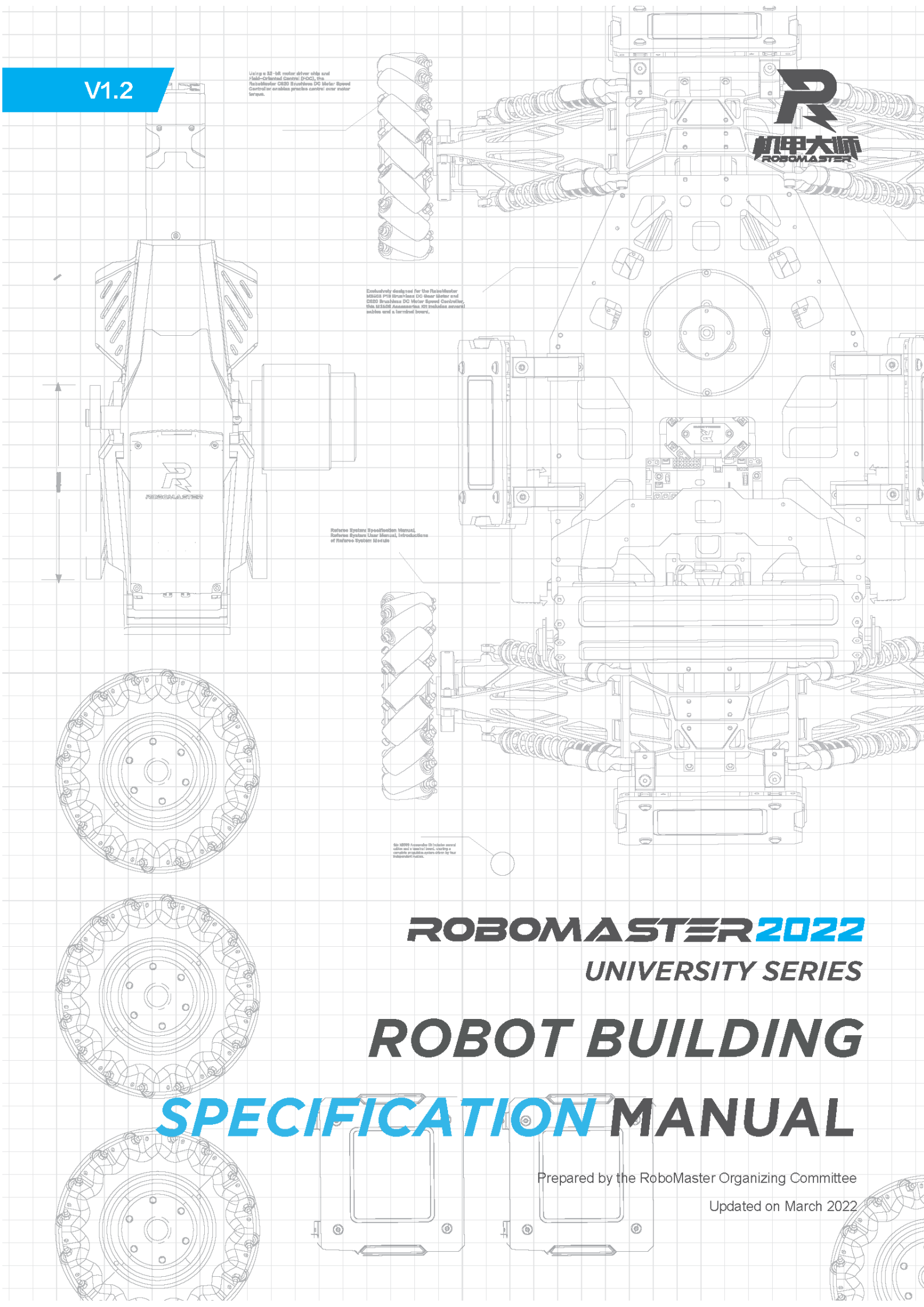
V1.2



ROBOMASTER 2022

UNIVERSITY SERIES

ROBOT BUILDING SPECIFICATION MANUAL

Prepared by the RoboMaster Organizing Committee

Updated on March 2022

Using this Manual

Legend

Prohibitions	Important notes	Hints and tips	Definitions and references

Related Documents

1. RoboMaster Referee System User Manual
2. User Manuals of Referee System Modules

We recommended that users read the Referee System Module Instructions respectively first to understand the functions of each Referee System module and how to mount them in order to mount the modules correctly. Thereafter, users may read the "RoboMaster Referee System User Manual" to learn the functions of the entire Referee System.

Release Notes

This manual will be updated twice in each season based on the circumstances of the competition. The manual will take effect from the specified date after its release.

Date	Version	Changes	Effective Date
2022.03.29	V1.2	1. Added restriction on the usage of third-party finished modules 2. Cancelled restriction on the posture of Dart	2022.03.28
2022.01.11	V1.1	1. Clarified definition of chassis power 2. Revised rules of usage for fully assembled robots and open-source robots	2022.01.11
2021.10.15	V1.0	First release	2021.10.15

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1. Foreword

RoboMaster participating teams are required to develop and create their robots, which must fulfill all the specifications in this document, failing which the team 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 RMOC.

The information of the basic parts, modules, educational products, sponsorship, discounts and other details relating to robots shall be subject to the announcements released on the official RoboMaster website.

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2. Technical Specifications

2.1 General Technical Specifications

2.1.1 Energy Source

- The use of combustion engines, explosives, hazardous chemicals, etc. is forbidden
- Except for Radar, players in the Competition Area are not allowed to connect to mains electricity.
- No hydraulic or other propulsion methods capable of causing pollution may be used.

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

2.1.1.1 Power Supply

- The batteries designated for use in this Season's competition shall be those produced by DJI.
- Lithium batteries not manufactured by DJI can be used in darts.

S2 Robots are required to use battery products designated by the RMOC or dry cells produced by other official manufacturers. Only dart may use lithium batteries produced by other official manufacturers.

S3 A Supercapacitor Management Module cannot be mounted on the chassis of a Sentry Robot. The total nominal energy of the Single Supercapacitor Modules of Standard and Hero 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).

Robot chassis: A mechanism that carries and has been mounted with a robot propulsion system and its accessories.

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

2.1.1.2 Gas Source

Robots using compressed gas for their propulsion system must meet the following requirements:

S5 The compressed gas pressure inside the cylinder must not exceed 20 Mpa. The cylinder used should have a nominal pressure of no less than 30 MPa. A double-gauge constant pressure valve should be mounted directly at the outlet of the cylinder. The working pressure must not exceed 0.8 Mpa.

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

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S7 The cylinder must have an approval certificate or a steel plate stamp. The certificate and plate stamp should be easily visible during Pre-Match Inspection.

S8 If a gas canister 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.

S9 The cylinder meets all the pressure requirements, and has been issued an approval certificate by an officially recognized approving institution in its country of manufacture.

S10 The cylinder and gas tube 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.

S11 The gas cylinder 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 The cylinder must be mounted safely and firmly on the robot body. To ensure safety, the cylinder's opening must be kept horizontal or facing up. The cylinder must be stabilized 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.

S13 The cylinder must be insulated from any possible heat source.

S14 All gas tubes 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 Wireless Equipment

- The remote controllers designated for use in this season's competition shall be the DT7 produced by DJI.
- The Video Transmitter Module (VTM) Remote Controller link refers to the link in the VTM used to transmit remote controller-related data. It can replace the DT7 and offer more superior stability.

S15 The specified control methods for this season are as follows:

Table 2-1 Summary of Control Methods

Data Link	Information Transmitted
DT7 Remote Controller	Mouse and keyboard commands, control stick movements
Video Transmitter Module (VTM) Remote Controller Link	Mouse and keyboard commands
Student Serial Port of the Referee System	Custom Controller, inter-robot communication, dart launching command

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S16 Each DT7 should connect with one receiver at most.

S17 Robots are not allowed to carry wireless communication equipment other than the remote controller (RC) and Referee System Module.

2.1.3 Optical Equipment

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

S18 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).

S19 Each Launching Mechanism 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.

The Dart Launcher is considered part of the Launching Mechanism.

S20 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 ground robots must not be equipped with other obvious visible light emitting equipment.

For the definitions of ground robots, please refer to the "RoboMaster 2022 University Championship Rules Manual".

S21 The optical equipment used by a robot must not cause any physical harm to any person.

S22 All infrared light sources must conform to the Class I requirements.

2.1.4 Vision 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 Vision 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

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interferences around the venue.

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

S23 Armor Modules cannot be blocked.

S24 The recognition of visual features by Armor Modules must not be interfered with by any means.

Armor visual features include the light indicators on both sides of the armor and armor stickers.

2.1.5 Robot Numbering

During Pre-Match Inspection and the competition, staff from the RMOC will provide each robot with a corresponding armor sticker in accordance with the robot serial numbers. For more details of the serial numbers, please refer to the "Robot Lineup" section in the "RoboMaster 2022 University Championship Rules Manual". For visual reference of the stickers, please refer to "Appendix 2 - Illustrations and Drawings".

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

S25 Armor sticker 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. One Armor Module must be attached with one armor sticker.

S26 Except for the exclusive armor stickers provided by the RMOC, no other stickers that resemble the exclusive armor stickers in their patterns may be attached on a robot's Armor Module or its other external structures.

The symbols on the armor stickers of the Sentry, Base and Outpost shall be their corresponding patterns. No armor stickers shall be attached on Aerial.

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:

S27 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.

S28 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.

S29 Fishing net cannot be used as an aesthetic material, but can be used in the protective guard of an Aerial Robot.

S30 Avoid sharp structures that may damage the battlefield or harm any person.

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Gloss:

S31 The exterior gloss of robots must not exceed 30Gs,

Except for the optical axis, camera lens and other components that cannot function under low gloss. However, they must be kept more than 100mm away from the edge of the armor light indicators.

Paint Color:

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

S32 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, to avoid confusion.

S33 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 Light Indicator must be more than 30 mm. 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.

S34 Reverse type 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:

S35 Reverse type can be applied for advertising spaces, or their original colors can be retained.

S36 The advertising spaces should be displayed on the left and right sides of the robot, and their distance with the Armor Light Indicator must not be less than 30 mm.

S37 The inkjet or stickers of the advertising spaces must not affect the robot's Computer Vision recognition effect, and cannot be illuminated.

S38 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.

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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 is not powered up).

S39 Robots using compressed gas as the propellant for projectiles must not have an acceleration length (defined as the lineal length of the launching mechanism that can provide acceleration to projectiles) exceeding 200 mm.

S40 Except Aerial and Sentry, robots' Launching Mechanisms must stably launch projectiles.

During the Pre-Match Inspection, each ground robot that is mounted with a Launching Mechanism must be able to launch 10 rounds of 17mm projectiles or 5 rounds of 42mm projectiles in a stable manner.

S41 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.

S42 Each team is allowed to mount no more than one mobile 17mm Launching Mechanism on one Standard, Hero or Aerial Robot. Any robot mounted with this mobile 17mm Launching Mechanism will gain 0.2 kg for its weight in the Referee System.

2.1.8 Custom Controller

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

Table 2-2 Description of Custom Controller building parameters

Item	Limit	Remarks
Target	Each robot can be configured with one Controller at most	Custom Controllers are not allowed to be used on Sentry or Auto Standard Robots
Maximum Power Supply Capacity (Wh)	200	-
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)

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Item	Limit	Remarks
		● Excluding the size of data or power cables of any equipment
Maximum Weight (kg)	10	Including the battery weight
Data Transmission	Serial Port Module	-
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	-
Protocol	Refer to the "RoboMaster 2021 Referee System Serial Port Protocol Appendix"	-

L*W*H：Size, Length*Width*Height

Mounting Requirements:

S43 It is recommended that a non-slip pad is placed under the Controller.

S44 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.

S45 Keep the cables of the Controller neatly stored in the device without being exposed.

S46 The interface between the Controller and the computer in the operation room should strictly comply with the requirements specified in “Table 2-2 Description of Custom Controller building parameters”. Unauthorized connection is strictly forbidden.

How to Use:

S47 Before you start to use the Custom Controller, you should test whether it functions properly by placing it on the computer desk in the operator room and connect it to the data interface available in the room.

S48 You must not use any wireless transmitter or receiver together with the Controller.

S49 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.

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- For self-made video glasses, the power supply must be provided by the Controller. No battery is allowed to be mounted in the glasses (excluding commercial video glasses which come with batteries).
- Only batteries produced by SZ DJI Technology Co., Ltd. are authorized to be used on the Controller. Use of mains electricity (220V) is strictly forbidden.

2.1.9 Miscellaneous

S50 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.

S51 Rescue robots must not grab any of the Referee System Modules on the robot being rescued.

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

- Teams who did not qualify for the offline tournaments of the RMUC 2021, RMUT 2021, RMUL 2021 are allowed to compete with only one RoboMaster Robot Self-Assembled Version Type A without modification or RoboMaster AI Robot 2020 Standard Version that fulfills the new structural design requirements.
- Other teams are not allowed to converse the above robots into newly designed robots when building their robots, nor use key components such as frame profiles, and only allowed to use some of the components, such as motor coupling, launching mechanism, and loading mechanism.
- When building robots, teams are not allowed to use third-party finished modules, except for the flight system of the Aerial Robot (including frame, power system, flight control system, perception system).

A finished module refers to a specific functional component composed of several basic functional components to form a system with complete functions, such as robotic arm, chassis, gimbal.

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

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teams representing their colleges or universities having the intellectual property rights over the robots' design and form or teams made up of individuals with such rights are allowed to use the robots' design and form in the competition. Other teams wishing to incorporate such design and form must perform a redesign to their robot by at least satisfying one complete redesign criterion or three partial redesign criteria. Once these criteria are satisfied, the design will be deemed new and the team may use the newly designed robots in the competition. Such redesigns include but are not limited to the following examples:

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. e.g., 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: Direct-drive, pulleys, connecting rods, gears, etc.;
- Increase quantity of effective launching mechanism.
- **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

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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 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.

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 cylinder 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

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it with a soft tube.

S52 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.

S53 Any team using a redesigned fully assembled robot or open-source robot must submit descriptions of the relevant modifications to the Inspection Area.

2.3 Robot Technical Specifications

2.3.1 Hero Robot

The building parameters for Hero are as follows:

Table 2-3 Hero building parameters

Item	Limit	Remarks
Operating Mode	There is no limit. One remote controller and one Custom Controller can be configured at most	-
Maximum Total Power Supply Capacity (Wh)	200	-
Maximum Power Supply Voltage (V)	30	-
Launching Mechanism	One 42mm Launching Mechanism	Fixed 42mm Launching Mechanism and mobile 17mm Launching Mechanism cannot be at an altitude of more than 600 mm from the ground (based on the center of the pitch axis of the gimbal)
Projectile Supply Capability	Can receive but cannot supply	-
Maximum Weight (kg)	35	Includes battery weight, but not the weight of the Referee System

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Item	Limit	Remarks
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	Four large Armor Modules, Speed Monitor Module (42mm projectiles)	Weight is 4.20 kg

Maximum Expansion Size: A robot is allowed to expand up to the maximum size it is structurally able to.

2.3.2 Engineer Robot

The building parameters for Engineer Robots are as follows:

Table 2-4 Engineer Robot building parameters

Item	Limit	Remarks
Operating Mode	There is no limit. One remote control and one Custom Controller can be configured at most	-
Maximum Total Power Supply Capacity (Wh)	200	-
Maximum Power Supply Voltage (V)	30	-

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Item	Limit	Remarks
Mineral-grabbing mechanism	● An “mineral-grabbing mechanism” refers specifically to the only mechanism that an Engineer Robot may use to grab minerals on a Resource or Small Resource Island. Each Engineer Robot can only be mounted with one mineral-grabbing mechanism. ● Only one mineral can be grabbed each time. ● 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 Resource Island.	● A robot is allowed to grab minerals in the manner of an assembly line when using one mineral-grabbing mechanism. ● There is no limit to the number of other grabbing mechanisms or mechanical claws allowed to be mounted (such as those used for moving obstacle blocks). ● When a mineral leaves the Resource Island (i.e. it is no longer in contact with the groove of the Resource Island), for example when it falls to the ground, any grabbing mechanism — and not necessarily an “mineral-grabbing mechanism” — may be used to collect the mineral.
Launching Mechanism	No Launching Mechanism is allowed to be installed	-
Rescue Method	● Using an Engineer Rescue Card (RFID Interaction Module Card) to revive the other ground robots of your own team. ● Move other ground robots of your own team to the Restoration Zone.	An Engineer Robot is allowed to carry at most one Engineer Rescue Card to interact with its own team’s Standard and Hero Robots. If an Engineer Robot is going to carry an Engineer Rescue Card, the Rescue Card must be fixed securely on the Engineer Robot to ensure it does not fall off during a match and is easy to replace.

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Item	Limit	Remarks
Projectile Supply Capability	Can receive and supply	-
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 ● An Engineer Robot is not allowed to transform beyond its maximum expansion size, except for the area occupied by an RFID Interaction Module Card carried by the robot and the area of orthographic projection where the card is located (only the mechanism grabbing the card, instead of all parts of the robot, is allowed in the area).
Referee System	Four Small Armor Modules, and a Video Transmitter Module (Transmitter), RFID Interaction Module, Positioning System Module, Main Controller Module, Power Management Module, Light Indicator Module, and RFID Interaction Module Card	Weight is 3.06 kg

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The overlapping of multiple RFID Interaction Module Cards will affect the sensing range of RFID Interaction Module. To minimize any such potential impact, it is recommended that when designing and building an Engineer Robot, a team should do its best to place its RFID Interaction Module Card right below and within 30 mm of the RFID Interaction Module of the robot being rescued.

2.3.3 Standard Robot

- In the absence of any special classification, Standard Robots include Regular, Automatic and Balancing Standard Robots.
- If any special classification is provided, Standard Robots will include the same robots excluding the specified type of Standard Robots.

The building parameters for Standard are as follows:

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Table 2-5 Standard building parameters

Item	Limit	Remarks
Operating Mode	There is no limit. One remote control and one Custom Controller can be configured at most	The Automatic Standard robots should be completely automatic in operation. Only a maximum of one remote control and one Custom Controller can be configured to perform testing and debugging.
Maximum Total Power Supply Capacity (Wh)	200	-
Maximum Power Supply Voltage (V)	30	-
Strength	Free-falling from a vertical altitude of 0.2 m three times without any damage to any part of the body	-
Launching Mechanism	A 17mm Launching Mechanism	-
Projectile Supply Capability	Can only receive projectiles	-
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

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Item	Limit	Remarks
Referee System	Four Small Armor Modules (Balancing Standard Robots to be mounted with two Large Armors), 17 mm Speed Monitor Module, Video Transmission Module (Transmitter), RFID Interaction Module, Positioning System Module, Main Controller Module, Power Management Module, Light Indicator Module, 17 mm Fluorescent Projectile Charging Device.	The referee system of a Balancing Standard Robot weighs 2.60 kg, while those of other Standard Robots weigh 3.25 kg.

The definition of Standard Balancing Robots:

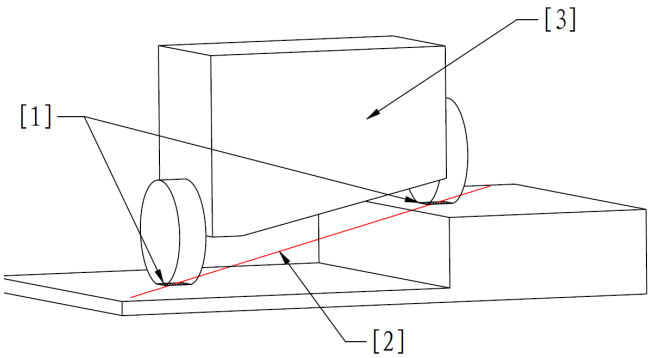
A robot's contact surface shall be any bordered ground surface that it has contact with. Any robot that meets all the following criteria is deemed a Balancing Standard Robot:

Criterion 1: When the robot is alive, the largest axial projections of all the wheels of a robot having a contact surface with the ground 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 robot is powered off, its Z-axis cannot be perpendicular to the ground.

Example: As shown below, the robot, when alive, has two wheels in contact with the ground, 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] The contact surface between [2] The straight line intersecting [3] Balancing Standard

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the wheels and the ground with the contact surfaces Robot

Figure 2-1 A Balancing Standard Robot

Under any of the following circumstances, a Balancing Standard Robot may use other propulsion mechanisms to prop itself up on the ground to restore its balance:

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

2.3.4 Aerial Robot

The building parameters for Aerial Robots are as follows:

Table 2-6 Aerial Robot building parameters

Item	Limit	Remarks
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 Power Supply Voltage (V)	48	-
Launching Mechanism	-	Aerial Robots no longer have Fixed Launching Mechanisms, and can now be mounted with a Mobile 17mm Launching Mechanism.
Projectile Supply Capability	Can receive but cannot supply	-

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Item	Limit	Remarks
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	Video Transmitter Module (Transmitter), Positioning System Module, Main Controller Module, Power Management System	Weight is 0.64 kg

2.3.4.1 Building Requirements

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

S54 An Aerial must be mounted with a fully covered propeller guard, where the propellers must not be exposed. The Aerial should be able to strike a rigid surface at a horizontal speed of (1.2 ± 0.1) m/s without suffering significant damage.

Fully covered propeller guard: A structure that fully protects each propeller.

The grid dimension constraint of the fully covered propeller guard will be updated subsequently. DJI Mavic Pro Propeller Guard is displayed as below for reference:

S55 After the fully enclosed propeller cage is 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 cm².

S56 If Aerial crashes into a tall cylindrical object of any diameter from any angle and at a certain horizontal speed,

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its propeller guard should protect its propellers from making direct contact with the cylindrical object, and should not suffer any significant deformation.

S57 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 hooked with the Aerial Safety Rope of the Battlefield Components. 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 50 mm, and release it into free fall once - the robot should not suffer any significant deformation and damage.

S58 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.

S59 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 100 mm 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 3200 Lux at a distance of 100 mm.

S60 Teams are required to design and mount their own external navigation lights on their Aerial to enhance its visual recognition. External navigation lights must ensure the projection planes on the front and back, left and right, and top of an Aerial can be effectively monitored. The specific requirements are as follows:

a) The distance between the external navigation lights and the center of an Aerial must exceed 1/3 of the radius of the maximum top view field of the robot.

b) External navigation lights must use Light Indicators and be joined with the Aerial securely, but cannot be mounted on propeller blades. The Light Indicators must be at least 180 mm in total length, and must appear aesthetic, symmetrical and not create any parallel light rays.

c) External navigation lights must be mounted facing up or on the side, and must not be mounted facing down. The external navigation lights of Aerial should be able to switch to red and blue, so as to be consistent with the team color during a match.. For instance, the external navigation lights on a Matrice 600 should have an effective illumination area shown as the red grid below.

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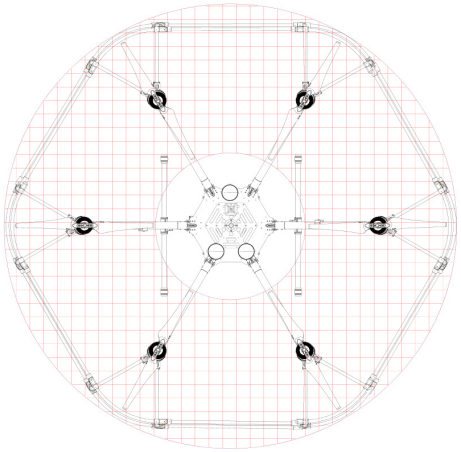

Figure 2-2 Effective Area of the External Navigation Lights

S61 A single area of external navigation light of Aerial must have an illuminance at 100 mm away ranging between 500 - 2,000 Lux.

S62 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.

S63 If the Aerial Robot is mounted with a Mobile 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.

S64 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.

2.3.5 Sentry Robot

The building parameters for Sentry are as follows:

Table 2-7 Sentry building parameters

Item	Limit	Remarks
Operating Mode	Fully automatic, with no more than one remote controller for debugging	-
Maximum Total Power Supply Capacity (Wh)	200	-
Maximum Power Supply Voltage (V)	30	-

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Item	Limit	Remarks
Launching Mechanism	At most two 17mm Launching Mechanism	-
Projectile Supply Capability	Can receive but cannot supply	-
Maximum Weight (kg)	15	Includes battery weight, but not the weight of the Referee System
Maximum Size (mm)	500*600*850	● The Light Indicator Module and the Positioning System Module and its mounting bracket are excluded from the calculation for the size restriction. Other Referee System modules must be taken into account for the size restriction. ● The Maximum Size of the Sentry below the top surface of the Sentry Rail must be 450 mm (including the Maximum Expansion Size). ● The size restriction applies to its length, width and height.
Referee System	Two Large Armor Modules, two Speed Monitor Modules (17mm projectile), and Positioning System Module, Main Controller Module, Power Management Module, Light Indicator Module, and two 17mm Fluorescent Projectile Energy-Charging Devices	Weight: 2.63 kg

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2.3.6 Dart System

- 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.
- When a dart strikes the object, it must strike the small Armor Module on the Dart Detection Module via the Dart Trigger Device. A dart attack will not be determined until the dart attack detection condition is fulfilled. Otherwise, it will be seen as other damage accoding to the impact force.

- 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. Staff at the Inspection Area will set the color.
- 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.

- The use of compressed air is prohibited in propelling a dart.

- If a Dart Trigger Device emits red-and-blue alternating lights, it means that the Dart Trigger Device is damaged. Please replace it with a backup Dart Trigger Device, otherwise any consequent losses shall be borne solely by the team.

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

A Dart uses its own Visionary Intelligence to locate objects, 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 object.

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 student's data terminal to control the Dart Launcher. A Dart Launcher can be equipped with a laser sight.

The building parameters for a Dart is as follows:

Table 2-8 Dart building parameters

Item	Limit	Remarks
Maximum Total Power Supply Capacity (Wh)	4	-

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Item	Limit	Remarks
Maximum Power Supply Voltage (V)	8.4	-
Maximum Weight (kg)	0.22	Not including Dart Trigger Device
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

S65 Dart can only be in the ready-to-launch state during the 7-minute match.

The building parameters for Dart Launcher are as follows:

Table 2-9 Dart Launcher building parameters

Item	Limit	Remarks
Operating Mode	There is no limit. One remote control and one Custom Controller can be configured at most	Use of the Referee System link is recommended.
Rotation Angle (°)	● Yaw angle: No limit ● Pitch angle: 25-45	-
Maximum Total Power Supply Capacity (Wh)	200	-
Maximum Power Supply Voltage (V)	30	-
Maximum Operating Power (W)	No limit	-
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.

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

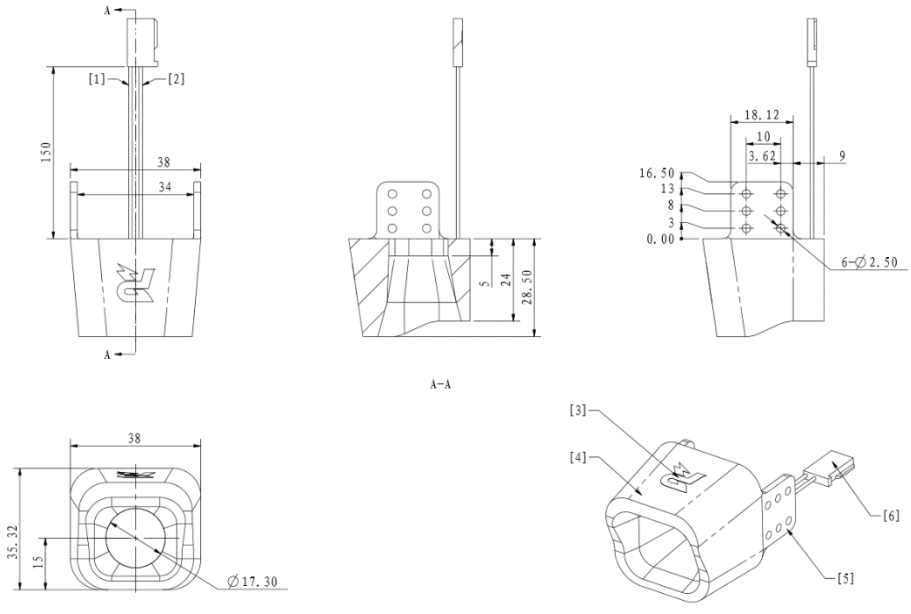
Ready-to-launch state: Energy storage element, which is used to provide initial kinetic energy for darts, is in states of tension, air inflation and rotation. Energy storage element includes but not limited to rubber band, cylinder, friction wheel, etc.

2.3.6.1 Mounting Specifications

During a match, infrared light is emitted from a Dart Trigger Device evenly across its surrounding space. When a Dart Trigger Device collides with the Small Armor Module area of the Dart Detection Module, the infrared light emitted from the Dart Trigger Device is received by the infrared light receiving device of the Dart Detection Module, while the collision triggers detection by the Small Armor Module. A dart attack is confirmed when both happen at the same time.

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.



[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

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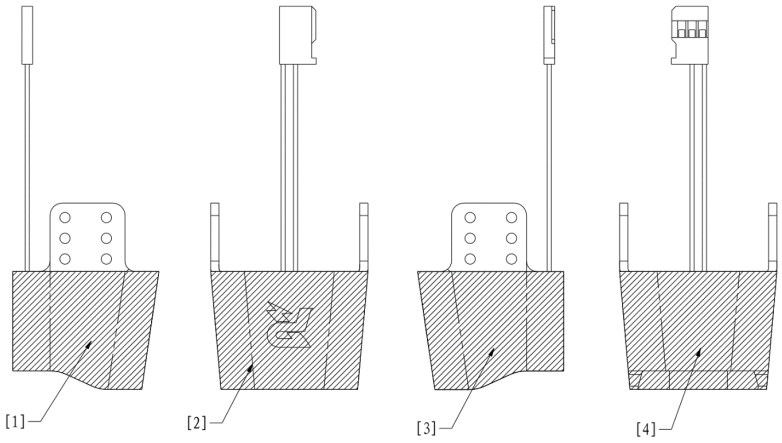
2.3.6.1.1 Installation Steps

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

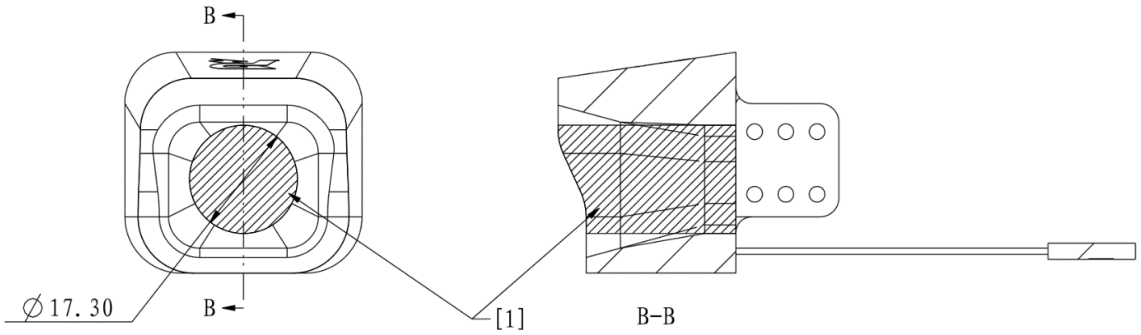
S66 After mounting Dart Trigger Device, its up and down, left and right sides must not be blokced by the dart structure, as shown below.



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

Figure 2-4 Dart Trigger Device is blocked

S67 Dart camera or other devices can be mounted in the internal cavity of Dart Trigger Device. The mounting area of dart camera or other devices must not exceed the shadow area as shown below.



[1] Shadow Area

Figure 2-5 Dart Trigger Device internal cavity is blocked

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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. The light beads emit a green visible light in the 520nm band. The power of the guiding light is about 2W, and the beam diameter is about 55mm. Please refer to the relevant descriptions of Outpost and Base in the RoboMaster 2022 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 2022 University Championship Rules Manual.

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 building parameters for a Radar Computing Platform are as follows:

Table 2-10 Radar Computing Platform building parameters

Item	Limit	Remarks
Operating Mode	Fully automatic, with no more than one remote controller for debugging	During the 7-minute match, remote controllers are not allowed to use
Maximum Power (W)	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.
Power Supply Frequency (Hz)	50	These are based on the electrical power standards in Mainland China. Users in other countries or regions may refer to their local electrical power standards.

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Item	Limit	Remarks
Maximum External Dimensions (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 and Power Management Module	Weight is 0.22 kg

The parameters for a Radar Sensor are as follows:

Table 2-11 Radar Sensor parameters

Item	Limit	Remarks
Maximum Weight (kg)	30	-
Maximum External Dimensions (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 1.2 m.

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 3 m.
- The portability of the Radar sensor mounting bracket will be checked during the Pre-Match Inspection, i.e. whether the bracket can be easily lifted with one hand.

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 and a video signal transmission cable to the operator's room (with an HDMI Type A plug). 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.

A monitor will be placed in the Operator Room, with the source image provided by the Radar and the signal format must be 1080P60.

S68 No wireless receiving device can be used on computing equipment. If a receiving device cannot be removed,

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it must be set as disabled in the operating system.

S69 The Main Controller Module and Power Management Module should 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 will only ensure the proper functioning of the display screen and HDMI signal cables in the operator room. Any issue with the connections must be resolved by the team itself.

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.

S70 Sensors must be fixed on the radar sensor mounting bracket and placed on the radar base.

S71 Teams must design their own radar sensor mounting bracket to increase the elevation for the installation of sensors.

S72 The size of the radar sensor mounting bracket should allow for proper installation on the surface of the radar base and be portable. The specifications of the Radar Base should follow the relevant description of the Radar Base in the RoboMaster 2022 University Championship Rules Manual. The signal transmission and power supply of the sensor must be handled by the teams themselves.

S73 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 Overview

The Referee System is a fully automatic electronic system that can monitor the state of a robot and make a determination. During the competition, the Referee System monitors each robot's HP, projectile initial firing speed, chassis power consumption, status, location and other details and then sends real-time information to the computer of the corresponding Operator Room and Referee System server. It also automatically determines the outcome of the competition, ensuring the fairness of the competition.

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).

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 requirements stated in this chapter.

A Referee System consists of the following modules:

Table 3-1 Referee System Component Modules

Module	Description
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.

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Module	Description
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.
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 attcked by projectiles and collisions. There are Small Armor Module and Large Armor Module.
Speed Monitor Module	A Speed Monitor Module is used to detect the initial launching speed and speed of projectile of robot. There are 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	Description
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

Robot / Quantity	Standard	Balancing Standard	Sentry	Hero	Aerial	Engineer	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	0	2	2	4	0	0	0	0
Small Armor Module	4	0	0	0	0	4	0	0
Video Transmitter Module (Transmitter)	1	1	0	1	1	1	0	0
RFID Interaction Module	1	1	0	1	0	1	0	0
Speed Monitor	1	1	2	0	0	0	0	0

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Robot / Quantity	Standard	Balancing Standard	Sentry	Hero	Aerial	Engineer	Dart System	Radar
Module (17mm Projectile)								
Speed Monitor Module (42mm Projectile)	0	0	0	1	0	0	0	0
Positioning System Module	1	1	1	1	1	1	0	0
17mm Fluorescent Projectile Energy-Charging Device	1	1	2	0	0	0	0	0
Supercapacitor Management Module	1	1	0	1	0	0	0	0

- The table above does not include the Mobile 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 and RoboMaster University Technical Challenge.

3.3 Mounting Specifications for Main Controller Module

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

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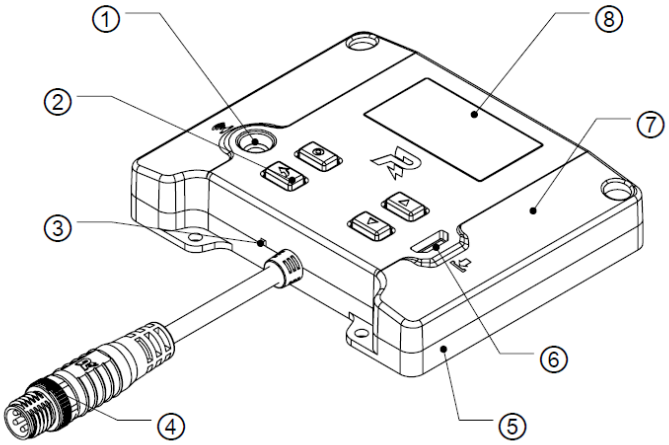

[1]	IR Receiver	[2]	Button	[3]	Power Indicator	[4]	Black Metal Ring Aviation Connector
[5]	Metal Bottom Cover	[6]	Upgrade Interface	[7]	Plastic Top Cover	[8]	Screen

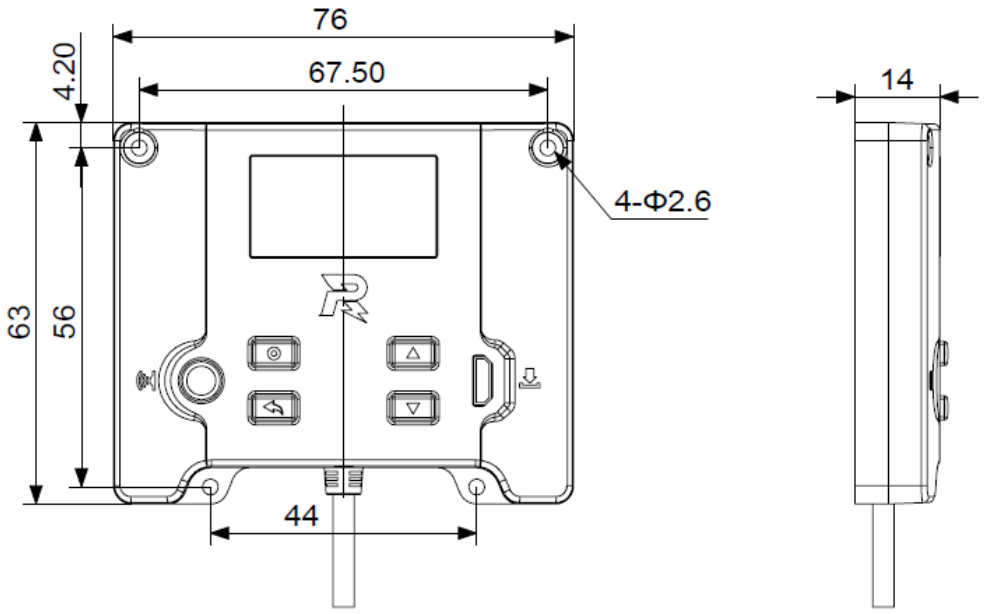

Figure 3-1 Main Controller Module

3.3.1 Installation Steps

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

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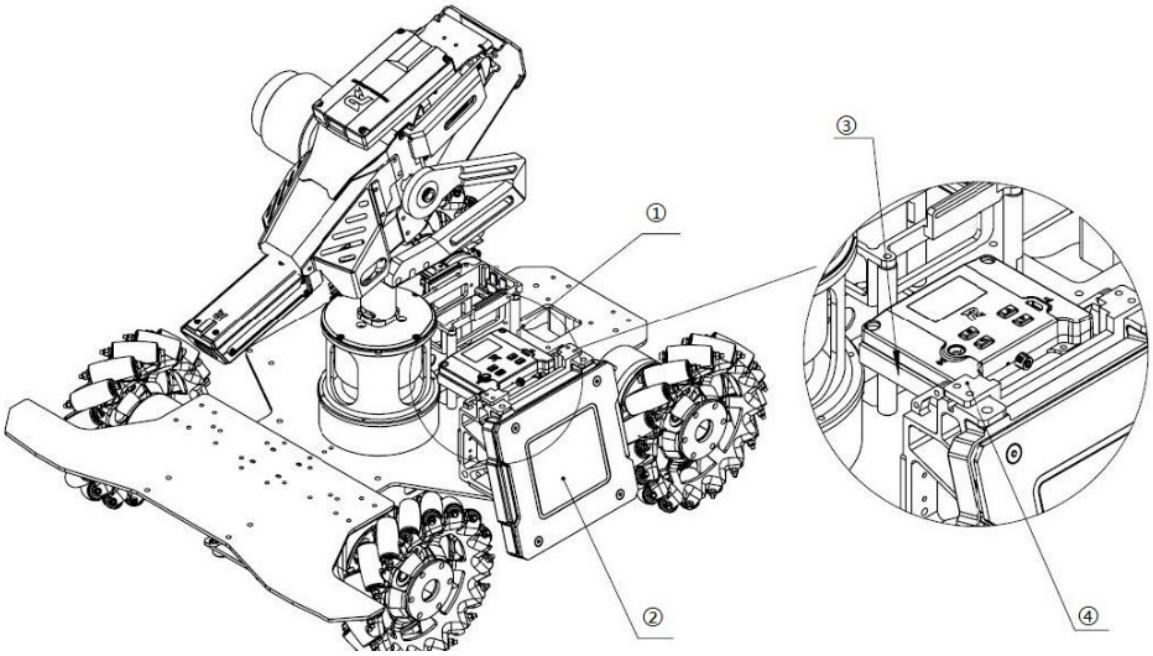
Mounting reference: Teams may design parts by themselves (not including those in the items list), and install them on the back of the edge of the Armor Module (the reserved M3 threaded hole on the Armor Module support frame can be used), with non-metal guards installed around them to prevent attacks by projectiles.



[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 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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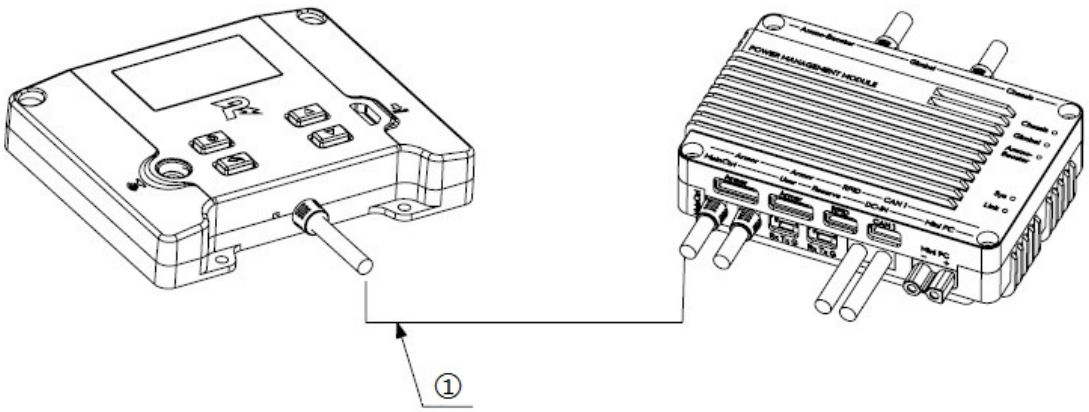

[1] Aviation Connector Cable

Figure 3-3 Main Controller Module Connection

3.3.2 Installation Requirements

When a Sentry Robot is mounted on the rail, its Main Controller Module must also meet the relevant installation requirements.

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

S74 Ensure the top surface of the Main Controller Module of a robot faces up when it is in working condition.

S75 The space above the interface of the Main Controller Module (screen and keys) must not be obstructed, and if any protective device is mounted (e.g. foam or fiberglass sheets), it must be easy to open for the interface to be accessed.

S76 No electromagnetic shielding material (including but not limited to metals, carbon fiber, conductive rubber, wave-absorbing materials, and conductive complexing agents) or other equipment carrying electromagnetic interference should be placed within a 70 mm radius, with the center being 14.5 mm directly below the center point of the logo.

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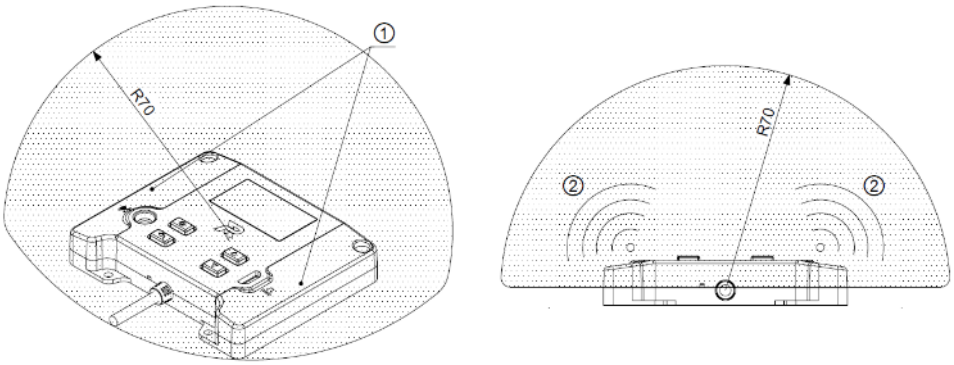

[1] Antenna Position [2] Signal Direction

Figure 3-4 Graph of Main Controller Module mounting position

S77 The infrared receiver of the Main Controller Module must not be blocked, to make it easy to manually connect to the server during the competition.

S78 The mounting position of a Main Controller Module must make it easy for staff to operate the press key, check information on the screen, and upgrade firmware.

3.4 Mounting Specifications for Power Management Module

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

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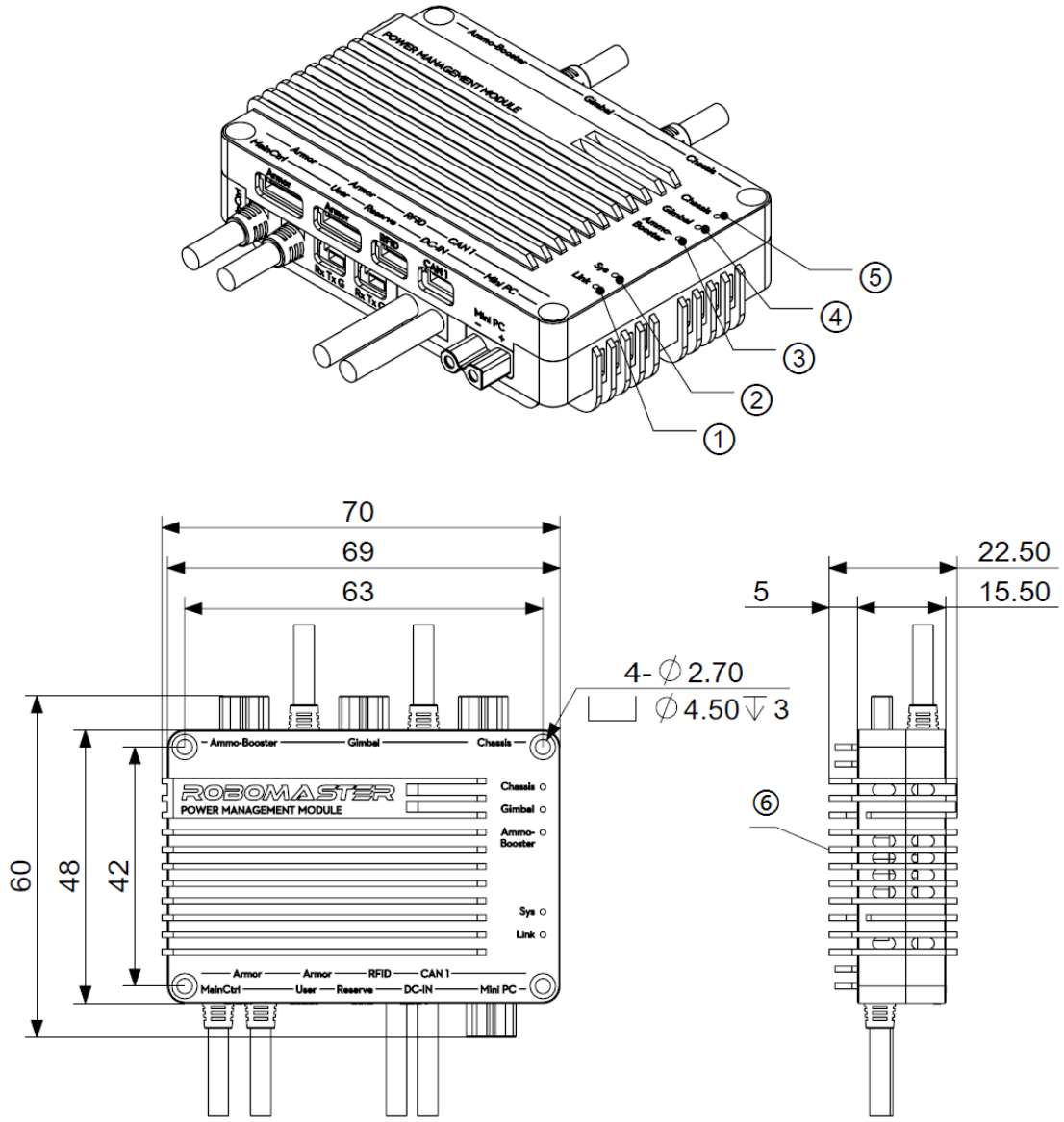

[1]	Connection Status Indicator	[2]	System Status Indicator	[3]	Launching Mechanism Power Output Indicator
[4]	Gimbal Power Output Indicator	[5]	Chassis Power Output Indicator	[6]	Bottom Mounting Surface

Figure 3-5 Power Management Module

3.4.1 Installation Steps

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

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

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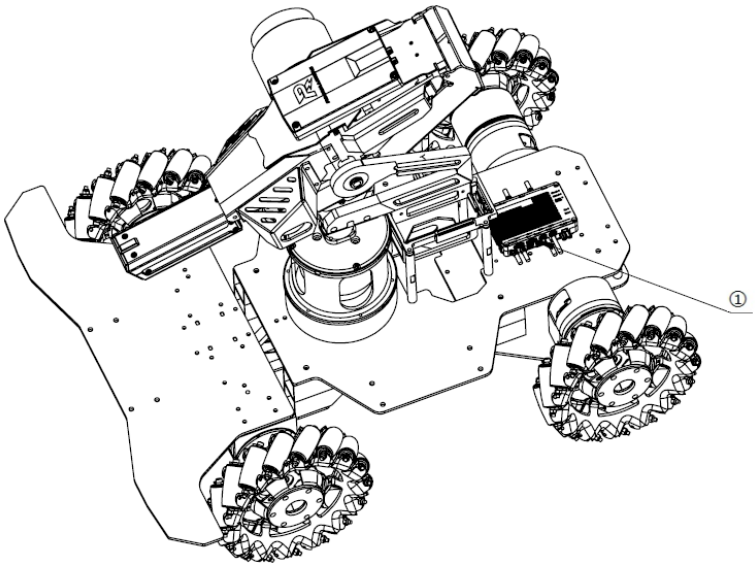
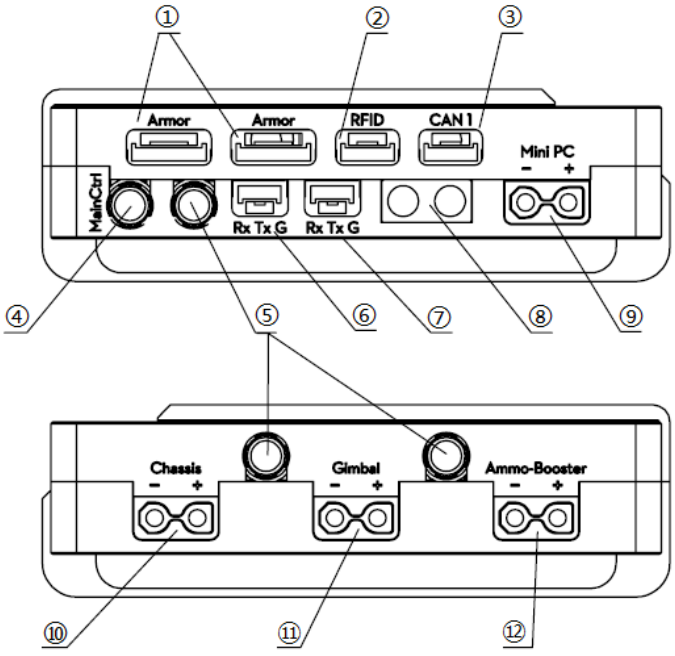


[1] Power Management Module

Figure 3-6 Power Management Module Mounting Graph



[1] Armor Module SM06B-GHS-TB Port

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

[3] CAN Communication SM04B-GHS-TB Port

[4] Main Control Module Port (the metal ring of the aviation plug is black)

[5] Ports of other Referee System Modules (Speed Monitor, Positioning System, Video Transmitter, and Light Indicator; the metal ring of the aviation plug is silver in color)

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[6] User SM03B-GHS-TB Port

[7] System Level Up SM03B-GHS-TB Port

[8] Referee System Power Supply XT60 Port (input)

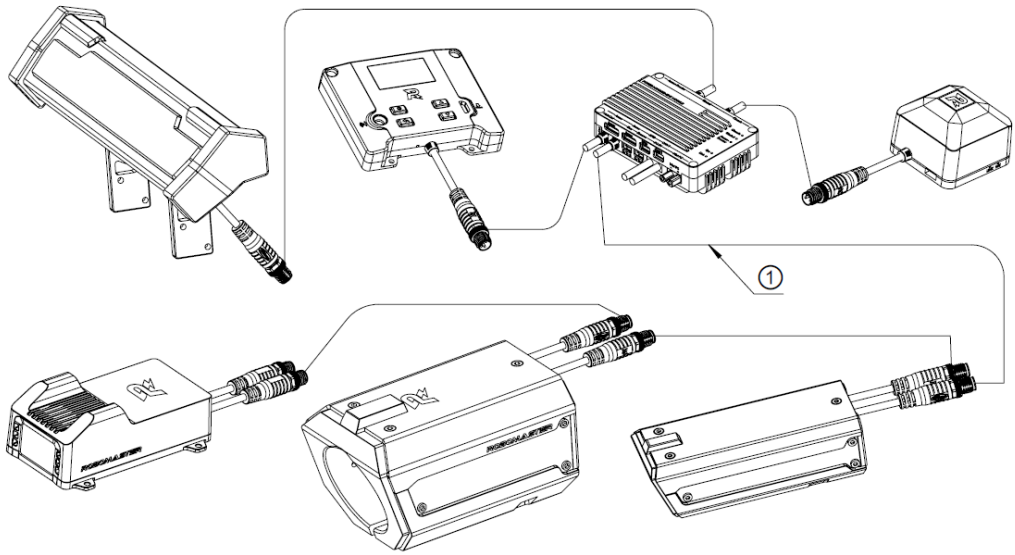
[9] Mini PC Power Supply XT30 Port (output)

[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



[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:

S79 The status indicators of the Power Management Module are not blocked.

S80 Each port on the Power Management Module is protected, to prevent damage by projectiles. However, the outer shell cannot be completely wrapped, so as to ensure good heat dissipation.

S81 Do not use glue such as 3M glue to secure the Power Management Module.

S82 For a robot with a power limit, the electric power for the power limiting mechanism must not bypass the monitoring of the Power Management Module.

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S83 Carefully differentiate between the ports on the Power Management Module to ensure correct cabling.

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

- If a Hero Robot is not installed with a 17 mm 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 Comparison of Power Management Module interfaces

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
Engineer Robot	Chassis	Chassis or Gimbal	/	/
Standard Robot	Chassis	Gimbal	Ammo-Booster	/
Sentry Robot	Chassis	Gimbal	Ammo-Booster	/
Aerial Robot	/	Gimbal	Ammo-Booster	/
Radar	/	/	/	/
Dart Launcher	/	/	/	/

S84 The circuit board and circuit of a robot with a power limit must meet the following requirements:

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- The power used to divert some of the force on a robot's chassis (except for balancing standard robots) shall be calculated into the chassis power, for example with the yaw motor of a ship's wheel standard robot.
- The power generated by active suspension systems for preventing a robot's horizontal movements does not count as chassis power.
- The power generated by the momentum wheels, momentum block motors, leg wheel motors and other components of Balancing Standard Robots for maintaining the horizontal state or achieving a jump movement of a Balancing Standard Robot does not count as chassis power.
- The circuit board related to the chassis power supply must be independent of the gimbal and Launching Mechanism power supply. A circuit board powered through the "Chassis" port on the Power Management Module cannot be connected to other power ports on the Power Management Module.
- All chassis-related circuits of a robot must be clearly laid out. A referee may conduct random inspections on a robot after a match, and, where required, the team must cooperate in the random inspection and disassemble the relevant robot parts to show the relevant circuits. It is strongly recommended that teams should 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 can only be connected using cables with sizes of or smaller than 24AWG, and can only be used for communication, with the total current flow equal to or smaller than 50mA.

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- 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. 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.

3.5 Mounting Specifications for Light Indicator Module

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

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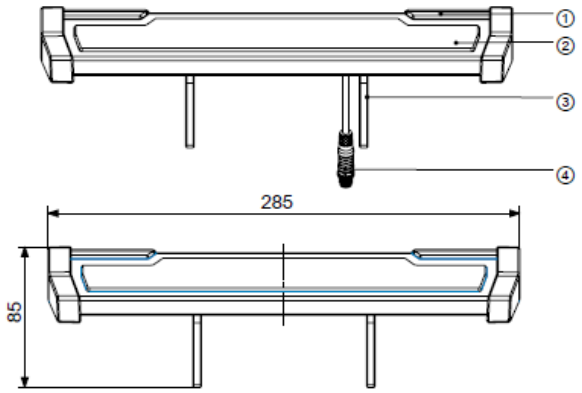


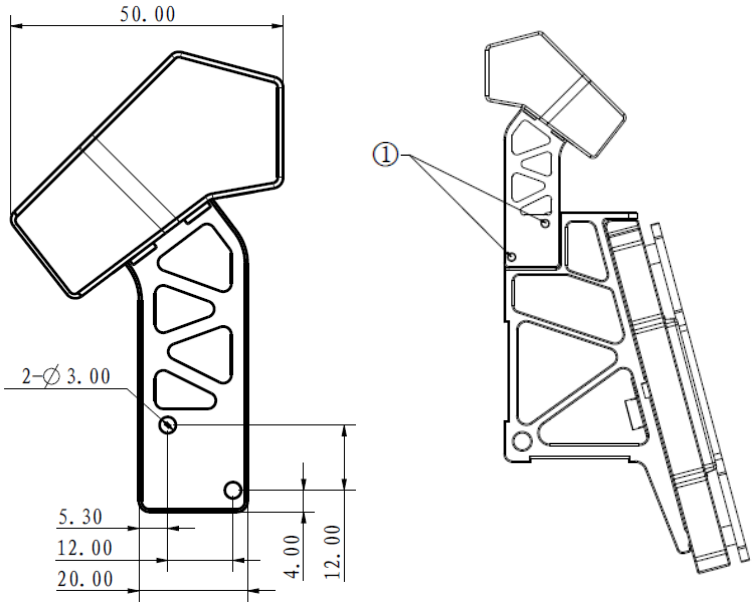
[1]	Auxiliary Light Indicator	[2]	Main Light Indicator	[3]	Mounting bracket	[4]	Aviation plug

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.

The position for installing a Light Indicator Module on a Sentry is different. A mounting bracket must be used to mount the Light Indicator Module onto the Sentry through the mounting holes on the side or the screw holes on the bottom.



[1] Screw Hole Mounting Position

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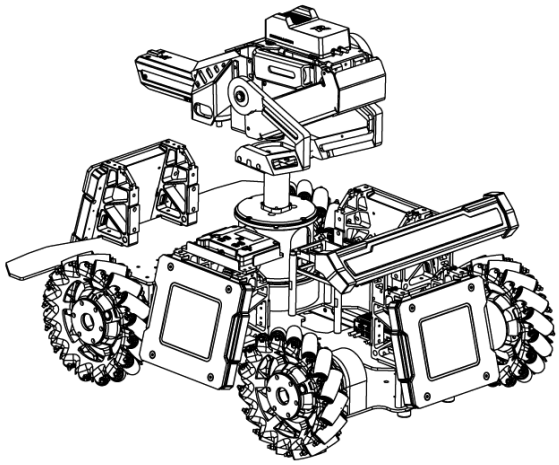


Figure 3-10 Mounting Light Indicator Module

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.

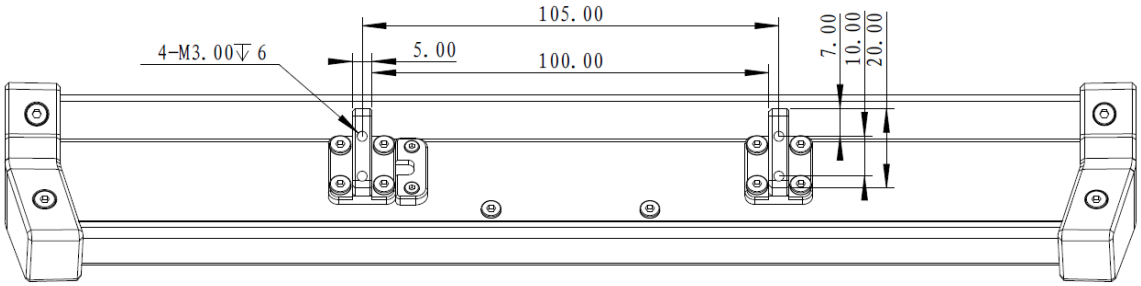
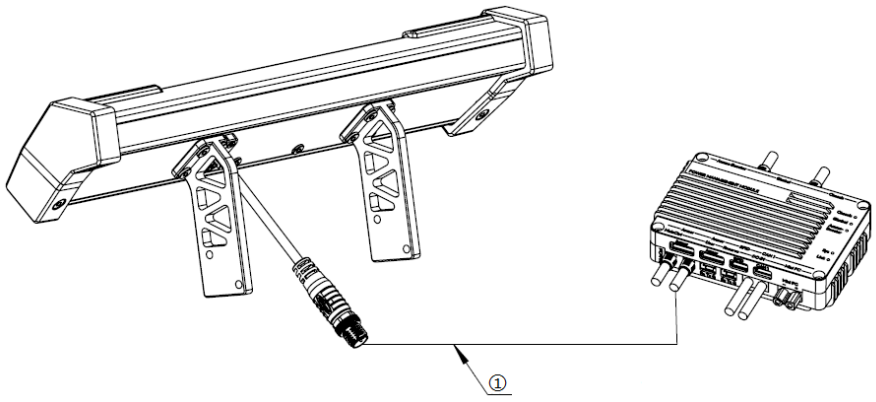


Figure 3-11 Bottom of Light Indicator Module

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



[1] Aviation Connector Cable

Figure 3-12 Light Indicator Module Cable Connection

3.5.2 Installation Requirements

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

S85 The connection cables of the left and right auxiliary Light Indicators are parallel to the ground.

S86 The main and auxiliary Light Indicators should be fully visible from at least one viewing angle.

S87 When mounting light indicator modules on a Ground Robot, the illuminant part must be at least 200mm from the ground.

S88 A Sentry is mounted onto the rail. After its mounting, the Light Indicator Module should be situated on one side of the rail, and the illuminated parts of the Light Indicator Module (the main and auxiliary light indicators) are above the top surface of the rail, as shown below.

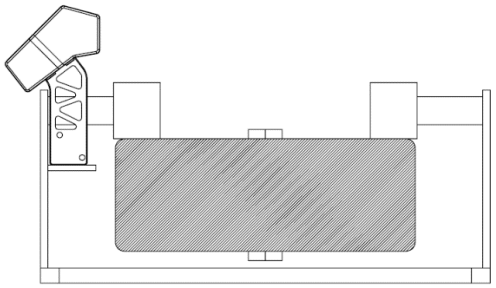

Figure3 –13 Sentry Light Indicator Module

3.6 Mounting Specifications for Armor Module

- The Armor Support Frame designated for use in this season shall be Armor Support Frame Type A.
- The 17 mm Speed Monitor Module is not considered a blockage of the armor. However, it must not be used to obstruct the armor or interfere with the armor's visual features intentionally.
- During the competition, an Engineer Robot is allowed to obstruct its armor in the following two situations that may occur simultaneously:

  1. When projectiles are loaded, or a Mobile Battlefield Component is grabbed or moved, any one of the Engineer Robot's armors is allowed to be blocked by a connected Mobile Battlefield Component and the relevant body structure, and the Armor Module obstructed can be different each time, but multiple Armor Modules are not allowed to be obstructed at the same time.
  2. An Engineer Robot's Armor Modules can be obstructed by a robot being rescued.

  Besides, no robots are allowed to obstruct any Armor Module with its body or transform beyond its maximum expansion size.

An Armor Module is mounted on a robot using a designated armor support frame. Below shows the designated armor support frame:

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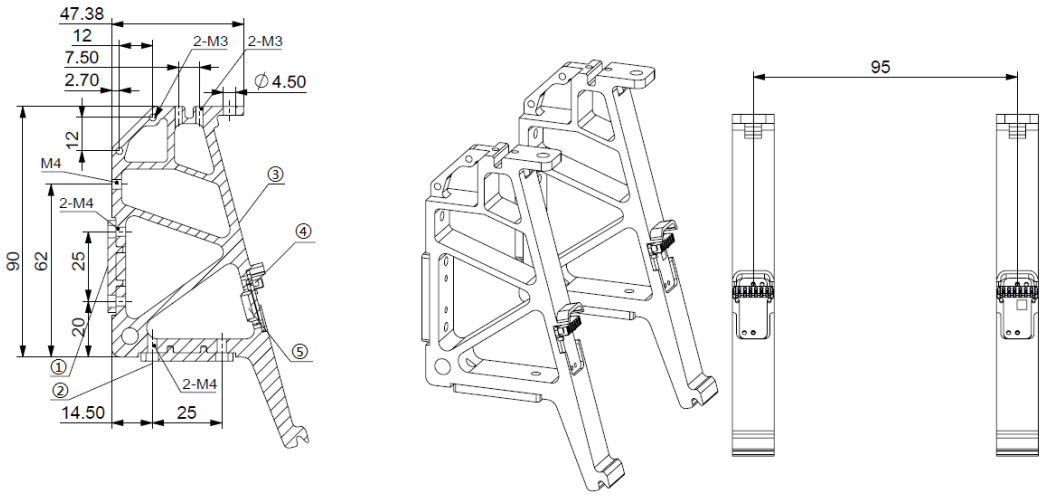
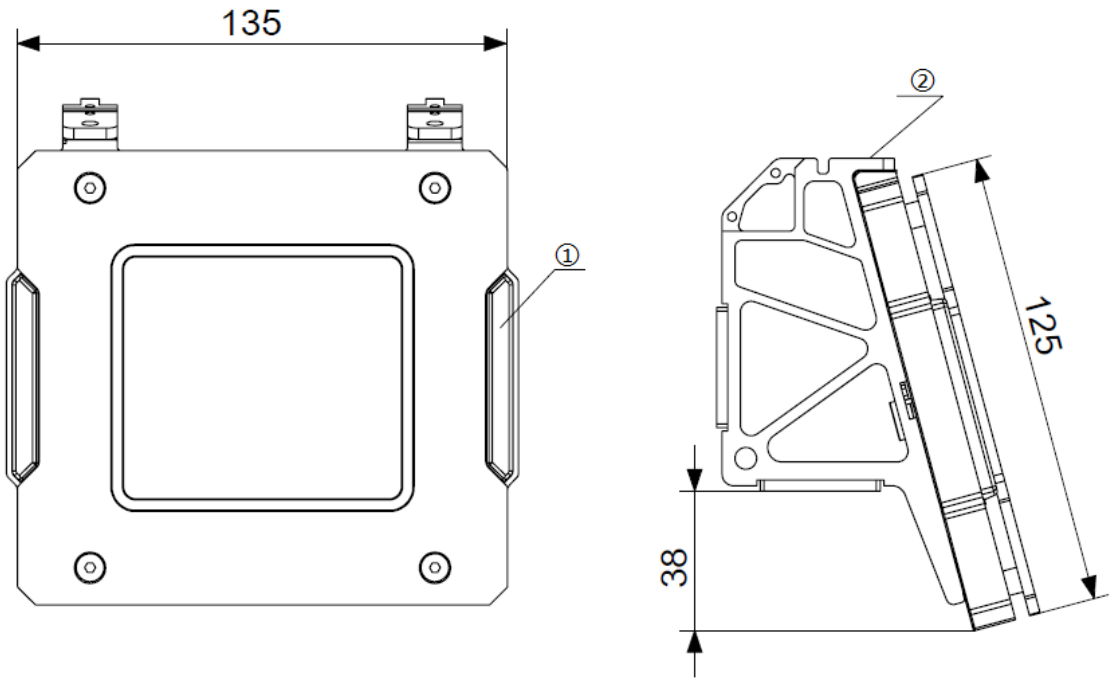


[1]	Back Mounting Surface	[2]	Bottom Mounting Surface	[3]	Armor Module Mounting Surface
[4]	Electrical Connection Point	[5]	JST 6-pin Port		

Figure 3-14 Designated Armor Support Frame

S89 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 3-15 Small Armor Module Graph

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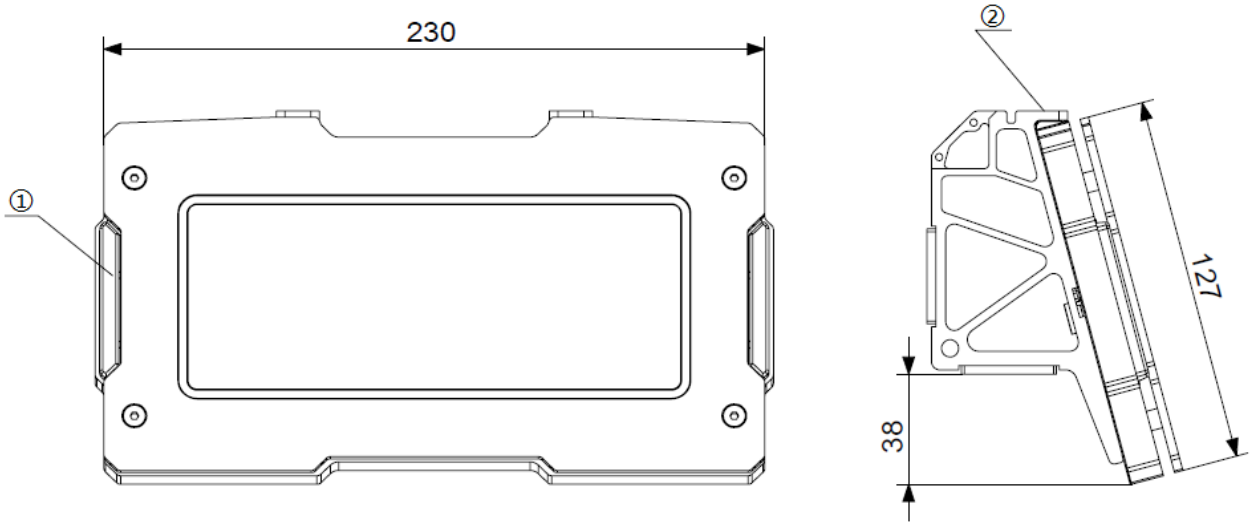
The Large Armor Module is shown in the figure below:



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

Figure 3-16 Large Armor Module

S90 Do not modify or decorate the Armor Modules.

3.6.1 General

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

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:

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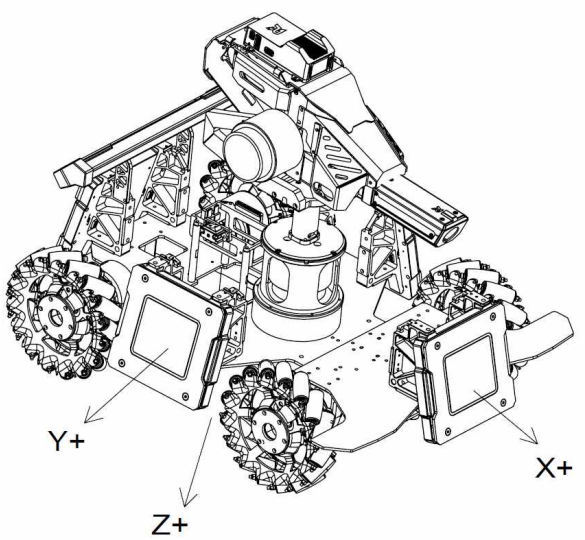

Figure 3-17 Robot Coordinate System

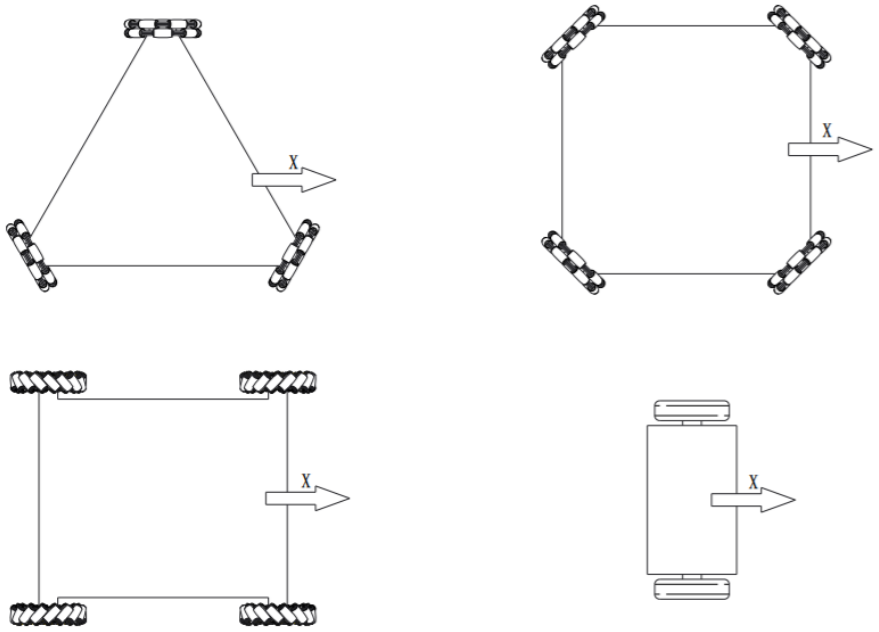

Figure 3-18 The X-axes of different robot chassis structures

3.6.1.1 Mounting the Armor Module

S91 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 onwhich 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

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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°.

S92 The kinematic equations of the robot should also be based on the above reference coordinate system. The mounting procedures for the Armor Modules must use the same reference coordinate system as the robot's own structural or kinematic characteristics. The geometric center point line of the Armor Modules mounted on the X-axis and the geometric center point line of the Armor Modules mounted on the Y-axis should be perpendicular to each other. The offset of the armor module from the geometric center of the robot must not exceed 50 mm on the X or Y axis.

3.6.1.2 Rigid Connection

S93 A mounted Armor Module and Support Frame must be rigidly connected to the chassis to form a whole body. 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°.

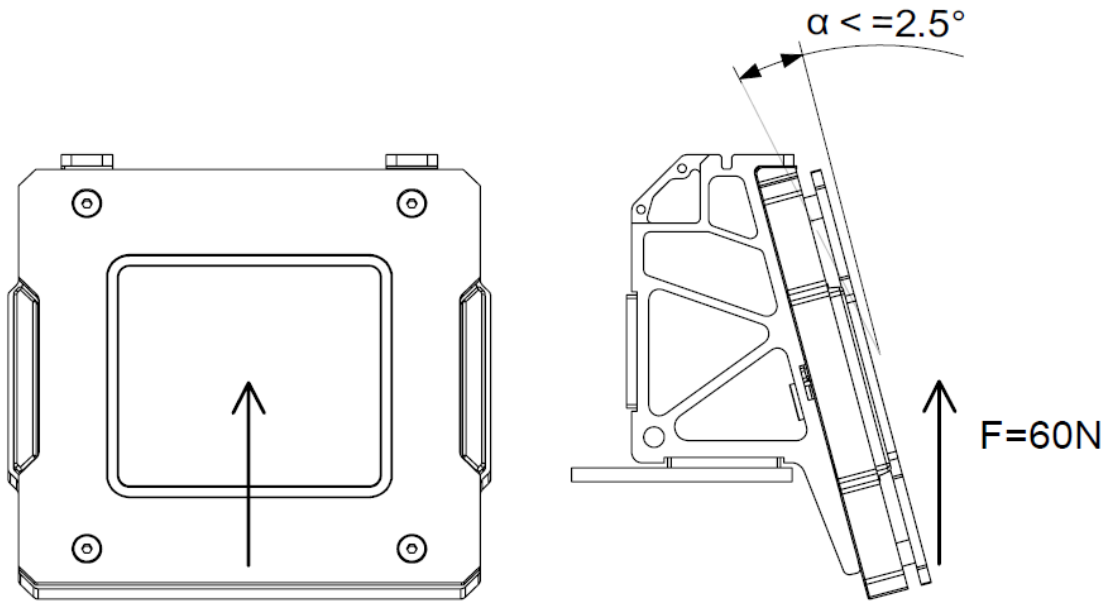

Figure 3-19 Application of Force on Armor Module

3.6.1.3 Robot Transformation

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.

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S94 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.

S95 For a 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 - 150mm.

S96 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.

S97 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 60mm - 400mm.

S98 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 60mm - 200mm.

S99 For Hero, Engineer and Balancing Standard Robots, the altitude difference between the lower edges of any two Armor Modules must not exceed 100 mm.

S100 For a Sentry Robot, the upper edge of any of its Armor Modules before and after transformation must be at an altitude within ±100 mm of the plane of the Sentry Rail’s top surface on which the Armor Module is located. The altitude of the Armor Module relative to the rail plane must remain the same throughout the competition. Any horizontal movement relative to the Sentry’s main structure is not allowed.

3.6.1.4 Armor Module Protection

S101 Teams should design bumpers for ground robots to reduce any damage caused by collision of Armor Modules.

S102 When a robot is mounted with a bumper and when it is facing and close to a vertical rigid plane (wall), its Armor Module must not have any direct contact with the rigid plane (wall), as shown below:

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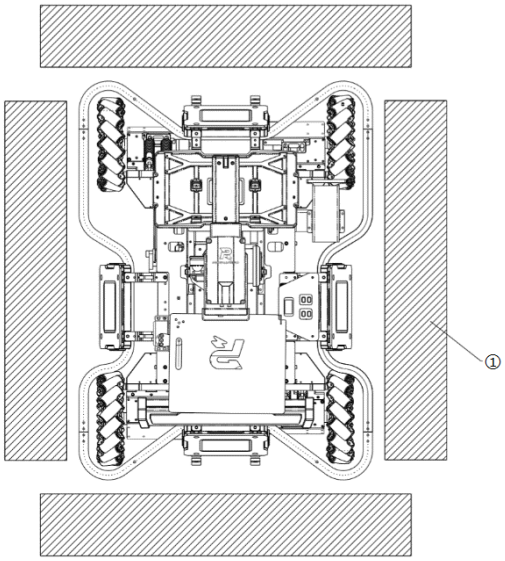

[1] Wall

Figure 3-20 Robot Protection

S103 Self-designed protective shells cannot have any contact with the Armor Modules provided by the RMOC.

3.6.2 Installation Steps

Ground Robots (excluding Balancing Standard Robots):

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

1. As per the dimensions in the drawings below, the chassis shall preserve four sets of built-in holes, each of which corresponds to one armor module. The sizes and locations of the four holes in each set must be kept aligned.

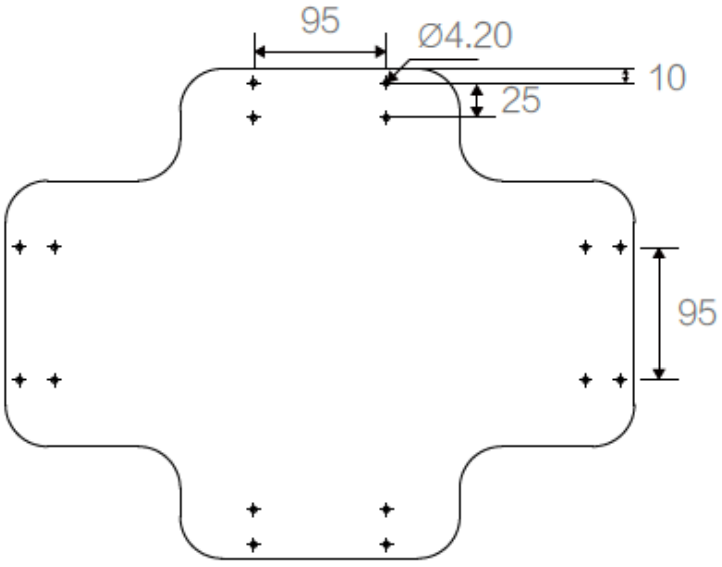

Figure3 –21 Reserved Holes on the Chassis

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

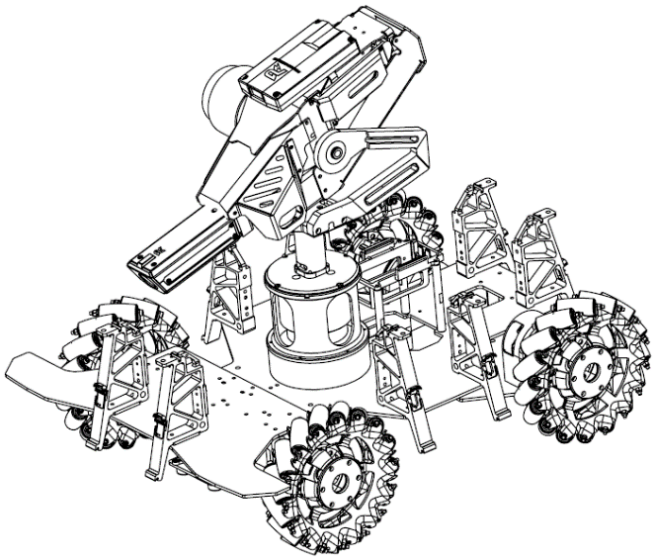
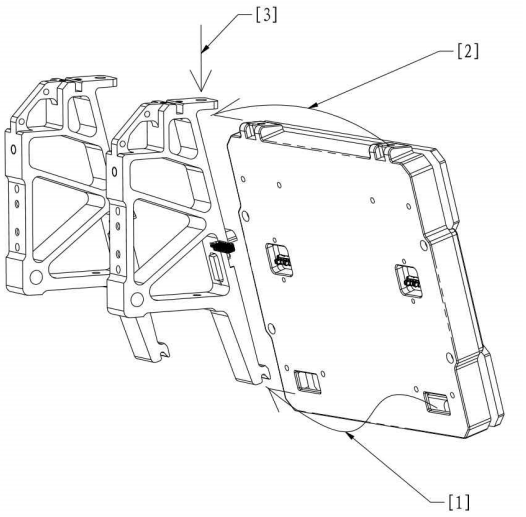


Figure 3-22 Mounting Armor Support Frame

3. Mount the Armor Module on the Armor Support Frame, and secure using M4 screws.



[1] Insert the lower slot of the Armor Module into the lower buckle of the Armor Support Frame

[2] Insert the upper surface of the Armor Module into the upper buckle of the Armor Support Frame

[3] Secure with screws

Figure 3-23 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. The

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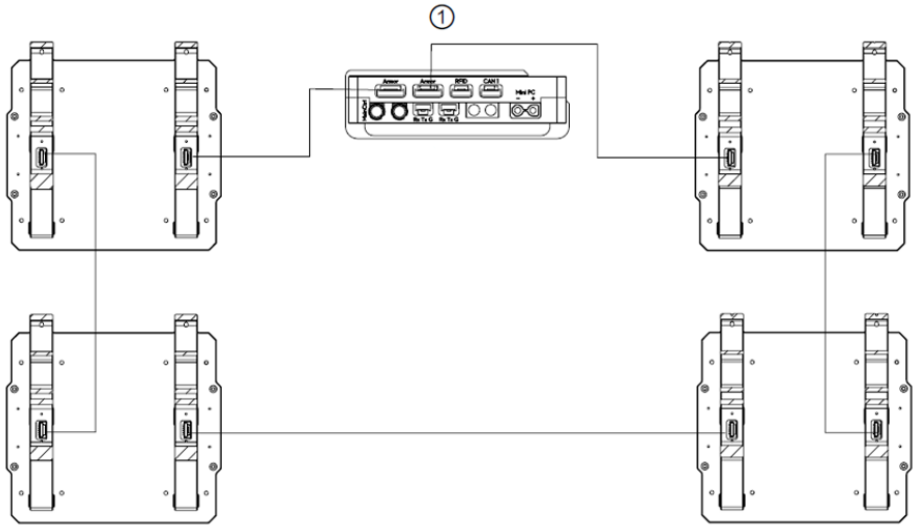
number of Armor Modules in series on the two 6-pin ports of the Power Management Module should preferably be equally distributed, to divide the current on the ports evenly.

Connect the robots reasonably based on their design and ensure that the cables are connected securely to prevent damage and wear.



[1] Power Management Module

Figure 3-24 Armor Module Cabling Diagram

Balancing Standard Robot:

1. As per the dimensions in the drawings below, the chassis shall preserve two sets of built-in holes, each of which corresponds to one Armor Module. The sizes and locations of the four holes in each set must be kept aligned.

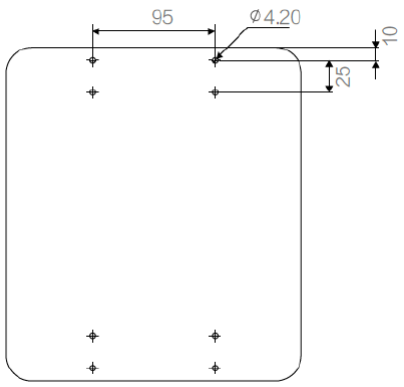


Figure 3-25 Reserved mounting holes on chassis

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

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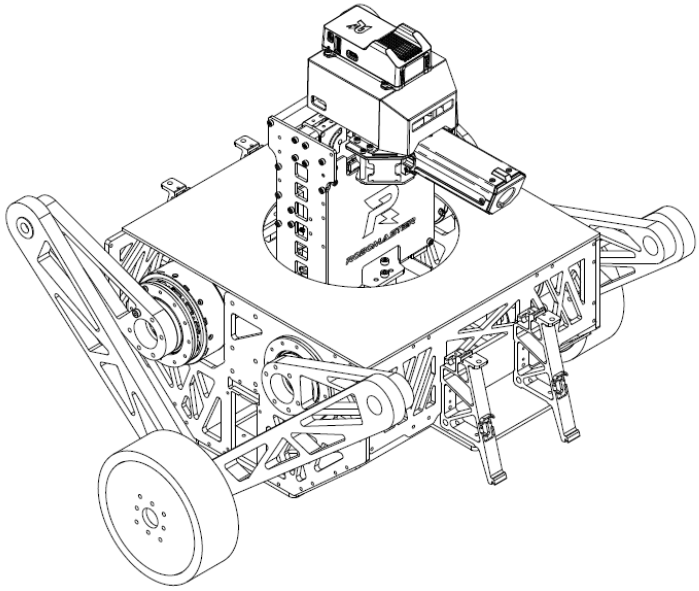
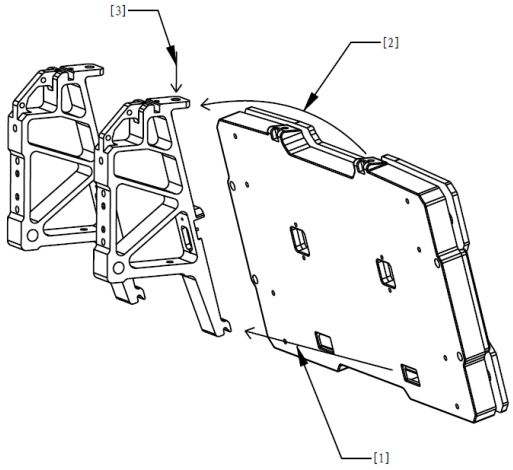


Figure 3-26 Mounting Armor Support Frame

3. Mount the Armor Module on the Armor Support Frame, and secure using M4 screws.



[1] Insert the lower slot of the Armor Module into the lower buckle of the Armor Support Frame

[2] Insert the upper surface of the Armor Module into the upper buckle of the Armor Support Frame

[3] Secure with screws

Figure 3-27 Armor Module Mounting Diagram

Sentry:

4. As per the dimensions in the drawings below, the chassis shall preserve two sets of built-in holes, each of

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which corresponds to one Armor Module. The sizes and locations of the four holes in each set must be kept aligned.

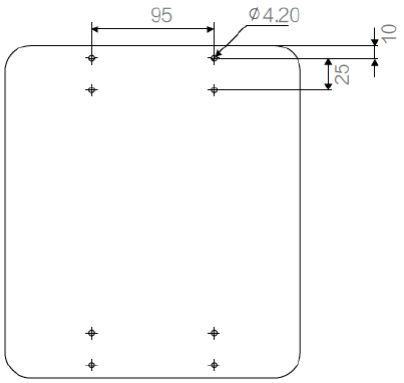

Figure 3-28 Reserved mounting holes on chassis

5. Secure Armor Support Frame on the chassis using M4 screws. The threaded holes on the installation surface at the bottom of the armor supporting frame should be used to fasten the framework. The threaded holes at the bottom of a correctly installed armor supporting frame should be perpendicular to the horizontal plane.

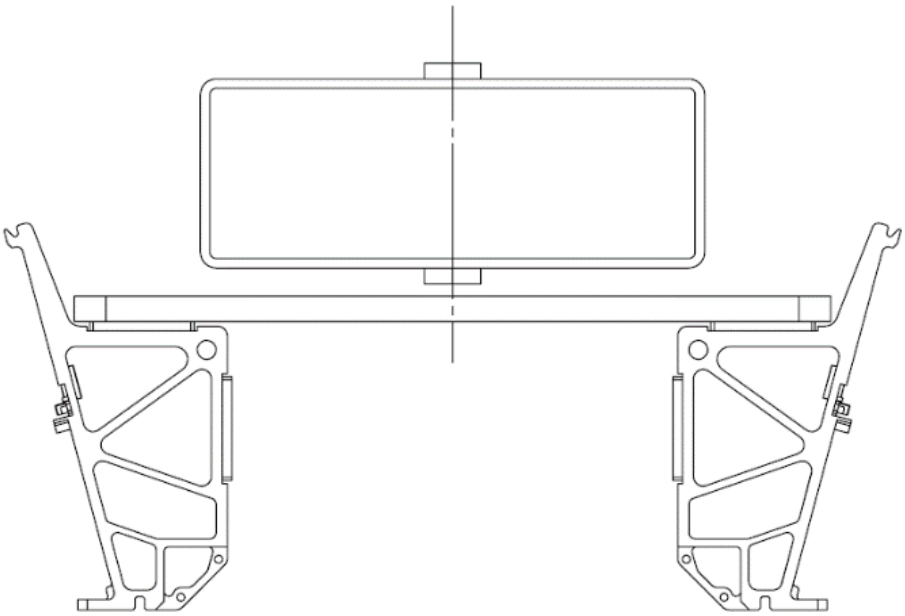

Figure 3-29 Mounting Sentry Armor Support Frame

6. Mount the Large Armor Module on the Armor Support Frame, and secure with M4 screws.

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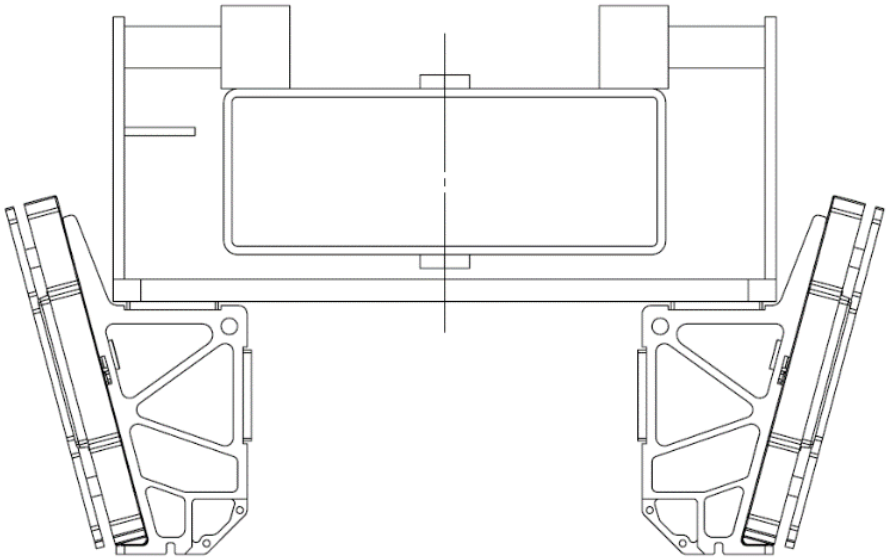
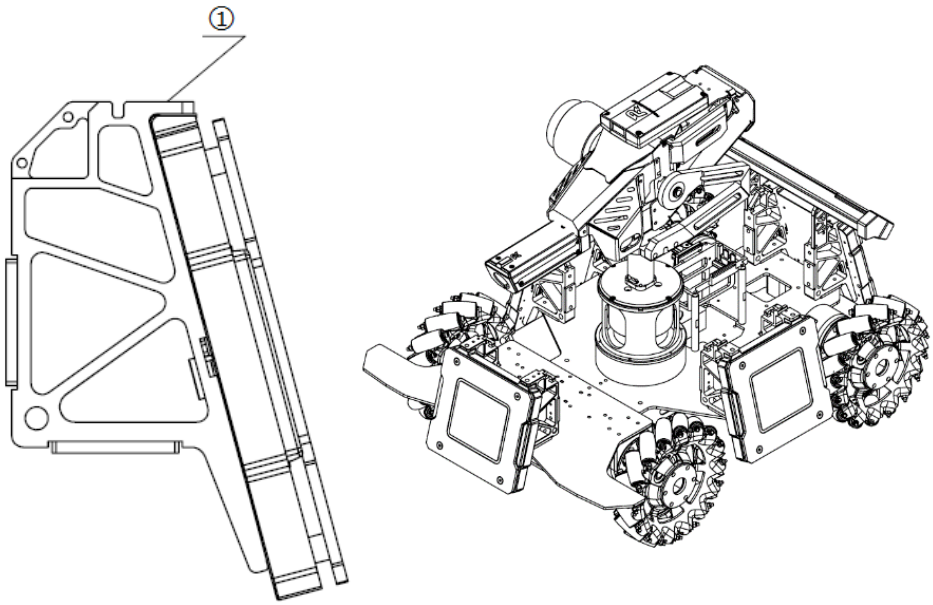


Figure 3-30 Sentry Armor Module Mounting

3.6.3 Installation Requirements

Ground Robots:

S104 The lower 105° area, and the upper, left and right 145° areas of the impact surface on the Armor Modules of Standard and Hero must not be blocked.



[1] The top fastened with M4 screws

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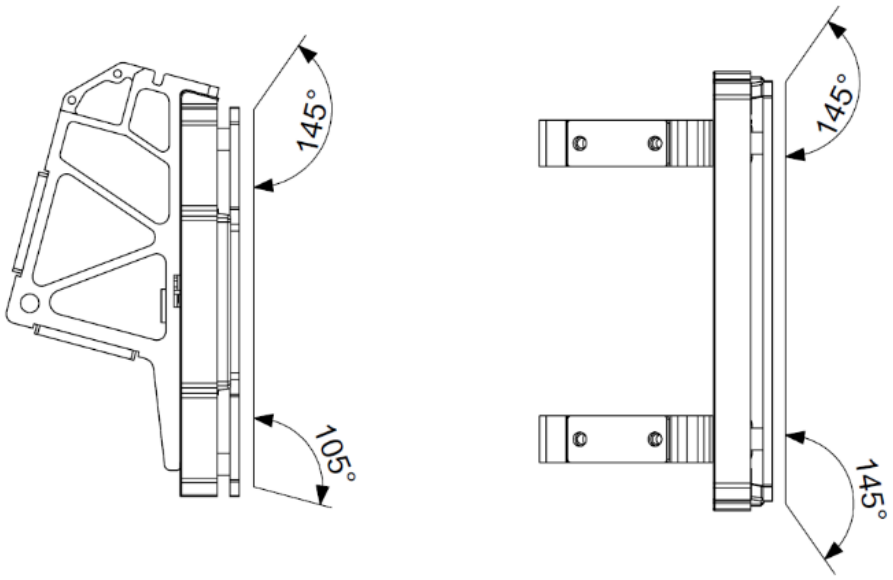
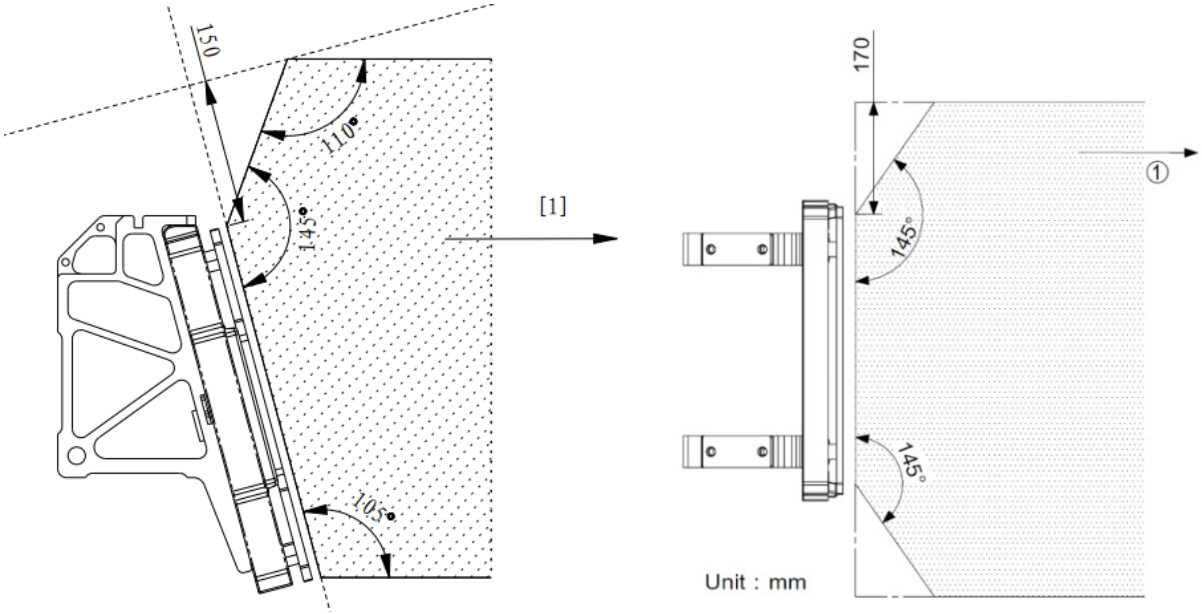


S105 For the armor modules of Engineers, the area within 105° of the lower edge of their impact surface must not be blocked. The vertical distance between the outer edge of a robot below its armor module and the lower edge of the module must be smaller than 100mm. The areas within 145° of the upper, left and right edges of at least three of four armor modules must not be blocked. Max one armor module is allowed to be blocked in the above-mentioned areas under certain conditions, including: On the plane of the impact surface of the armor module, the area beyond 150 mm from the upper edge or the area beyond 170 mm from the left and right edges of the armor module can be obstructed, i.e. the grey areas in the following drawings cannot be obstructed.



[1] Unlimited extension

Sentry:

S106 When a Sentry is mounted on the Sentry Rail, the long side of the Large Armor Module on the Sentry shall remain parallel to the length of the rail.

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S107 The top edge of the Armor Module of a Sentry must be within the altitude range of ±100mm from the plane of the upper surface of the Sentry Rail.

S108 The surface of the Armor Module being attacked is at an angle of 75° to the horizontal plane of the Battlefield ground, and the normal line of the Armor Module's impact surface points towards the Battlefield ground.

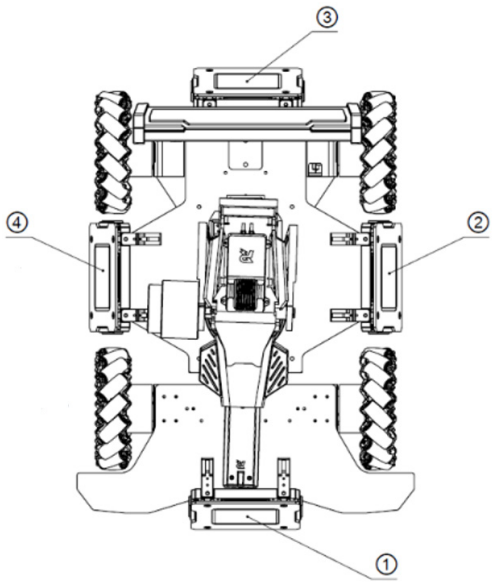
S109 The 145° area of the impact surface on the Armor Module must not be blocked.

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):

S110 According to the armor module installation requirements for ground robots, after activating the ID setting mode, the Armor Module facing the Video Transmitter Module (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:



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

Figure 3-31 Ground Robot Armor Module ID Setting

Sentry and Balancing Standard Robots:

S111 A Sentry has two Armor Modules, the ID configuration for the Armor Module facing the Base Zone is 0, and the one for the Armor Module facing the other side is 1.

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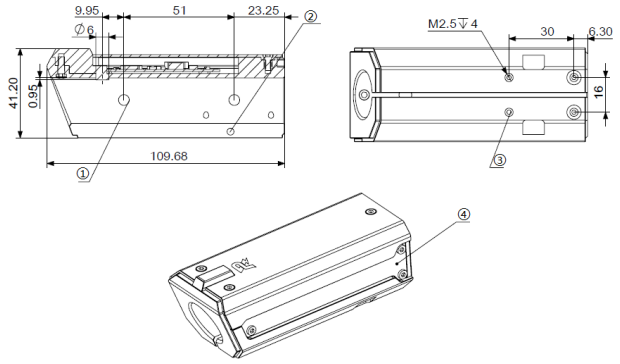
S112 The ID configuration for a Balance Standard Robot's Armor in the positive X-axis direction is 0, and the one for the Armor in the negative X-axis direction is 1.

3.7 Mounting Specifications for Speed Monitor Module

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

Speed Monitor Module (17mm projectile):

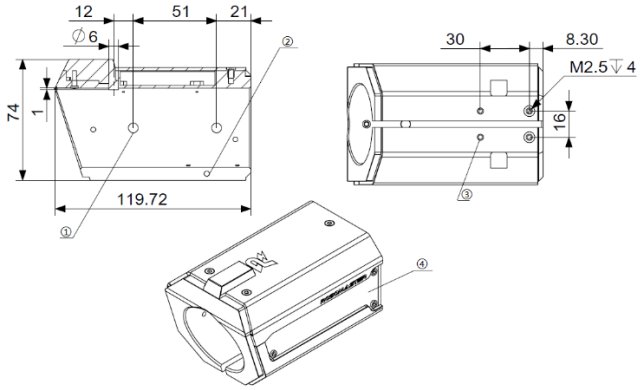


[1] Phototube [2] launching mechanism Clamping Screw Hole

[3] M2.5 mounting screw hole for Laser Sight 4 [4] LED Light Indicator

Figure 3-32 17mm Speed Monitor Module

Speed Monitor Module (42 mm projectile):



[1] Phototube [2] launching mechanism Clamping Screw Hole

[3] M2.5 mounting screw hole for Laser Sight 4 [4] LED Light Indicator

Figure 3-33 42mm Speed Monitor Module

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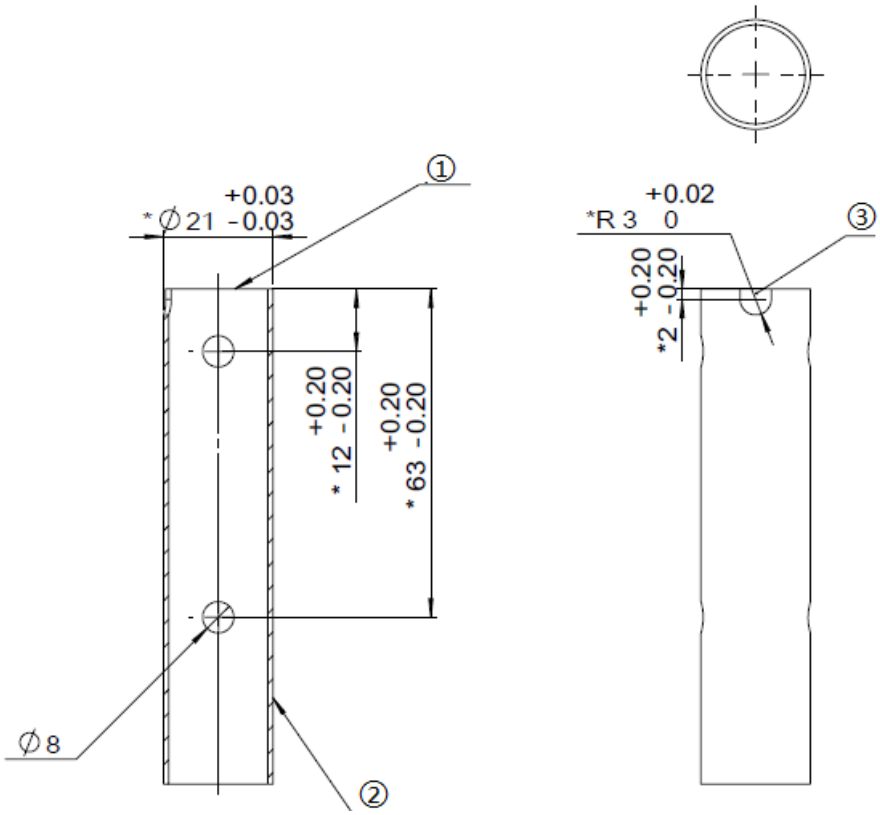
3.7.1 Installation Steps

To improve the aiming accuracy of robots, 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). Teams may choose to adopt any one of the securing methods.

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

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



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

Figure 3-34 17mm launching mechanism

Production requirements for 17mm launching mechanism:

S113 The phototube must not be blocked.

S114 Transparent and luminous materials and use of infrared ray sensors near the launching mechanism are forbidden.

S115 The inner wall of a launching mechanism 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

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Mounting Steps for Securing Method 1:

1. Place the Speed Monitor Module on the launching mechanism 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 screw holes in the rear of the Speed Monitor Module to clamp the launching mechanism.
3. Aviation connector of the Speed Monitor Module should be connected to the aviation connector of the Power Management Module using an aviation connector cable.

The completed mounting is shown in the figure below:

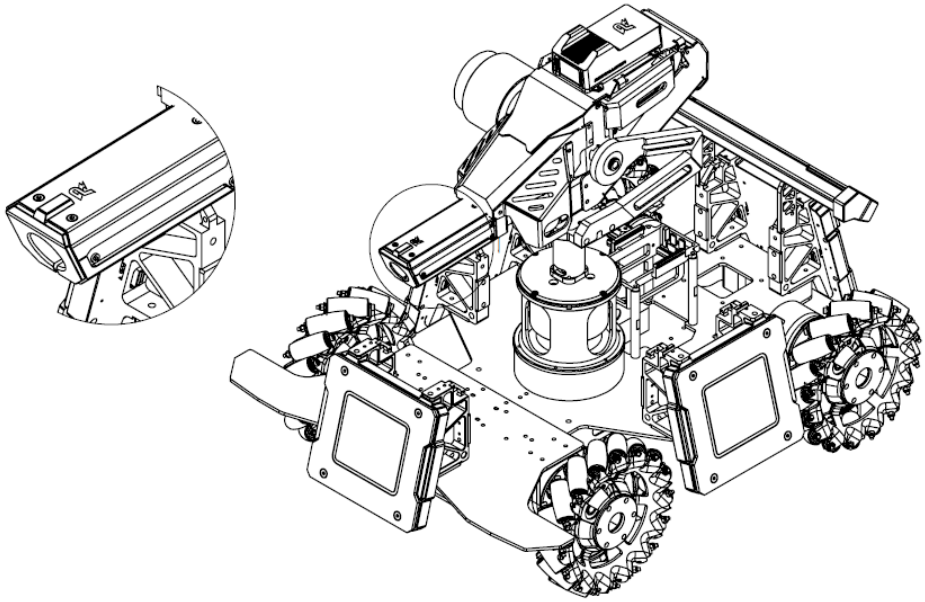

Figure 3-35 Mounting Speed Monitor Module

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

The team designs and develops its own transfer block, to connect the Speed Monitor Module (17mm projectile) and Launching Mechanism and replace the securing method for the long launching mechanism.

See "Appendix 1 - Drawing of Transfer Block for Speed Monitor Module (17mm projectile)" for the specifications of transfer block parts. Its 3D model can be downloaded from the Speed Monitor Module product page on RoboMaster's official website as a reference.

The reference graph for a transfer block is shown below:

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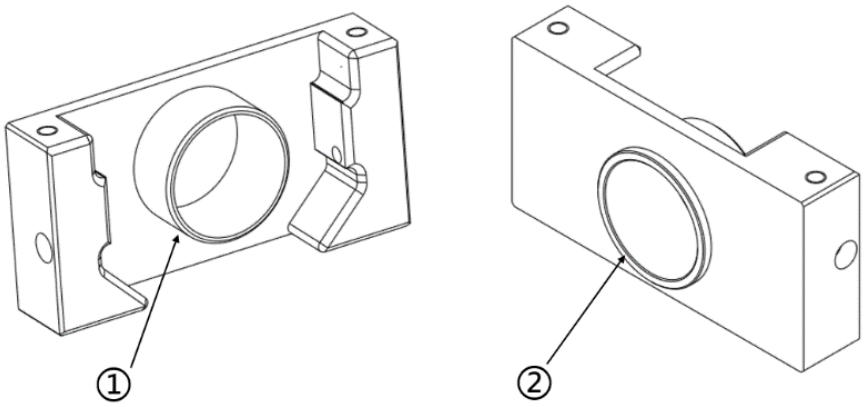
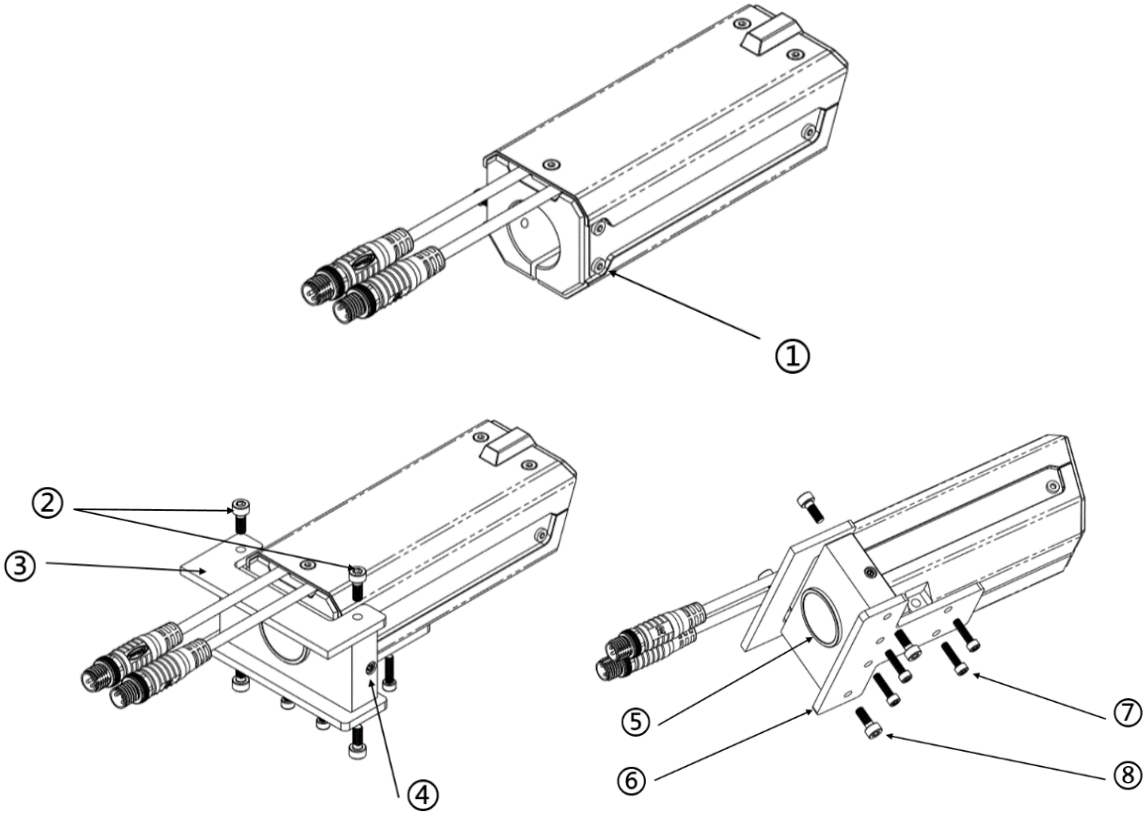


[1] Front Protrusion [2] Back Protrusion

Figure 3-36 17mm Transfer Block



[1]	M2.5 Securing Screw for LED Light Indicator	[2]	M3 Screws	[3]	Robot's Original Board Part 1 (self-produced)
[4]	Side Securing Hole	[5]	Back Protrusion	[6]	Robot's Original Board Part 2 (self-produced)
[7]	M2.5 Screw	[8]	M3 Screws		

Figure 3-37 Securing Method for 17mm Transfer Block

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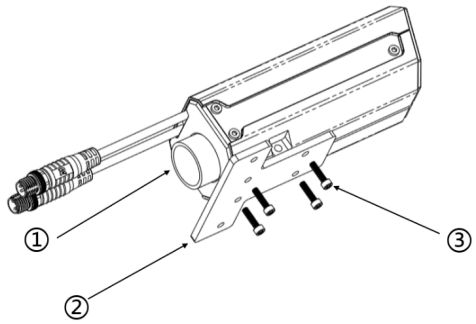
Mounting Steps for Securing Method 2:

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 transfer 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. Aviation connector of the Speed Monitor Module should be connected to the aviation connector of the Power Management Module using an aviation adapter cable.

- The rear protrusion of the transfer block must work well with the gimbal's original parts, to ensure the concentricity of the projectile's axis with the transfer block's axis.
- The front protrusion of the transfer block can on the one hand ensure the concentricity of the transfer block's axis with the Speed Monitor Module's axis, and on the other hand absorb some of the force when the Speed Monitor Module is impacted on the front.
- 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. Any violation 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 short launching mechanism spare parts, to connect the Speed Monitor Module (17mm projectile) and Launching Mechanism to replace the securing method for the long launching mechanism.



[1] Short launching mechanism [2] Robot's Original Board Part 1 (self-produced) [3] M2.5 Screw

Figure 3-38 Mounting 17mm short launching mechanism

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Mounting Steps for Securing Method 3:

1. Insert the Speed Monitor Module into the short launching mechanism.
2. Use four M2.5 screws to secure the robot's original board part 1 on the bottom of the Speed Monitor Module.
3. Aviation connector of the Speed Monitor Module should be connected to the aviation connector of the Power Management Module using an aviation connector cable.

- The length of the launching mechanism installed into the Speed Monitor Module must not exceed 23 mm, to avoid obstructing the speed-monitoring phototube.
- The outer diameter of the launching mechanism should preferably be kept within the range of 21 mm +0.05. A launching mechanism diameter that is too small will create a bigger gap between the outer wall of the launching mechanism and the inner wall of the Speed Monitor Module, which may result in the axis of a projectile not overlapping with the axis of the Speed Monitor Module, leading to 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 launching mechanism size restrictions (* denotes the key dimensions that teams must adhere to):

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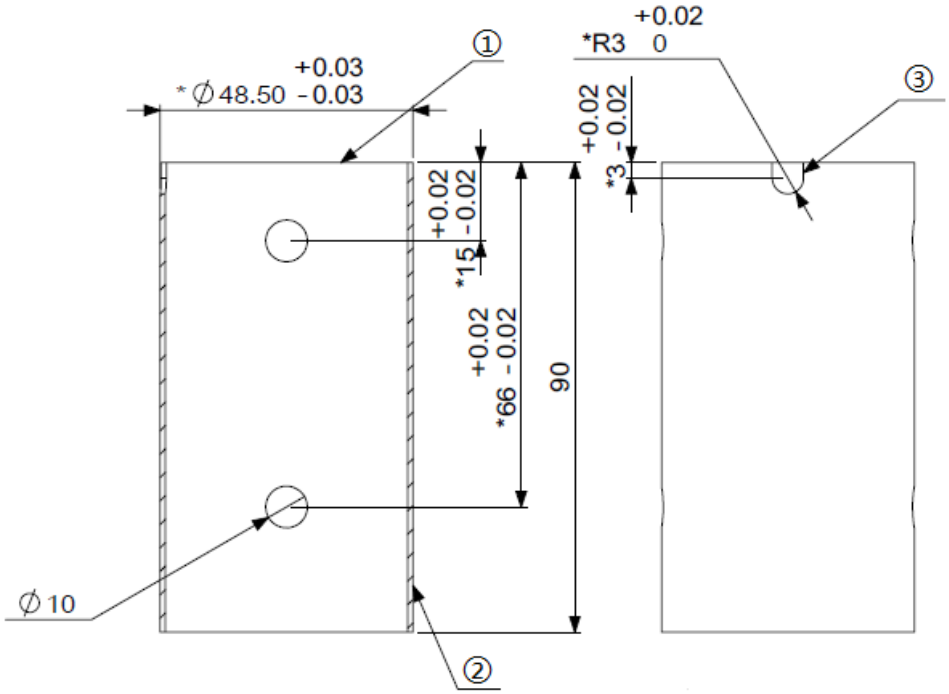

[1] Launching mechanism [2] * Wall thickness must be no less than 1mm [3] The U-shaped groove must face upward after installing the launching mechanism

Figure 3-39 42mm launching mechanism

Production requirements for 42mm launching mechanisms:

S116 The phototube must not be blocked.

S117 Transparent and luminous materials and use of infrared ray sensors near the launching mechanism are forbidden.

S118 The inner wall of a launching mechanism 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 launching mechanism and ensure that the U-shaped step of launching mechanism is stuck in cylindrical location protrusion within the module inner diameter.
2. Insert M3 screws through the screw holes in the rear of the Speed Monitor Module to clamp the launching mechanism.
3. Aviation connector of the Speed Monitor Module should be connected to the aviation connector of the Power Management Module using an aviation connector cable.

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3.7.2 Installation Requirements

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

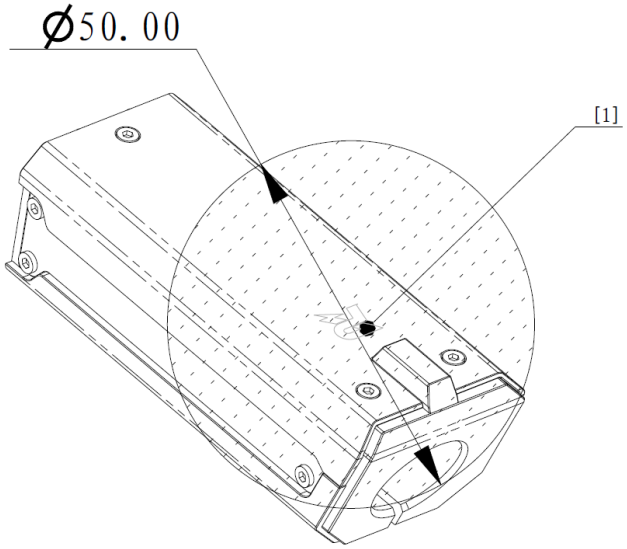
S119 A Speed Monitor Module must be installed at the end of the Launching Mechanism. Measure the launch speed of a projectile after it has fully accelerated.

S120 When performing horizontal calibration on a Speed Monitor Module, its logo should be facing up.

S121 The Speed Monitor Module should be firmly secured to ensure that the Module and the launching mechanism do not move relative to each other during movements of the robot.

S122 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.

S123 As shown in the installation drawing for the Speed Monitor Modules, no large magnetic conductive materials (such as iron launching mechanisms, cooling fans on the VTM (Transmitter) or friction wheel motors) should be placed within an area of 50 mm in diameter with the logo as the center, to avoid any interference with the magnetometer inside the Speed Monitor Module.



[1] Circular center

Figure 3-40 Speed Monitor Module Mounting Specification

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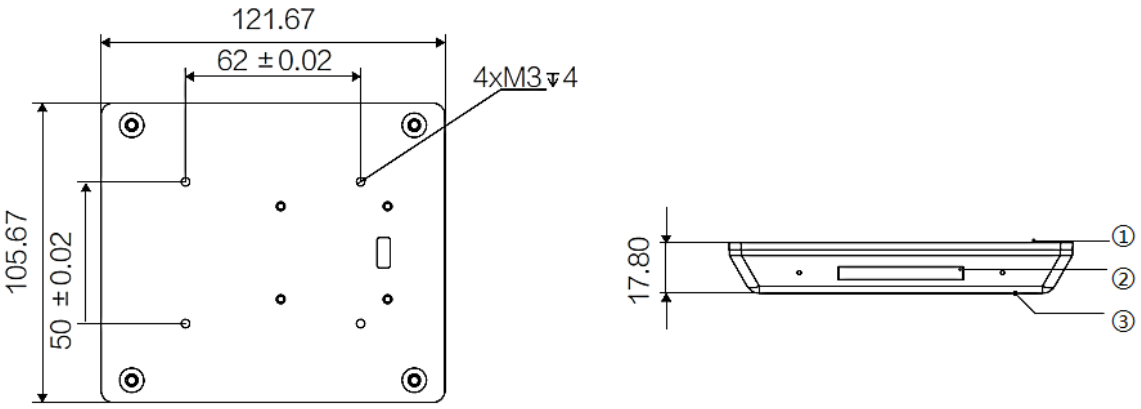
- Four M2.5 screw holes should be available for installing the RoboMaster Laser Sight or the laser sight prepared by your own team.
- Do not look directly at the laser without eye protection. Goggles are recommended during operation.
- Do not block the phototube holes. Otherwise the initialization of 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.
- In the case of two Speed Monitor Modules, they can be installed in parallel to one another, which means that the light panel on one side of the modules is allowed to be blocked.
- It shall be deemed a violation if a mesh-like or other similar structure is used to block more than 1/5 of the surface area of a Speed Monitor Module's light panel.

3.8 Mounting Specifications for RFID Interaction Module

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



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

Figure 3-41 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.

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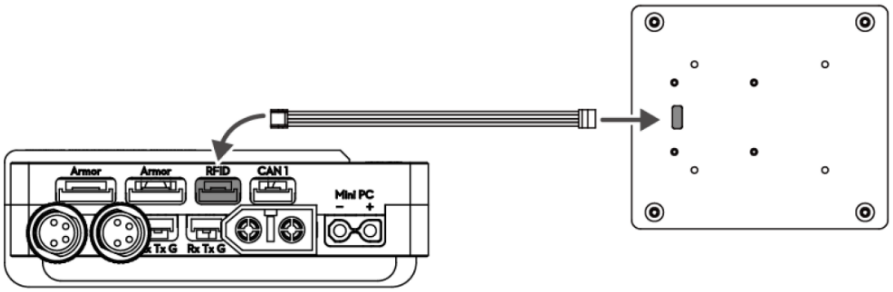

Figure 3-42 RFID Interaction Module Cable Connection

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.

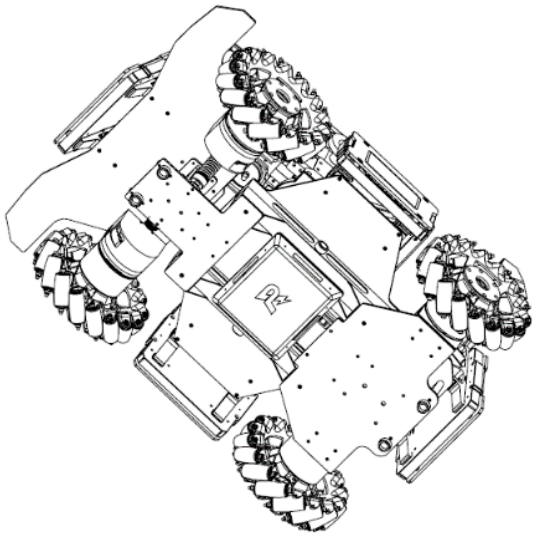

Figure 3-43 Mounting RFID Interaction Module

3.8.2 Installation Requirements

- The effective detection range of the RFID Interaction Module is 100 mm (±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 expansion and transformation dimensions 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.

S124 The rear of the RFID Interaction Module should be free of interference from strong currents or high-

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frequency signals (such as motor cables, RoboMaster Center Board, CAN cables and supercapacitors).

S125 The front and rear of the RFID Interaction Module must not be obstructed by any metal, and the rear surface must be kept at least 30 mm away from the metal plate.

3.8.3 RFID Interaction Module Card

RFID Interaction Module Cards are functional cards. They are laid in corresponding locations in the Battlefield. During the competition, robots that detect RFID Interaction Module Cards using their own RFID Interaction Modules will gain the corresponding buffs.

The size of a RFID Interaction Module Card is as follows:

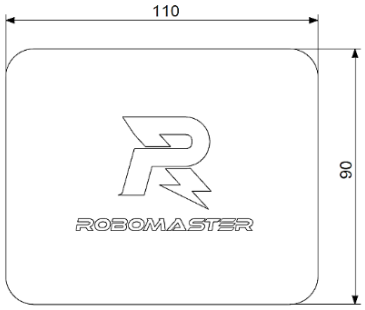

Figure 3-44 RFID Interaction Module Card

3.9 Mounting Specifications for Video Transmitter Module (Transmitter)

- Video Transmission Remote Controller link data are output from the UART serial port of a Video Transmitter Module (Transmitter).
- The UART serial interface of a Video Transmitter Module (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.

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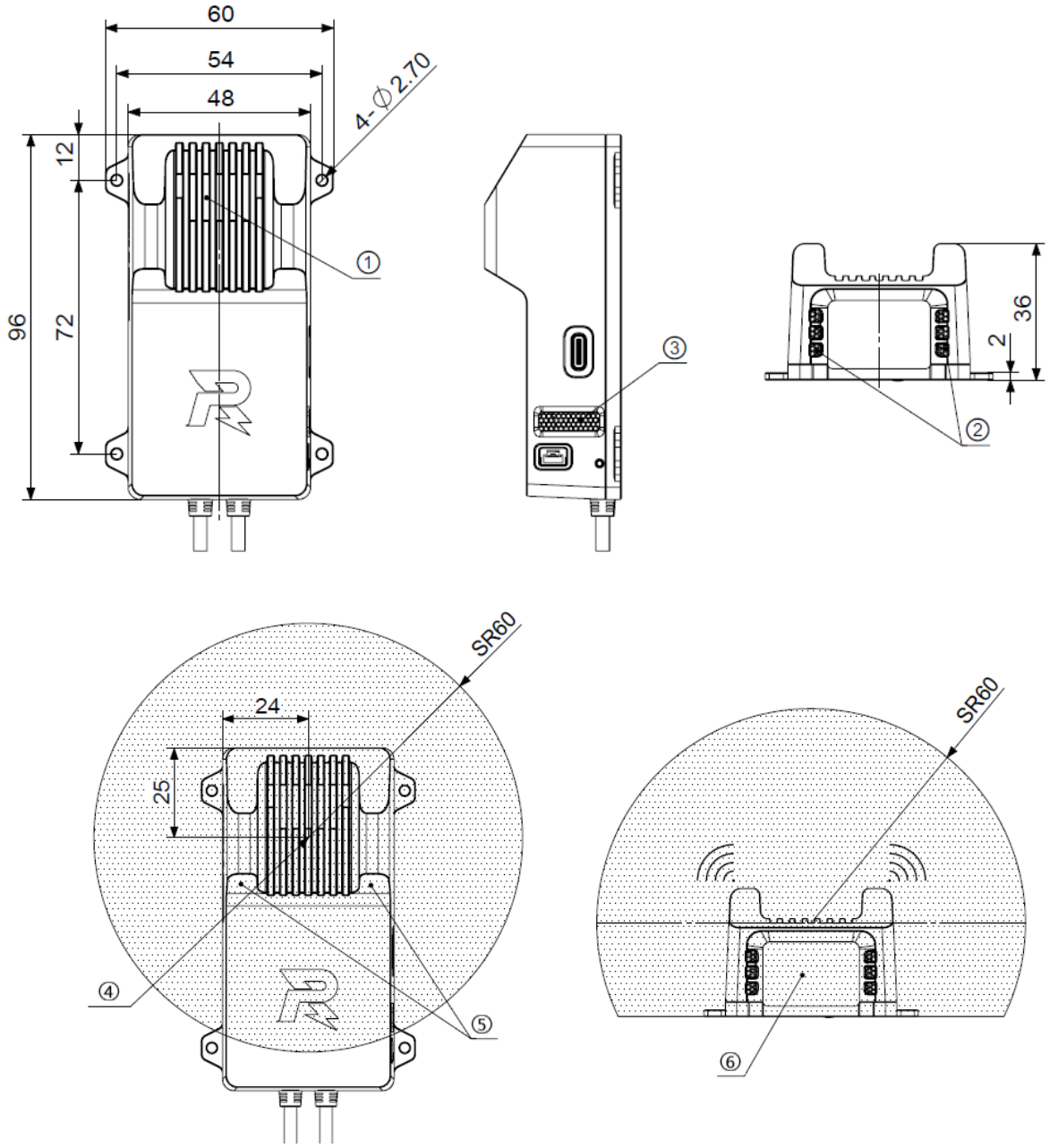

[1] Air Inlet [2] Air Inlet [3] Air Outlet [4] Circular center [5] Antenna [6] Camera

Figure 3-45 Video Transmitter Module (Transmitter)

3.9.1 Installation Steps

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

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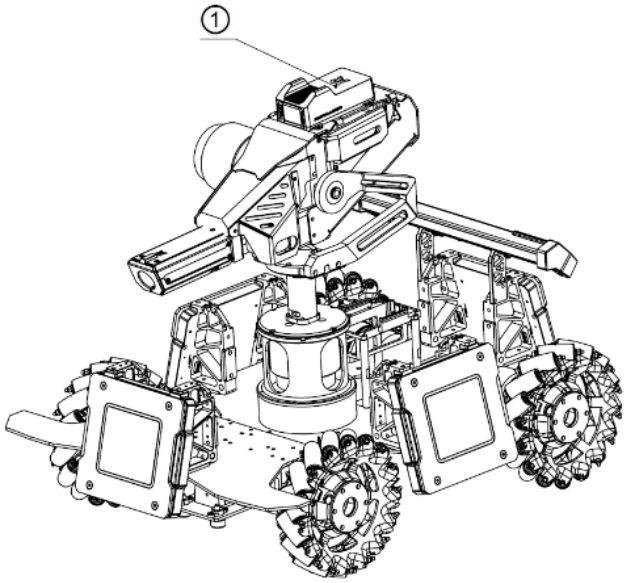

[1] Video Transmitter Module (Transmitter)

Figure 3-46 Mounting Video Transmitter Module (Transmitter)

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

3.9.2 Installation Requirements

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

S126 The inlet and outlets of the Transmitter must not be blocked.

S127 As the Transmitter's antenna is located at the top of the Module, the top should not be blocked by any metal.

S128 As shown in the Video Transmitter Module (Transmitter) drawing, set the center of the Video Transmitter Module (Transmitter) be the circular center, no motor or electromagnetic device that may interfere with the Module should be within a hemisphere measuring 60 mm from the center, to avoid interfering with Video Transmitter signals.

S129 If the Video Transmission Remote Controller link is used, the UART serial interface of the Video Transmitter Module (Transmitter) needs to be partially protected, by using protective devices such as foam and non-metallic guards.

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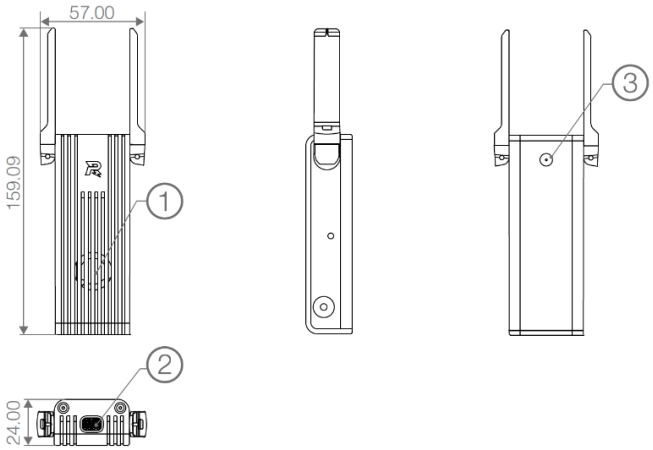
3.10 Mounting Specifications for Video Transmitter Module (Receiver)

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 3-47 Video Transmitter Module (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.

S130 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.

S131 Ensure that the cooling inlet and outlet ①② are not blocked.

S132 The rotation angle for the antenna is 0°-190°. Please fold it gently. The distance to the antenna's center point should preferably be larger than 60 mm.

S133 The specific mounting position and angles can be adjusted by checking the quality of receiver images.

3.11 Mounting Specifications for Positioning System Module

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

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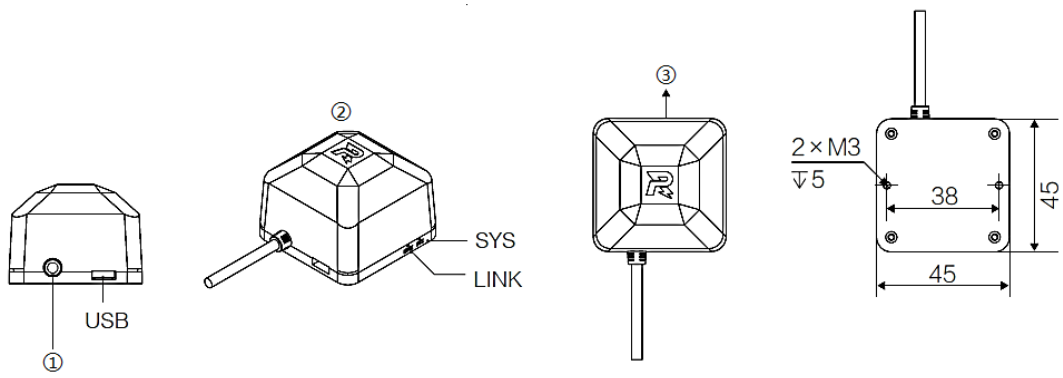

[1] Referee System Connection Cable [2] Top [3] Front

Figure 3-48 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:

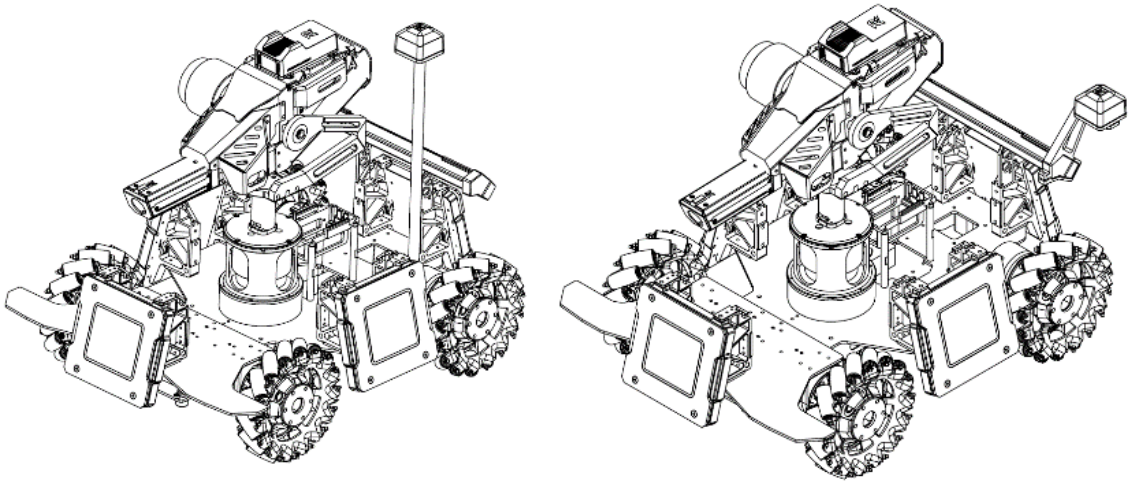

Figure 3-49 Positioning System Module

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

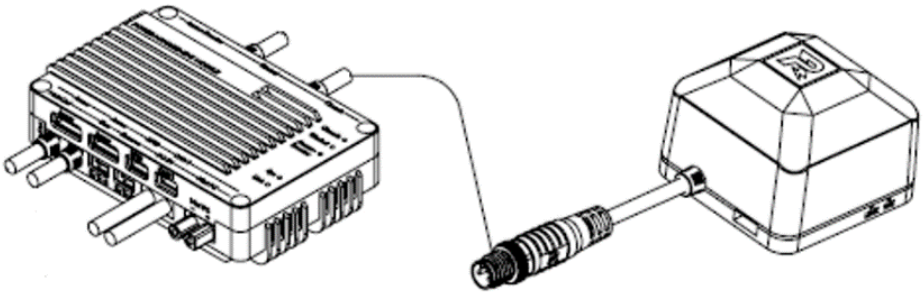

Figure 3-50 Positioning System Module Cable Connection

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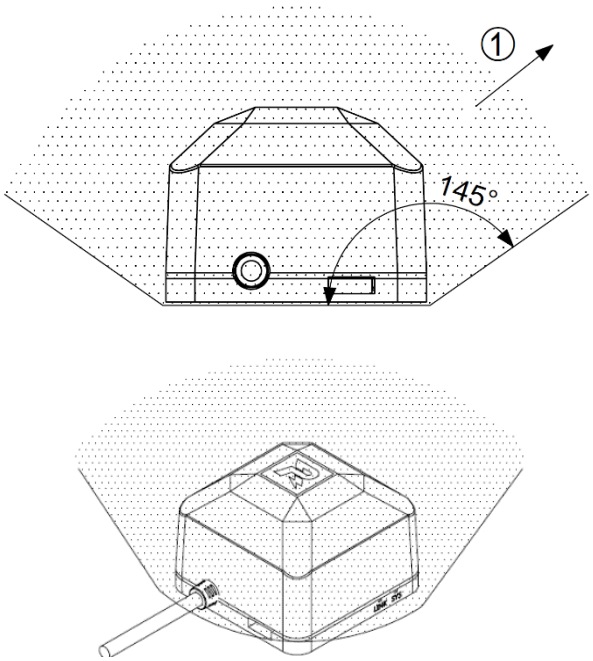
3.11.2 Installation Requirements

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

S134 Positioning System Module should be horizontally installed with the top facing up. The 145° area above the Positioning System Module must not be blocked by any conductor, as shown below:

> According to the above mounting specifications, only one out of the front, back, left and right horizontal directions of an Aerial's Positioning System Module is allowed to be blocked by a conductor at a horizontal distance of 100 mm away.



[1] Unlimited extension

Figure 3-51 Positioning System Module

S135 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 200 mm away.

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

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

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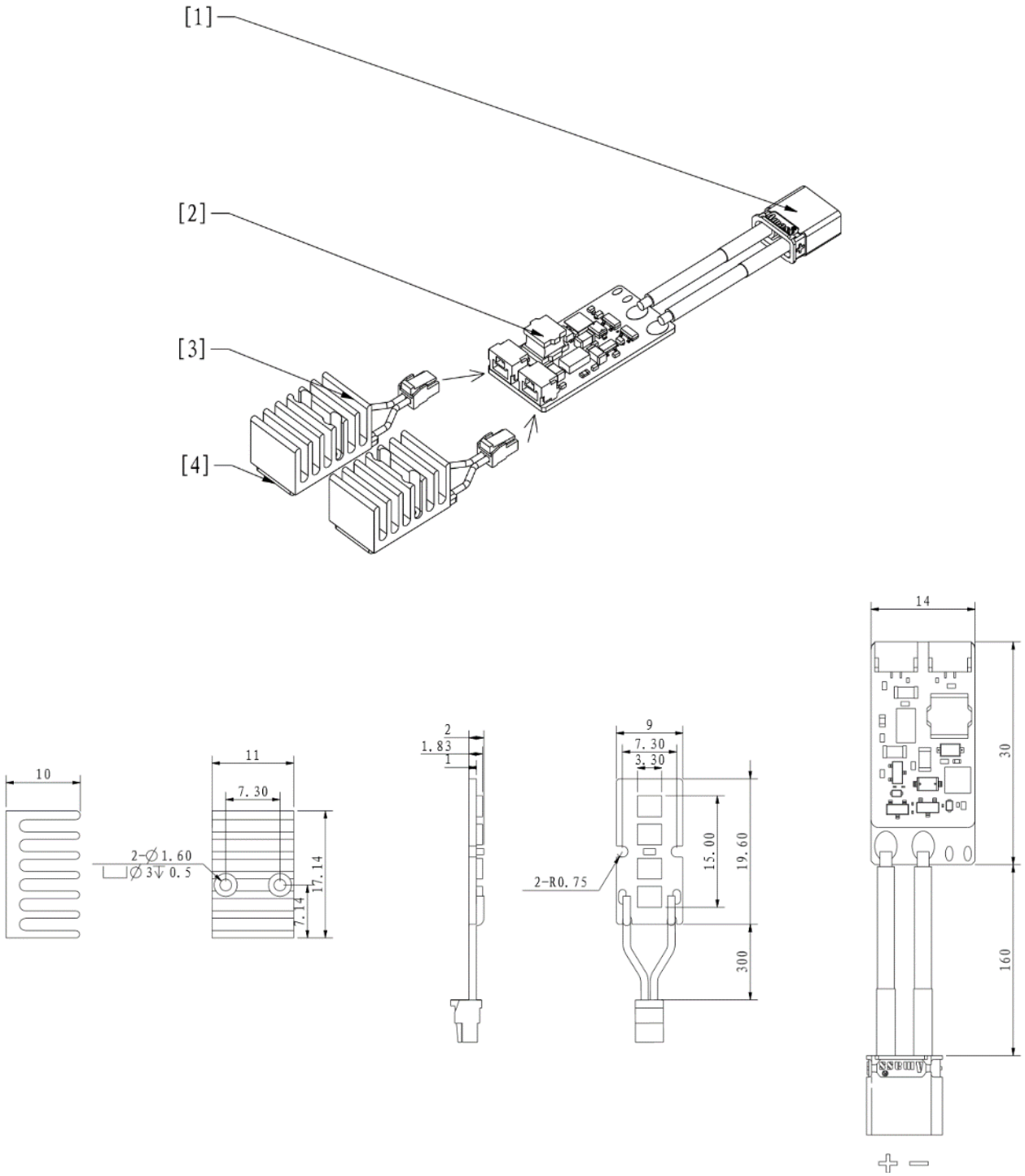

[1] XT30 port [2] LED actuator [3] Heat dissipation panel [4] UV light panel

Figure 3-52 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.

1. The UV light panel should be installed on a specific part of the robot, and should cover the standby projectile

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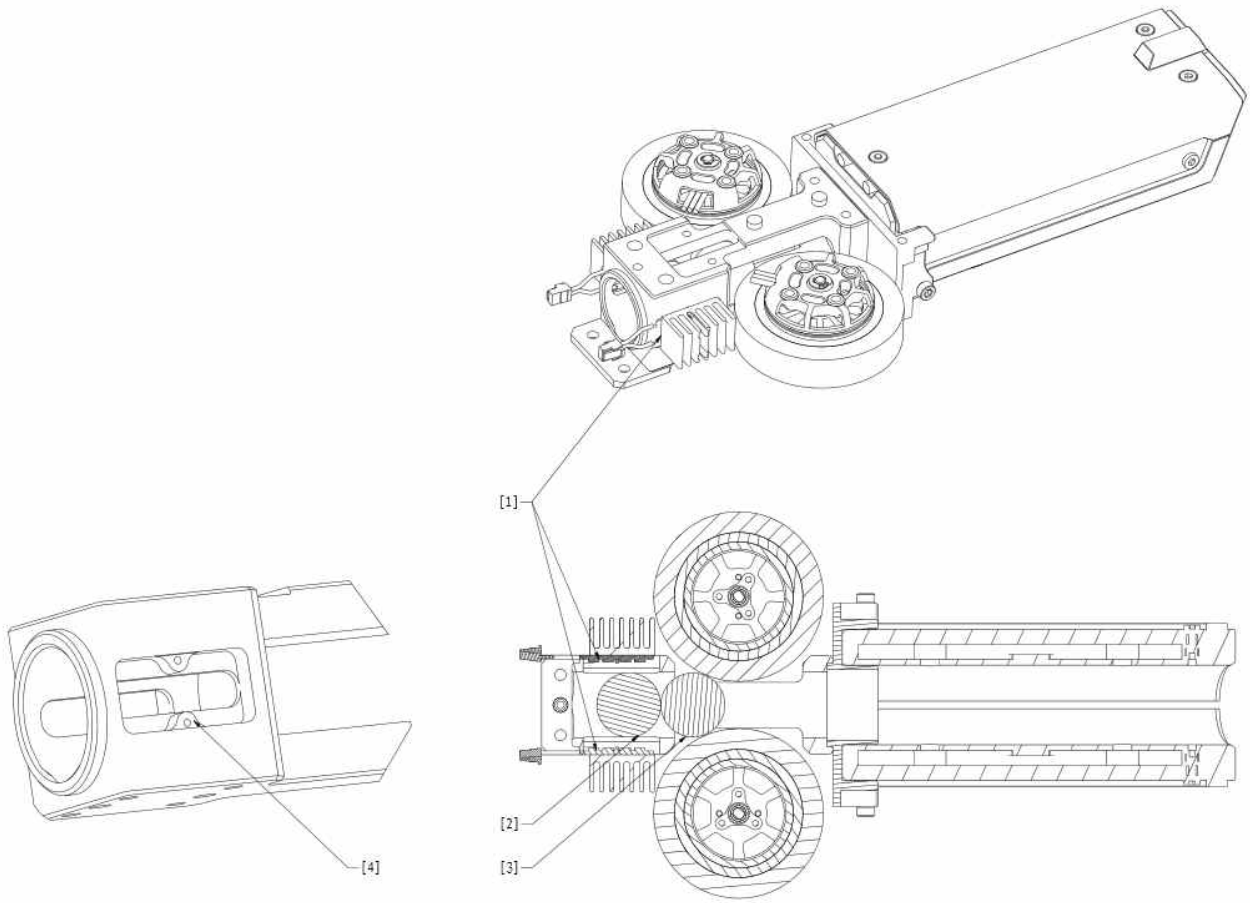
next to the launching projectile, as shown in the drawings below.

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 3-53 Mounting UV Light Panel

3.12.2 Installation Requirements

S136 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.

S137 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.

S138 The UV light panel must cover the standby projectile next to the launching projectile to ensure the proper

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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 Controlller:

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

- 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.

S139 The UV light beads used should be 390-410 nm with a 2835 packaging. The beam angle should be 120°, the power of each bead should be 0.2 W, and the total power of the light panels should not be smaller than 1.5W. The panels should refer to the official design for the competition, with the total length no less than the official panel length.

S140 Aluminium 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.

3.13 Mounting Specifications for Super-capacitor Management Module

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

The Supercapacitor Management Module (hereinafter referred to as the “Capacitor Management Module”) is used to detect the capacitance of the Supercapacitor Module and the energy of the Supercapacitor Module during the competition. The estimated size of a Capacitor Management Module is 60*30*7.5 mm(L*W*H), and heat-shrink

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tubing is used as external protection for the module.

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

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.

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.

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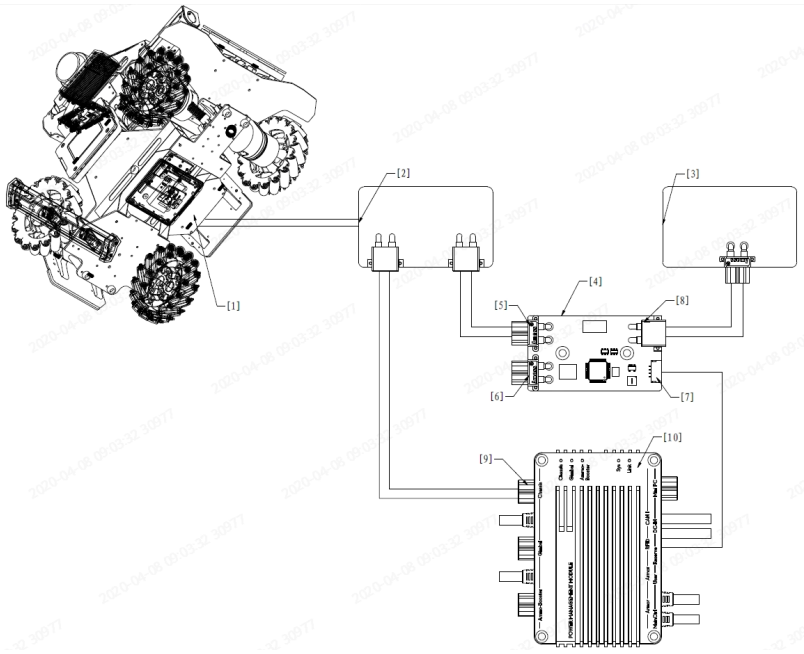
The connection of the Capacitor Management Module is shown below:



[1] Robot chassis power supply interface

[2] Power control panel

[3] Supercapacitor Module

[4] Capacitor Management Module

[5] Capacitor Management Module interface (output, XT30 receptacle) – connecting to power control panel

[6] Inspection 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 3-54 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. 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.

- Considering the potential issues that may occur with the current discharge from the supercapacitors of a team's robots, an XT30 receptacle cable of a length of at least 10cm should be used on the inspection interface of the Capacitor Management Module.
- The weight limit for the installation of a Supercapacitor Management Module on a robot shall be the weight of one Capacitor Management Module added to the robot's default weight.

S141 Both Standard and Hero 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.

S142 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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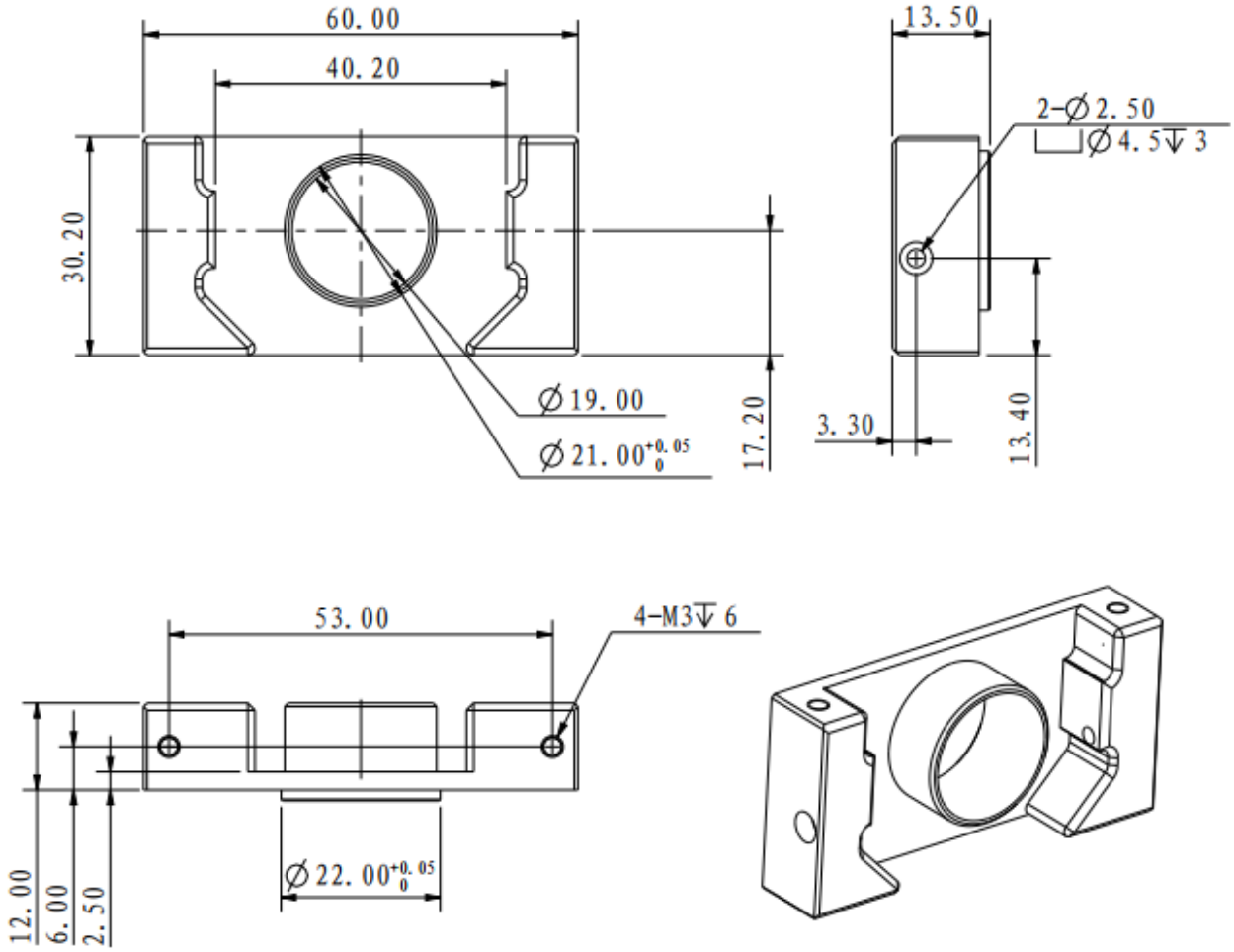
Appendix 1 Drawing of Transfer Block for Speed Monitor Module (17mm projectile)



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Appendix 2 Reference Drawings

Appendix Diagram 1 Engineer Armor Sticker - No. 2

Appendix Diagram 2 Standard Armor Sticker - No. 3

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Appendix Diagram 3 Standard Armor Sticker - No. 4

Appendix Diagram 4 Standard Armor Sticker - No. 5

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Appendix Diagram 5 Hero Armor Sticker - No. 1

Appendix Diagram 6 Balancing Standard Robot Armor Sticker - No. 3

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Appendix Diagram 7 Balancing Standard Robot Armor Sticker - No. 4

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

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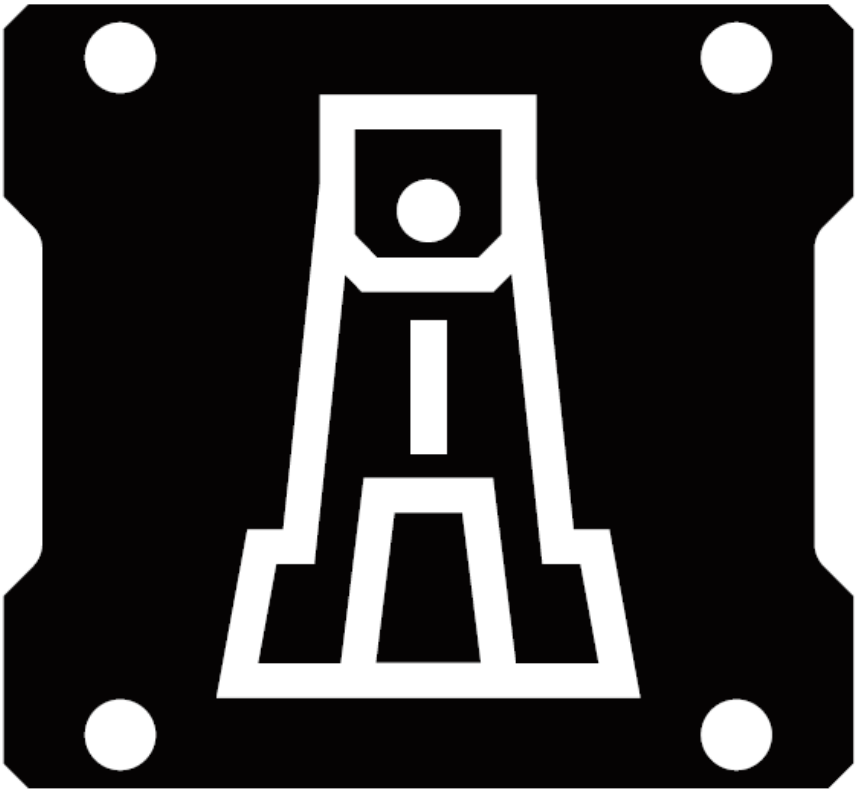
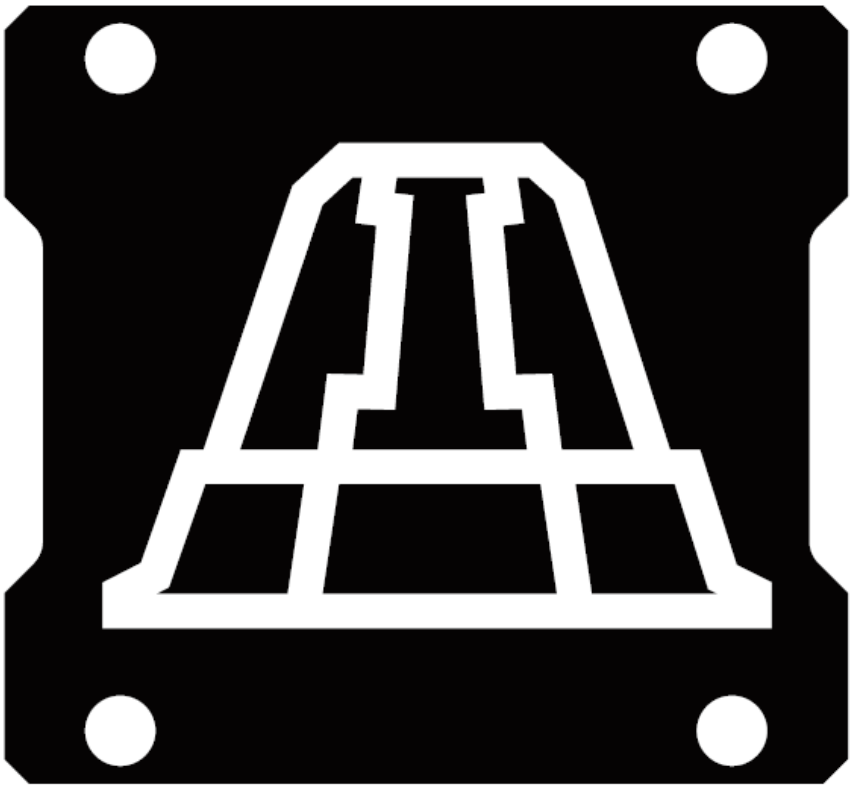


Appendix Diagram 9 Outpost Armor Sticker



Appendix Diagram 10 Base Small　Armor Sticker

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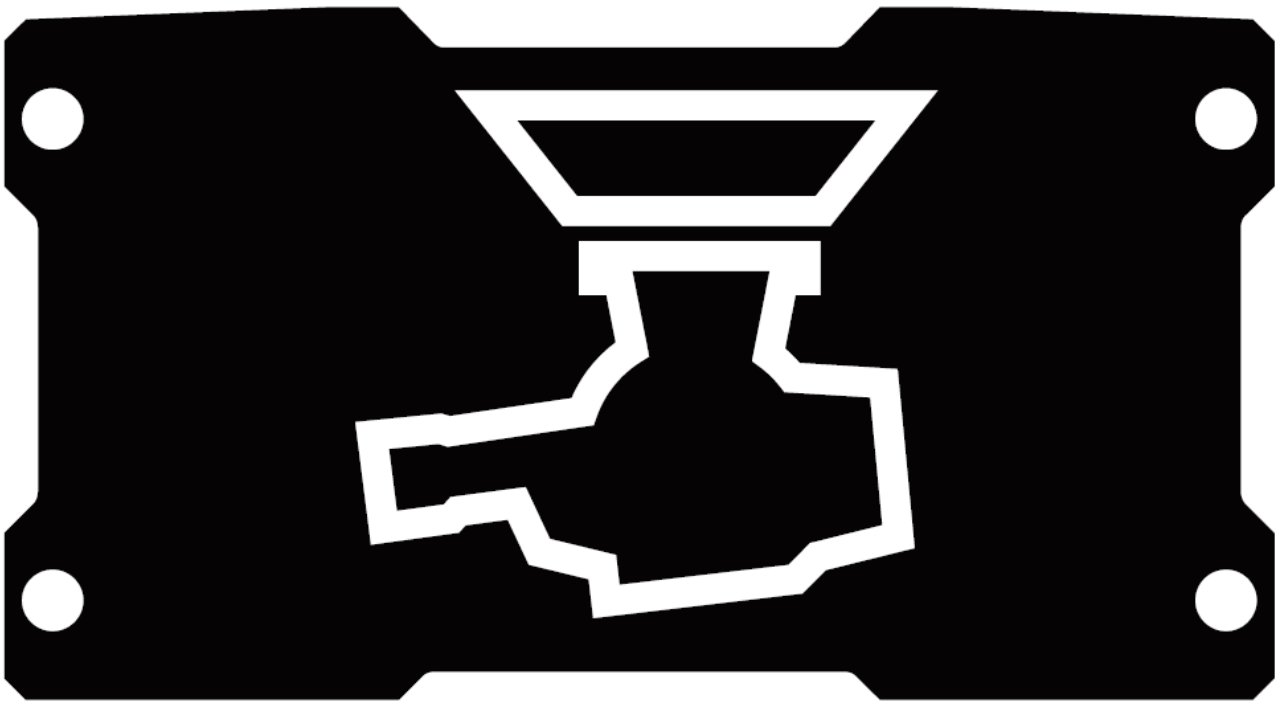
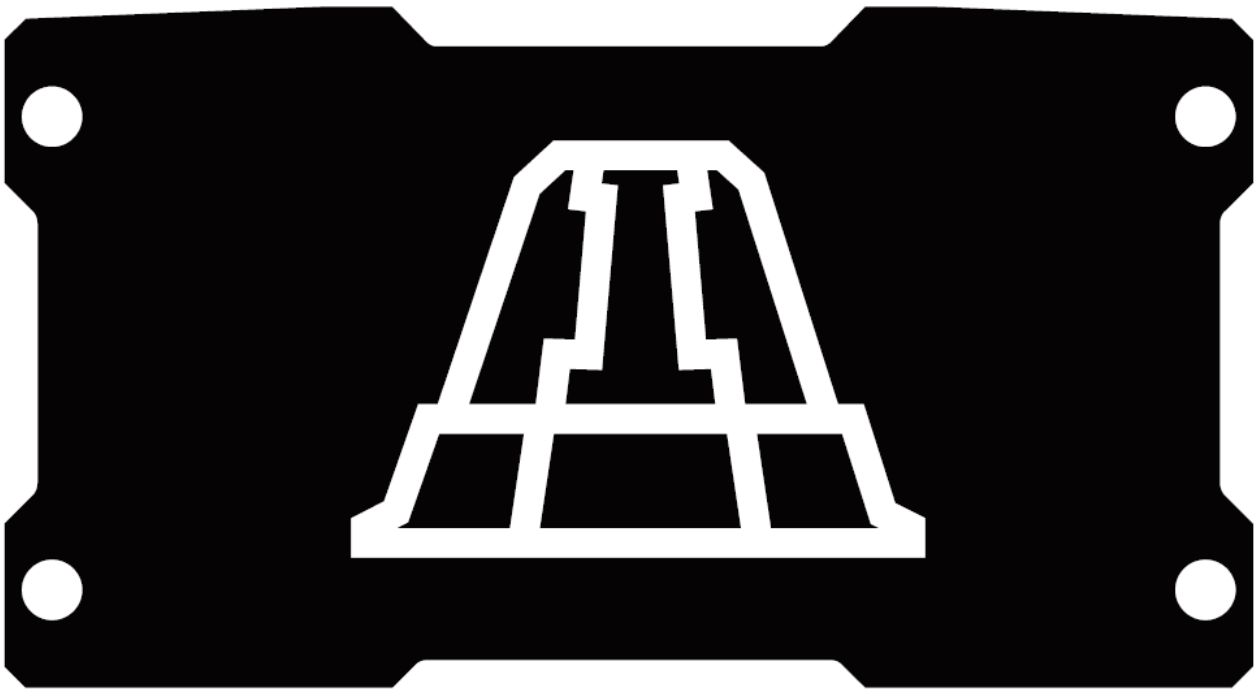


Appendix Diagram 11 Sentry Armor Sticker



Appendix Diagram 12 Base Large Armor Sticker

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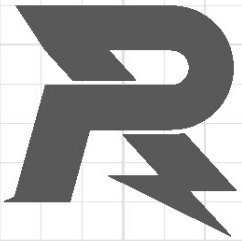

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