectile next to the launching projectile, as shown in the drawings below.
2. If the projectile supply tube is metal, its area in contact with the light panel should be maximized as much as possible, 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 12V or 24V 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

S138 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.

S139 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.

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S140 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 measurement 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

3.12.3 Instructions and Requirements for Production of UV Light Panels

S141 The UV light beads used must be the 390-410nm 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 1.5W. Participants should refer to the competition’s official design for light panels. Their total length must be at least 19.60mm which is the official panel length.

S142 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 panels should be heated and dried at 120℃ 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 Supercapacitor Management Module Installation Specifications

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*7.5mm(L*W*H), and heat-shrink tubing is used as external protection for the module.

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The hardware interface includes one XT30 plug, two XT30 receptacles, and one Capacitor Management Module communication interface.

- 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 interface 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 30A and a continuous current of 15A.
- For the chassis power source of a robot limited by its power, the maximum total capacity of all capacitors shall be 10mF, 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 interface 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:

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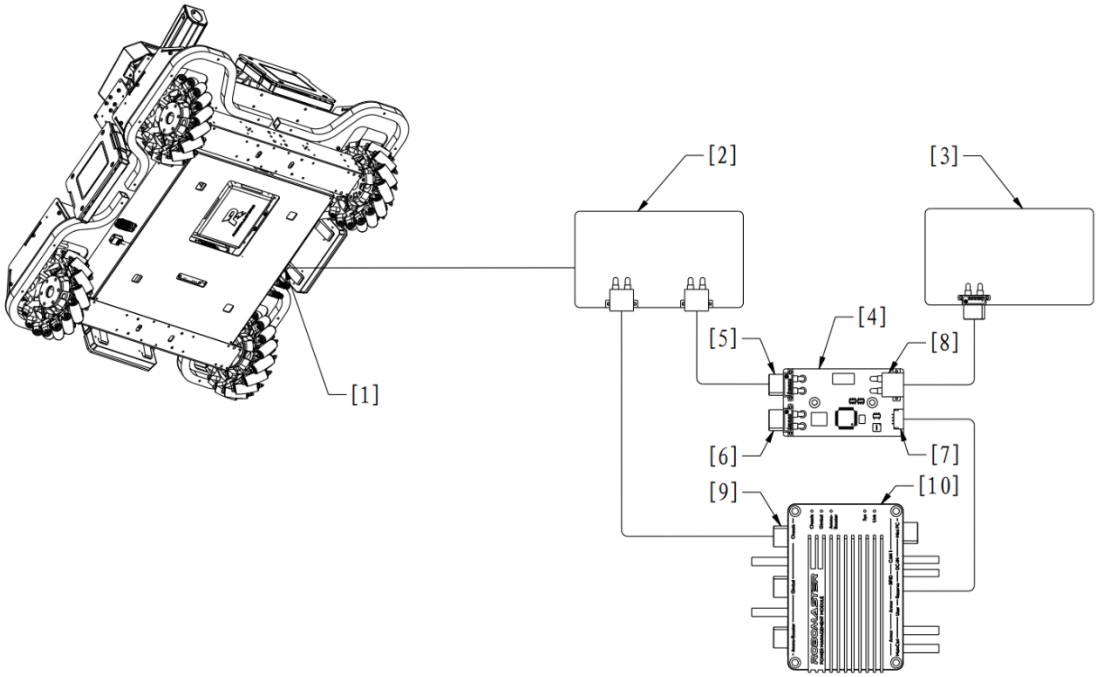

[1] Robot chassis power supply interface

[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 interface of Capacitor Management Module (output, XT30 receptacle) – for Pre-Match Inspection only

[7] Communication interface 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 interface of Power Management Module

[10] Power Management Module

Figure 3-49 Capacitor Management Module Connection

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3.13.2 Installation Requirements

- The communication interface 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 interface of the Capacitor Management Module to carry out discharge measurement.

S143 From a fully charged state, the capacitor's voltage needs to drop past 1V. If the capacitor's voltage drops at an unusually rapid pace, it is deemed to have failed the inspection.

S144 An XT30 receptacle cable of a length of at least 10cm should be attached to the inspection port of the Capacitor Management Module.

S145 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.

S146 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.

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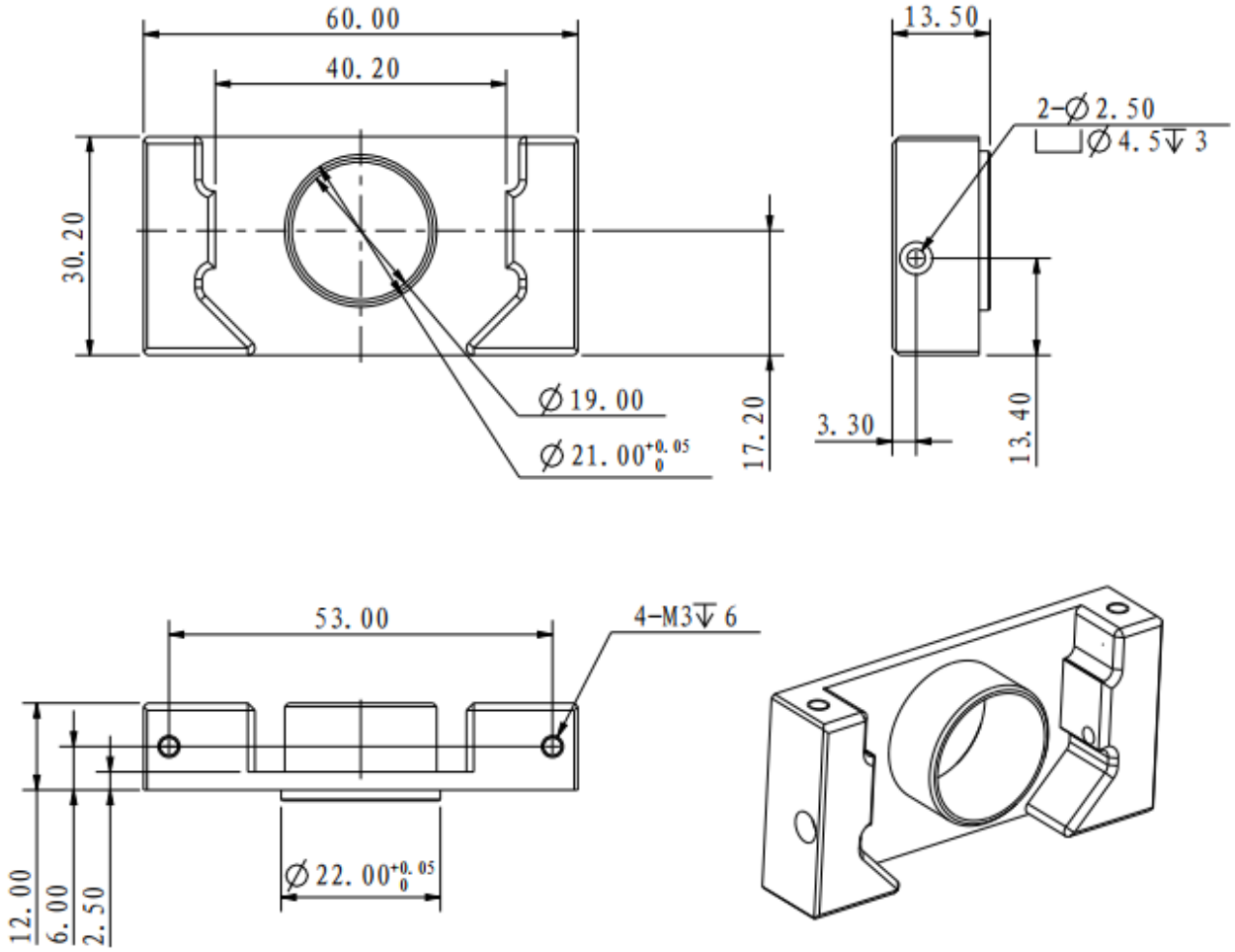
Appendix 1 Drawing of Adapter Block for Speed Monitor Module (17mm projectile)



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Appendix 2 Reference Drawings

Appendix Diagram 1 Hero Armor Sticker - No. 1

Appendix Diagram 2 Engineer Armor Sticker - No. 2

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Appendix Diagram 3 Standard Armor Sticker - No. 3

Appendix Diagram 4 Balancing Standard Robot Armor Sticker - No. 3

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Appendix Diagram 5 Standard Armor Sticker - No. 4

Appendix Diagram 6 Balancing Standard Robot Armor Sticker - No. 4

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Appendix Diagram 7 Standard Armor Sticker - No. 5

Appendix Diagram 8 Balancing Standard Robot Armor Sticker - No. 5

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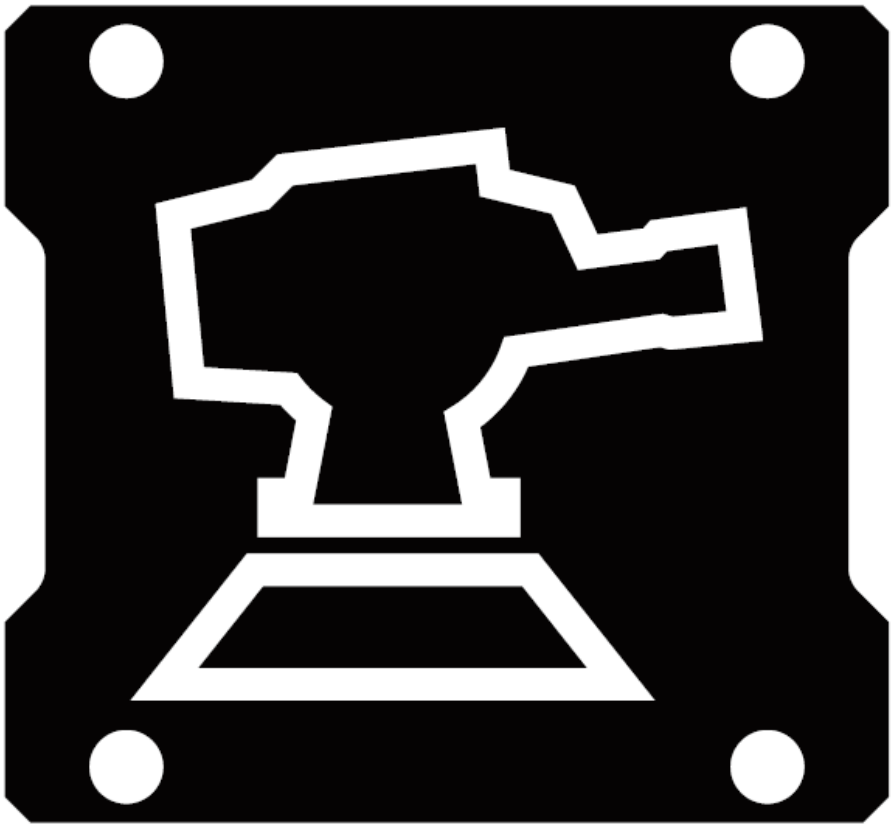
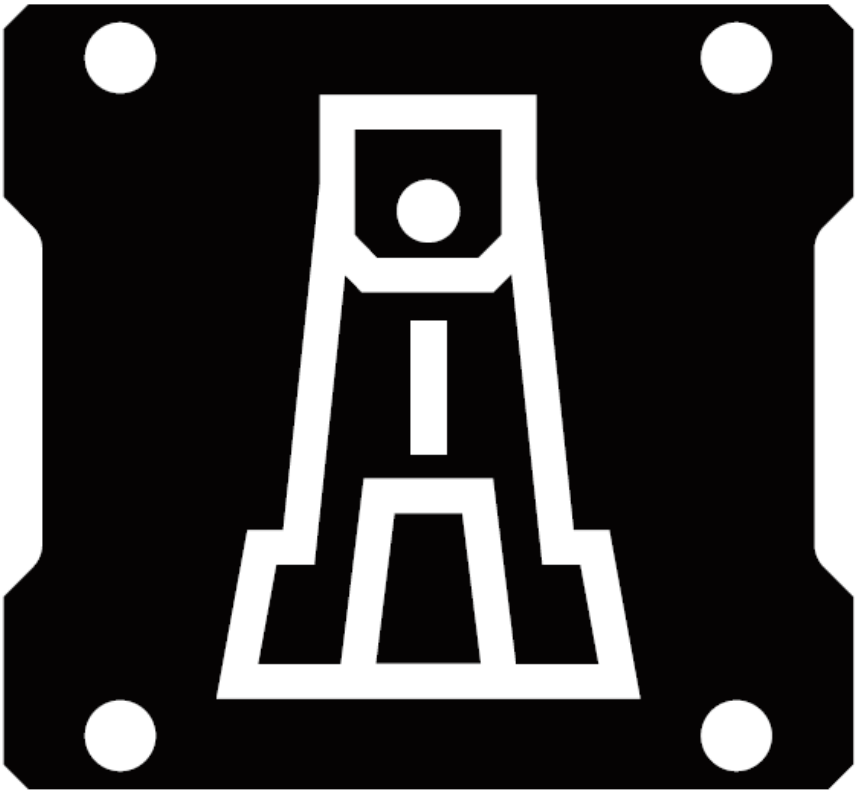


Appendix Diagram 9 Sentry Armor Sticker



Appendix Diagram 10 Outpost Armor Sticker

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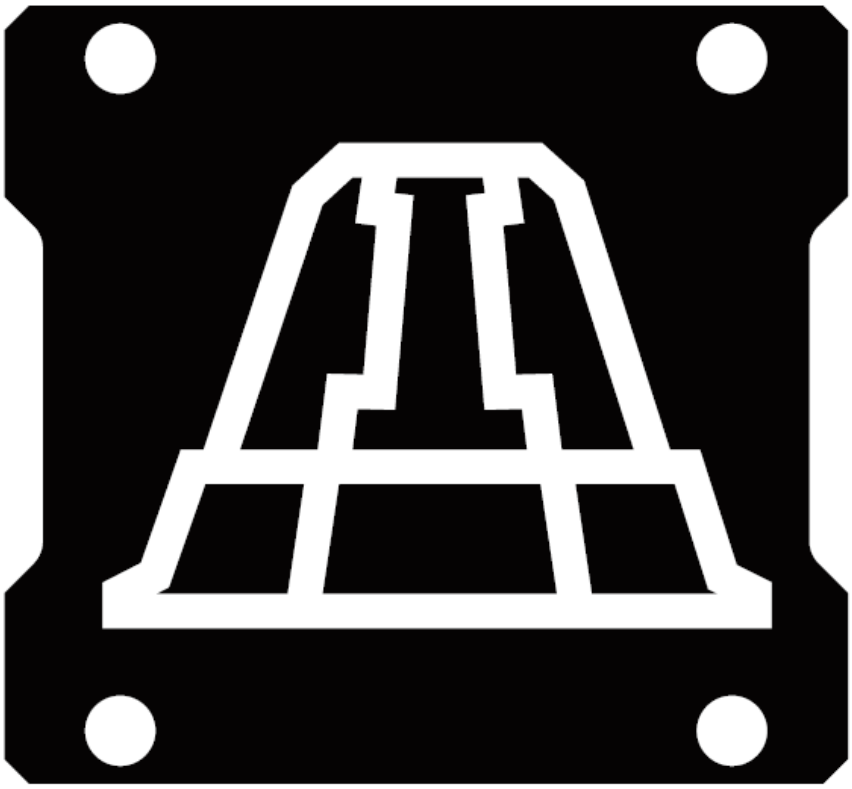
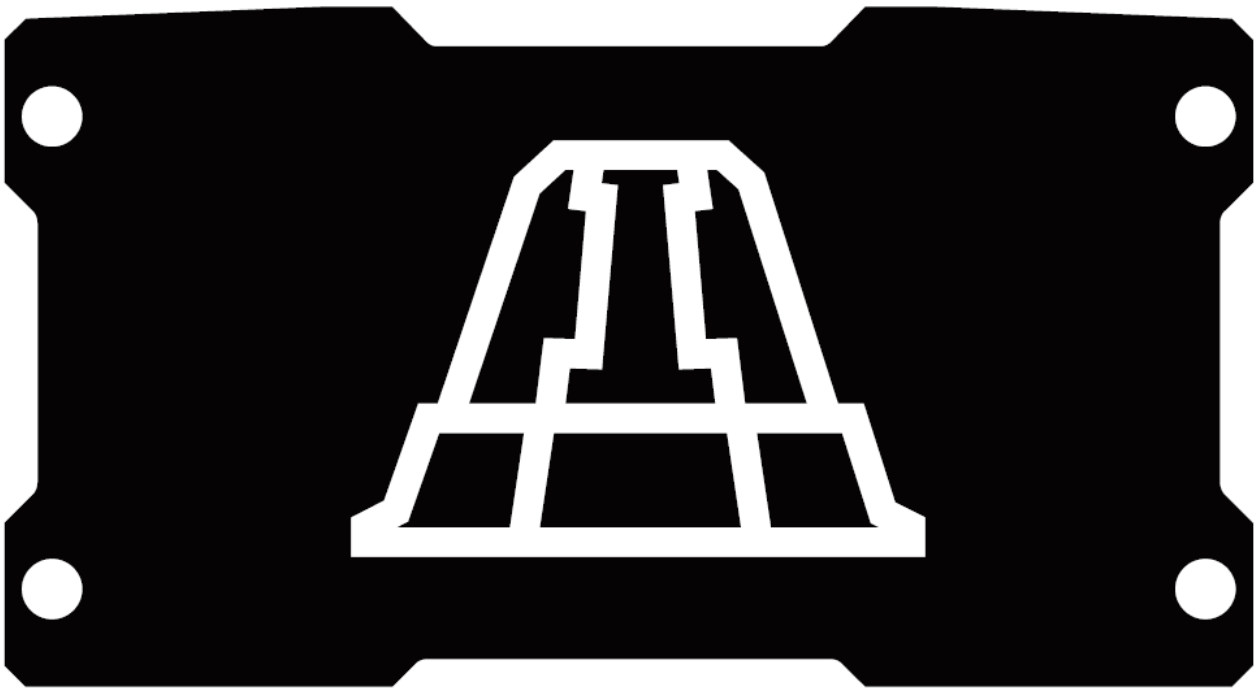


Appendix Diagram 11 Base Small Armor Sticker



Appendix Diagram 12 Base Large Armor Sticker

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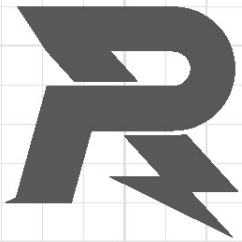

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