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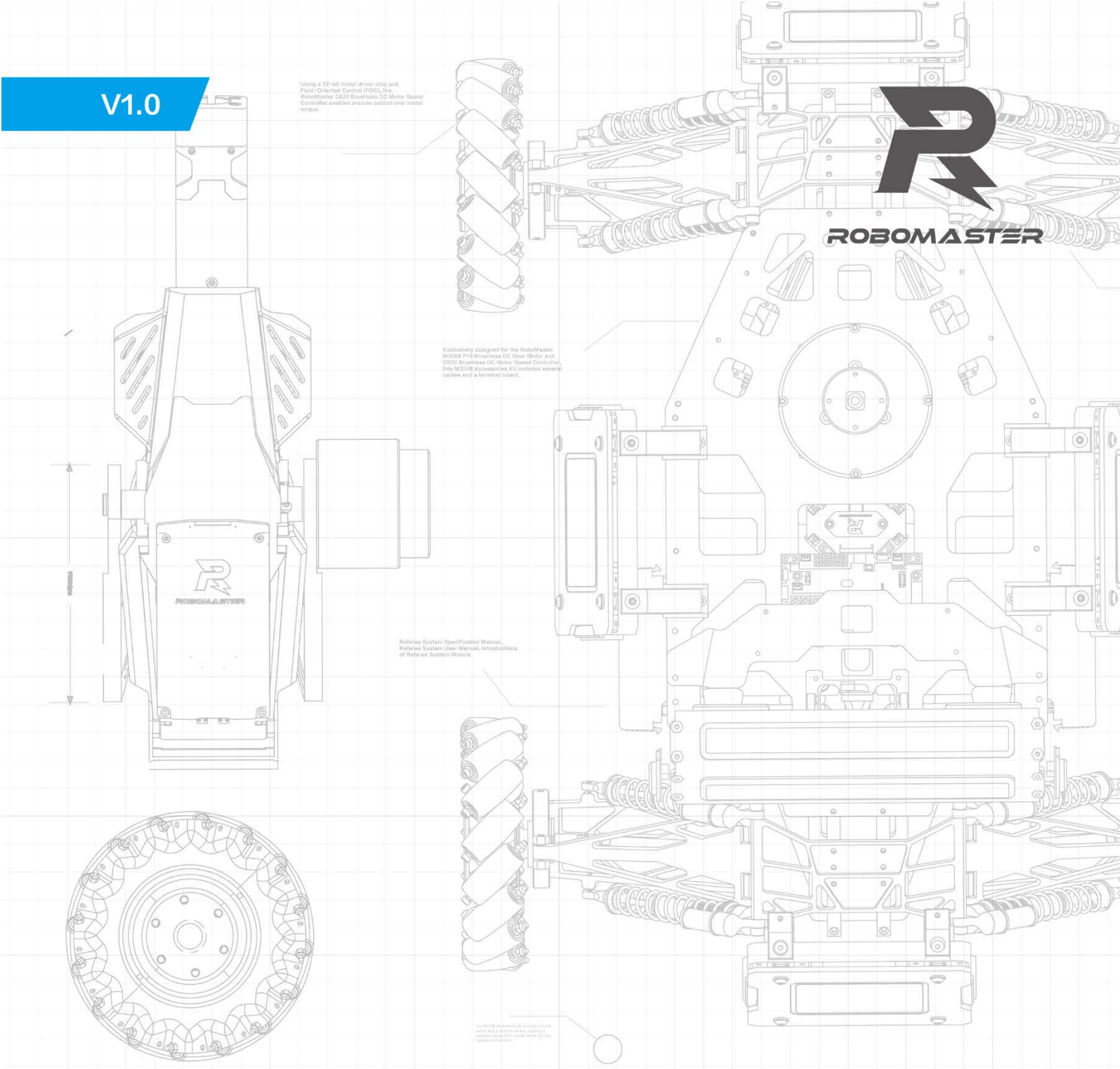
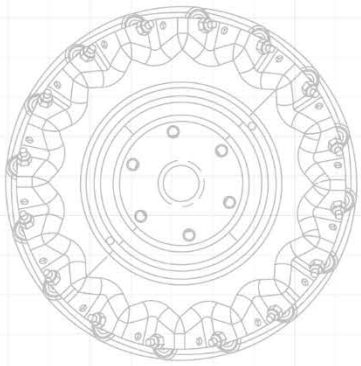


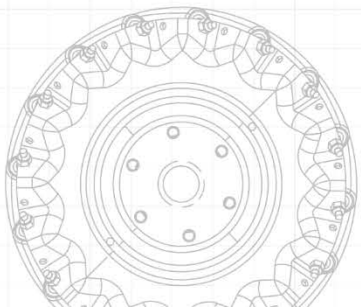
ROBOMASTER 2020 COMPETITION

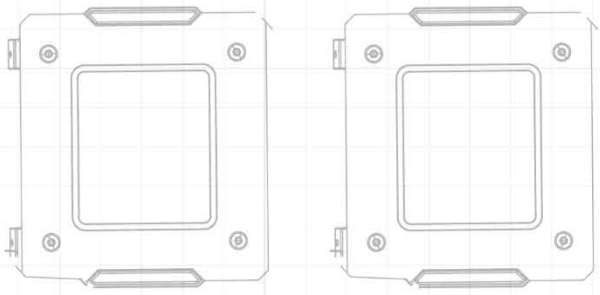
ROBOT BUILDING SPECIFICATION MANUAL

Prepared by the *RoboMaster* Organizing Committee

Updated on October, 2019







Using this Manual

Legend

Prohibition	Important	Hints and Tips	Reference

Related Document

1. Latest version of Referee System User Manual
2. Referee System Module Instructions

Users should preferably read the Referee System Module Instructions first to understand the functions of and mounting methods for each Referee System module, and mount each module on the Robot Side of the Referee System correctly. Thereafter, users can then read the Referee System User Manual to learn about the functions of the entire Referee System.

Release Notes

Date	Version	Changes
2019.10.31	V1.0	First Release

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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 violation rules, the RoboMaster Organizing Committee (hereinafter referred to as “the RMOC”) reserves the right to hold the violating party legally responsible. Any dispute arising from these specifications 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.

2. Technical Specification

2.1 General Technical Specification

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.

S1 Robots can be powered 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.

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

S3 As for the supercapacitor of Hero and Standard, the total nominal voltage of all supercapacitors in a single robot should not exceed 2000J. The energy calculation formula for a single capacitor is $E = \frac{1}{2} * C * U^2$ (U is the withstand voltage value of the capacitor and C is the capacitance).

2.1.1.2 Gas Source

During the competition, if the gas cylinders are found to have safety hazards (such as damage to the external protection device, hidden dangers arising from aging, etc.), the participating members must follow the instructions of the referee to deal with the safety hazards. Otherwise, the robot will not be allowed to enter the stage and must be brought to the designated area.

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

S4 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.

S5 The working gas must be inflammable, non-toxic and non-polluting, such as air, nitrogen, and carbon dioxide.

S6 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.

S7 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.

S8 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.

S9 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.

S10 The cylinder must be mounted safely and firmly on the robot's frame. 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.

S11 The cylinder must be insulated from any possible heat source.

S12 All gas tubes and parts must be able to withstand the highest possible working pressure used in the system. A safety relief valve should preferably be installed on the low pressure gas circuit.

2.1.2 Wireless Equipment

The remote controllers designated for use in this season's competition shall be those produced by DJI.

S13 The remote controllers used must be products designated by the RMOC.

S14 A remote controller must correspond to only one receiver.

S15 A robot cannot carry any wireless equipment other than the remote controller and Referee System Modules.

2.1.3 Optical Equipment

Ground Robots: Hero, Standard, Engineer, and Sentry, collectively.

S16 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).

S17 Apart from laser sights, Engineer may install visible light launching equipment, to use as supplement lights to enhance visual recognition features when procuring Projectile Containers. Other Ground Robots are not allowed to mount any other obvious visible light-launching equipment.

S18 The optical equipment used by a robot must not cause any physical harm to any person.

2.1.4 Computer Vision Features

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 complicated. The Computer Vision algorithm should adapt to the changes of the lighting of the venue and other possible interferences around the venue. The RMOC cannot guarantee that the Computer Vision features of the Battlefield will not cause visual interference.

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

S19 An Armor Module cannot be blocked.

S20 Do not project light onto an Armor Module and do not mount any structure or device that interferes with Computer Vision feature recognition of the Armor Module by reflecting or refracting light on both sides of the Armor Module on the robot.

S21 The light source and sensors mounted on a robot must avoid wavelengths of around 940 nm.

2.1.5 Robot Numbering

During Pre-Match Inspection and the match, staff from the RMOC will provide each robot with a corresponding armor sticker according to the robot numbering rules. For the numbering rules please refer to the Robot Lineup chapter in RoboMaster 2020 Robotics Competition Rules Manual; for the sticker images please refer to Appendix 2 Reference Drawings. Reference drawings will be updated subsequently.

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

S22 The 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.

S23 Except for the exclusive armor stickers provided by the RMOC, no other stickers that resemble the exclusive armor stickers may be pasted on a robot's Armor Module or its other external structure.

2.1.6 Aesthetic Design

To ensure the external armors 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:

S24 The lines of the robot are neat and not exposed. Exposure that is unavoidable requires line protection using materials such as drag chains and cable managers.

S25 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.

S26 Fish nets should not be used as external design materials, unless absolutely necessary for functional reasons.

S27 Avoid sharp structures that may damage the site or harm any person.

Gloss:

Matte paint and stickers are provided at the Inspection Area. If a robot fails to meet the gloss requirements during inspection, the participating team can apply matte treatment on the exterior surface of the robot.

S28 The exterior surface of a robot must not have gloss exceeding 15Gs at a distance within 100mm from the edge of the Armor light bar.

Coating Color:

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

S29 The Red Team’s robots may use a color from the red spectrum for their protective armor, 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.

S30 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 bar 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.

S31 Reverse type can be applied on a school badge or team badge, or its original colors can be retained.

Mounting of Protective Case:

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

Aesthetic Requirements:

S32 Reverse type can be applied for advertising spaces, or their original colors can be retained.

S33 The advertising spaces should be displayed on the left and right sides of the robot, and their distance with the Armor light bar must not be less than 30 mm.

S34 The inkjet or stickers of the advertising spaces must not affect the robot's Computer Vision recognition effect, and cannot be illuminated.

S35 The size of a single robot advertising space shall not be more than 100mm*100mm. Each robot can be set with up to two advertising spaces for the display of sponsor information. If the exterior of a robot does not meet specifications, an Inspector may require the position or size of an advertising space to be altered.

2.1.7 Launching Mechanism

S36 Robots using compressed gas as the propellant for projectiles must not have an acceleration length (defined as the lineal length of the barrel that can provide acceleration to projectiles) exceeding 200 mm.

> Launching Mechanism: A mechanism capable of launching a projectile from a robot on a fixed trajectory to inflict damage on another robot.

S37 During Inspection, a robot is required to launch ten rounds of 17mm projectiles or five rounds of 42mm projectiles, where the maximum speed difference detected by the Speed Monitor Module must not be more than 5 m/s.

S38 Each Launching Mechanism must be mounted with a corresponding Speed Monitor Module according to specifications, and must be equipped with not more than one laser sight. A 17mm Launching Mechanism must be mounted with a charging device according to specifications.

S39 Each team is allowed to mount at most another 17mm Launching Mechanism on a Standard, Hero or Engineer 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 Others

S40 Fragile materials must not be used in the design and creation of robots.

S41 Rescue robots must not grab any of the Referee System Modules on the robot being rescued.

2.2 Robot Technical Specification

2.2.1 Hero

The building parameters for Hero are as follows:

Table 2-1 Hero Building Parameters

Item	Limit	Notes
Operating Mode	No limits; to be equipped with no more than one remote controller.	-
Maximum Total Power Supply Capacity (W·h)	200	-
Maximum Power Supply Voltage (V)	30	-
Launching Mechanism	One 42mm Launching Mechanism	Existing 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
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

Item	Limit	Notes
Referee System	Four Large Armor Modules, and a Speed Monitor Module (42mm projectile), Video Transmitter Module (Transmitter), RFID Interaction Module, Positioning System Module, Main Controller Module, Power Management Module, Light Indicator Module, and Energy-charging Device	Weight is 4.3 kg

- Maximum Expansion Size: The maximum size of a robot during its transformation.
- L*W*H: Length * Width * Height.

2.2.2 Engineer

The building parameters for Engineer are as follows:

Table 2-2 Engineer Building Parameters

Item	Limit	Notes
Operating Mode	No limits; to be equipped with no more than one remote controller.	-
Maximum Total Power Supply Capacity (W·h)	200	-
Maximum Power Supply Voltage (V)	30	-

Item	Limit	Notes
Projectile Obtain Mechanism	• Only one Projectile Obtain Mechanism can be mounted • No adhesive materials can be used • When the Projectiles Obtain Mechanism is extending forward, the size protruding out of the body must not exceed 470mm	When the side of the body of the Projectiles Obtain Mechanism where it extends out is in close contact with a vertical surface, no part of the Projectile Collection Mechanism can exceed the center line of the Resource Island Resource Island Center Line: The top view of Resource Island is square. The center line of the Island refers to the central axes that are cross the geometric center of the square and perpendicular to the two sets of opposite sides respectively.
Launching Mechanism	If Engineer is mounted with a mobile 17mm Launching Mechanism, the 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)	-
Rescue Method	• Can revive a robot using a RFID Interaction Module Card • Can revive a robot by dragging it to the revival spot	Allowed to use only one RFID Interaction Module Card to revive its team's Standard or Hero on the spot.
Projectile Supply Capability	Can receive and supply	-
Maximum Weight (kg)	35	Includes battery weight, but not the weight of the Referee System

Item	Limit	Notes
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 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	2.6kg

2.2.3 Standard

The building parameters for Standard are as follows:

Table 2-3 Standard Building Parameters

Item	Limit	Notes
Operating Mode	No limits; to be equipped with no more than one remote controller.	-
Maximum Total Power Supply Capacity (W·h)	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	-

Item	Limit	Notes
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
Referee System	Four Small Armor Modules, and a Speed Monitor Module (17mm projectile), Video Transmitter Module (Transmitter), RFID Interaction Module, Positioning System Module, Main Controller Module, Power Management Module, Light Indicator Module, and Energy-charging Device.	Weight is 3.0 kg

2.2.4 Aerial

The building parameters for Aerial are as follows:

Table 2-4 Aerial Building Parameters

Item	Limit	Notes
Operating Mode	No limits; to be equipped with no more than two remote controllers	-
Maximum Total Power Supply Capacity (W·h)	600	-

Item	Limit	Notes
Maximum Power Supply Voltage (V)	48	-
Launching Mechanism	A 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, 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	Speed Monitor Module (17mm projectile), Video Transmitter Module (Transmitter), Positioning System Module, Main Controller Module, Power Management System, Energy-charging Device	Weight is 0.6kg

Building Requirements

The following requirements must be adhered to when producing Aerial:

S42 Aerial must be mounted with fully enclosed propeller guards, and 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.

S43 If Aerial crashes into a tall cylindrical object of any diameter from any angle and at a certain horizontal speed, its propeller guards should protect its propellers from making direct contact with the cylindrical object, and should not suffer any significant deformation.

S44 Cables, slip rings and retractable Aerial Safety Ropes are in place above the Battlefield to ensure the flying safety of Aerial. Aerial must have a vertical rigid safety rod mounted on top of the body at a height of 300 mm above the propellers (the height limit for the Vertical Safety Rod may be changed subsequently). The lower

end of said safety rod is rigidly connected to Aerial; a rigid ring is fixed on the upper end of the rod to connect with the Aerial Safety Rope above the Battlefield Components. When Aerial is lifted up by its rigid ring, its vertical rigid safety rod and rigid ring must be able to bear its weight. During inspection, attach the robot to a pull string, raise it vertically by 0.05 m, and release it into free fall once - the robot should not suffer any significant deformation and damage.

S45 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.

S46 Aerial can be equipped with indicator lights on its body to indicate its current flight status for better visual recognition during the competition (indicator lights on the body can only be placed at six locations at most, each of these six locations must not have more than three light beads, and the illuminance of each bead cannot exceed 3500 Lux at a distance of 100 mm). The indicator lights should not interfere with the competition on the Battlefield (mounting high-power LEDs that beam directly at the Battlefield are prohibited).

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.

S47 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 for the front and back, left and right, and up and down flying directions can be effectively monitored. The distance of the external navigation lights to the edge of the Aerial should not be more than 1/3 of the robot body's Maximum Size. The shortest distance between two lights must not be smaller than 1/3 of the robot body's Maximum Size. The external navigation lights must be firmly connected to Aerial, but must not be mounted on the propellers. The external lights on Aerial should be illuminated in the color of the corresponding team.

S48 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.

S49 Aerial should have a corresponding structure to keep projectiles secure in the magazine. Projectiles should not be allowed to fall out of the magazine in flight.

2.2.5 Sentry

The building parameters for Sentry are as follows:

Table 2-5 Sentry Building Parameters

Item	Limit	Notes
Operating Mode	Fully automatic; to be equipped with no more than one remote controller for debugging	-
Maximum Total Power Supply Capacity (W·h)	200	The total capacitance of the robot does not exceed 10mF
Maximum Power Supply Voltage (V)	30	-
Launching Mechanism	Maximum of two 17mm Launching Mechanisms	● If Sentry is configured with two 17mm Launching Mechanisms, the barrel heat of the two Launching Mechanisms shall be calculated separately ● During each round of a match, when all initial projectiles have been launched, the Launching Mechanism will be powered off
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, L*W*H)	Choose one of the following two methods: ● 500*600*800 ● 800*500*600	● The Light Indicator Module and the Positioning System Module and its mounting bracket are not included in the size restriction. Other Referee System modules must be included in the size restriction.

Item	Limit	Notes
		● The Maximum Size of Sentry below the top surface of the Sentry Rail is no more than 450 mm (including the Maximum Expansion Size)
Referee System	Two Large Armor Modules, two Speed Monitor Module (17mm projectile)s, and a Positioning System Module, Main Controller Module, Power Management Module, Light Indicator Module, and Energy-charging Device	Weight is 2.4 kg

2.2.6 Dart System

A Dart System consists of a Dart Robot (herein after referred to as “Dart”) and a Dart Launcher. A Dart Launcher is the carrier of Darts and provides them with initial propulsion.

A Dart uses its own Visionary Intelligence, Elevated Imagination system to locate the object, and controls its flight direction using rudders, propellers, 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 2-6 Dart Building Parameters

Item	Limit	Notes
Maximum Total Power Supply Capacity (W·h)	4	-
Maximum Power Supply Voltage (V)	8.4	-
Maximum Weight (kg)	0.15	-

Item	Limit	Notes
Maximum Size (mm, L*W*H)	200*120*80	● The flight length of a Dart is no more than 200 ● The wingspan of a Dart is no more than 120
Flying Mode	Aircraft capable of hovering are not permitted	-

The building parameters for Dart Launcher are as follows:

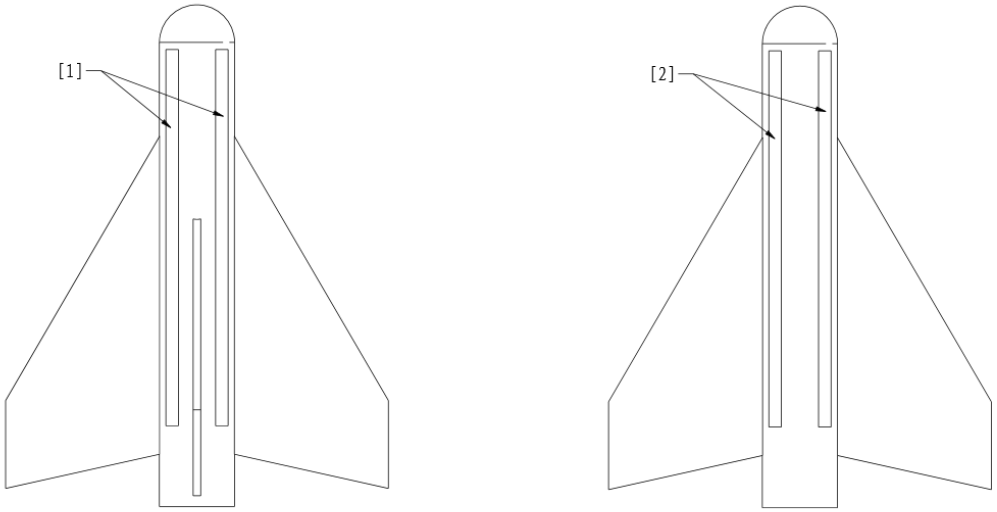
Table 2-7 Dart Launcher Building Parameters

Item	Limit	Notes
Operating Mode	No limits; to be equipped with no more than one remote controller for debugging	-
Rotation Angle (°)	● Yaw angle: No limits ● Pitch angle: 25-45	-
Maximum Total Power Supply Capacity (W·h)	200	-
Maximum Power Supply Voltage (V)	30	-
Maximum Operating Power (W)	No limits	-
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	Its orthographic projection on the ground should not exceed a 1000*600 square

Item	Limit	Notes
Referee System	Main Controller Module and Power Management Module	Weight is 0.2 kg

2.2.6.1 Building Requirement

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.



[1] Mounting position for external lights on the back of Dart

[2] Mounting position for external lights on the belly of Dart

Figure 2-1 Graphs of external lights on Dart

S50 A Dart should be mounted with green external lights. An external light consists of 10 emerald-green surface-mounting LED light beads, each having a power of 0.1~0.2 W. Mount the lights according to the mounting positions for external lights shown in the graphs, and ensure the green light beads can be seen from any angle during the Dart's flight.

2.2.6.2 Guidance Feature

The integrated 940 nm infrared-ray LED light beads mounted on a Base and Outpost are Computer Vision recognition features for Darts. The layouts, quantities, sizes and other parameters for light beads on a Base and an Outpost are different.

2.2.6.3 Dart Launching Station

A Dart Launching Station is an official Battlefield Component. A Dart Launch Opening should be aimed at the middle point of the connecting line between the enemy Base and Outpost. A Launch Opening can either be in an open or closed state. A Dart Launcher is mounted in the Dart Launching Station.

2.2.1 Radar

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

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

Table 2-8 Radar Computing Platform production parameters

Item	Limit	Notes
Operating Mode	Fully automatic	-
Maximum Power (W)	1000	-
Power Supply Voltage (V)	220	Can also be powered using other power supplies that conform to general power supply standards
Power Supply Frequency (Hz)	50	-
Maximum External Size (mm, L*W*H)	400*250*500	Its orthographic projection on the ground should not exceed a 400*250 rectangle
Referee System	Main Controller Module and Power Management Module	Weight is 0.2 kg

The parameters for a Radar Sensor are as follows:

Table 2-9 Radar Sensor parameters

Item	Limit	Notes
Maximum Weight (kg)	10	-

Item	Limit	Notes
Maximum External Size (mm, L*W*H)	1200*300*300	Its orthographic projection on the ground should not exceed a 1200*300 rectangular

2.2.1.1 Mounting Specification

2.2.1.1.1 Computing Platform

During the three-minute setup period, a team must place their computing platform on a Radar Base with a protective cover on side of the Battlefield. A power supply with an air switch supplies power to the computing equipment. 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 Radar Base.

A monitor will be placed in the Operator's Room, with the source image provided by the Radar. The signal format must be 1080P60, and the port is HDMI Type A. The computing equipment must not use wireless equipment as a receiving device. If the receiving device cannot be removed, it must be disabled in the operating system.

2.2.1.1.2 Sensor

The sensor is placed on the Radar Base. The Radar Base is 3 meters high, located near the short Perimeter Wall on its team's side. The signal transmission and power supply of the sensor must be handled by the teams themselves.

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.

3. Referee System Mounting Specification

3.1 Overview

A Referee System is a fully automatic electronic referee system that can monitor the state of a robot and make a determination - in other words, an “Intelligent Referee”. During the competition, the Referee System provided by the RMOC monitors each robot’s HP, 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 robots designed by each team must have a mechanical and electrical port built in, and each module of the Referee System must be correctly mounted according to the requirements in this chapter.

A Referee System consists of the following modules:

Table 3-1 Referee System Modules

Module	Description
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 on the monitor in the Operator Room.
Speed Monitor Module	A Speed Monitor Module is used to detect the initial firing speed and frequency of projectile or Dart. It consist of two types which are the 17mm and 42mm S-peed Monitor Modules. A robot’s HP will be deducted by the Referee System if the speed limit has been exceeded.
Armor Module	An Armor Module is the damage sensory system of a robot, which consists of Small and Large Armor Modules. They are used to assess the attacks by projectiles and collisions sustained by a robot.  The interval of two rounds of 17mm projectiles hitting the same Armor Module should not be less than 50 ms, two 42mm projectiles not less than 200 ms. When a 17mm projectile and 42mm projectile come into contact with the large Armor Module at speeds of 12 m/s and 8 m/s respectively, they can be effectively detected.

Module	Description
RFID Interaction Module	An RFID Interaction Module can exchange information with functional zones in the Battlefield to perform mutually corresponding functions.
Positioning System Module	A Positioning System Module can detect a robot's location on the Battlefield, and can authorize a robot to establish connection with the competition server.
Main Controller Module	A Main Controller Module is the core control module of a Referee System. It can monitor the operation of the entire system, and integrates functions such as human-machine interaction, wireless communication and status display.
Power Management Module	A Power Management Module's functions are to: control the chassis, gimbal, and power supply for the Launching Mechanism of a robot; transmit data; detect chassis power; automatically cut off power supply for propulsion when a robot's HP drops to zero; etc.
Light Indicator Module	A Light Indicator Module indicates the level of HP through the length of the light bar, and the color of the light bar distinguishes the red/blue teams and the status of the robot.
Energy-charging Device	An Energy-charging Device provides light energy to fluorescent projectiles.

3.2 Configuration of the Robot Referee System

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

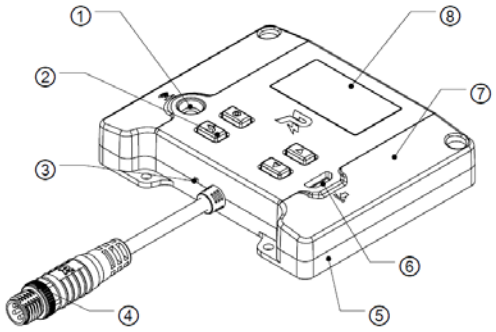
Table 3-2 Configuration of Robot Referee System Modules

Qty. / Type	Main Controller Module	Power Management Module	Light Indicator Module	Large Armor Module	Small Armor Module	Video Transmitter Module (Transmitter)	RFID Interaction Module	Speed Monitor Module (17mm Projectile)	Speed Monitor Module (42mm Projectile)	Positioning System Module	Energy-charging Device
Standard	1	1	1	0	4	1	1	1	0	1	1

Qty. / Type	Main Controller Module	Power Management Module	Light Indicator Module	Large Armor Module	Small Armor Module	Video Transmitter Module (Transmitter)	RFID Interaction Module	Speed Monitor Module (17mm Projectile)	Speed Monitor Module (42mm Projectile)	Positioning System Module	Energy-charging Device
Sentry	1	1	1	2	0	0	0	2	0	1	2
Hero	1	1	1	4	0	1	1	0	1	1	0
Aerial	1	1	0	0	0	1	0	1	0	1	1
Engineer	1	1	1	0	4	1	1	0	0	1	0
Dart System	1	1	0	0	0	0	0	0	0	0	0
Radar	1	1	0	0	0	0	0	0	0	0	0

3.3 Installing Main Controller Module

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



[1] IR Receiver [2] Button [3] Power Indicator [4] Black Metal Ring Aviation Connector

[5] Metal Bottom Cover [6] Level Up Interface [7] Plastic Top Cover [8] Screen

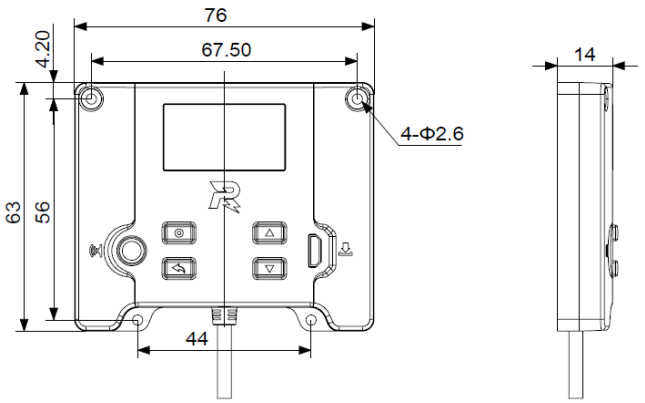
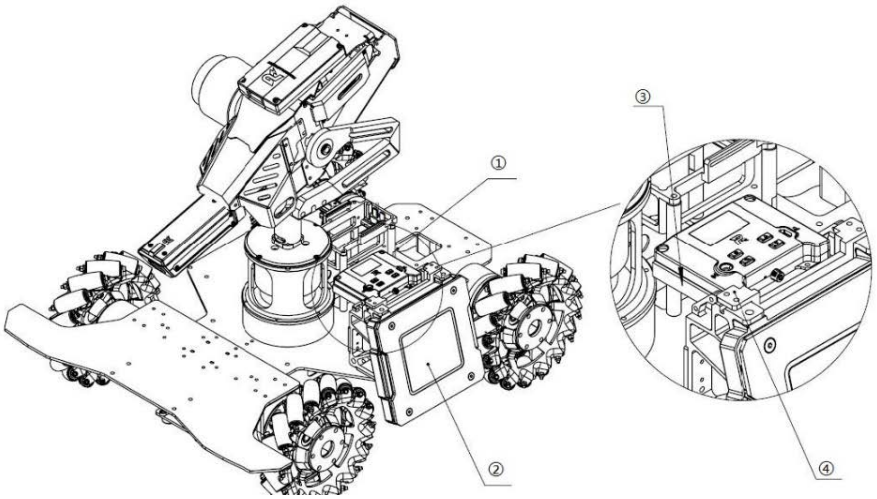


Figure 3-1 Main Controller Module Graph

3.3.1 Mounting Steps

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

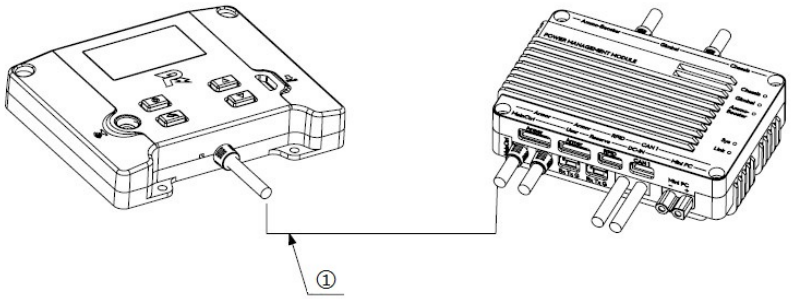
> Mounting reference: Teams may design parts by themselves (not including those in the items list), and install them on the back of the edge of the Armor Module (the built-in M3 threaded hole on the Armor Module support frame can be used), with non-metal guards installed around them to prevent attacks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



[1] Main Controller Module [2] Armor Module [3] Self-designed Protective Guard [4] Self-designed Part

Figure 3-2 Main Controller Module Mounting Graph

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.



[1] Aviation Connector Cable

Figure 3-3 Main Controller Module Connector Cable Graph

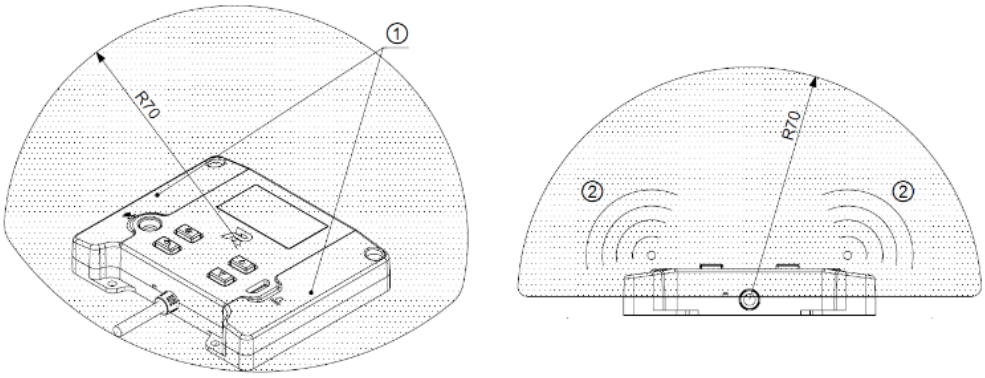
3.3.2 Mounting Requirements

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

S51 Ensure the top surface of the Main Controller Module of a robot faces up when it is in working condition.

S52 The area above the interface of the Main Controller Module (screen, keyboard) for 50 mm is not blocked by any metal. Foam that is easily opened can be used as protection to facilitate interaction.

S53 The circular center of the mounting position should be the center of the logo. No motor or electromagnetic device that may interfere with the Main Controller Module should be within a hemisphere measuring 70 mm from the center of the logo, to avoid blocking any Wi-Fi signals.



[1] Antenna Position [2] Signal Direction

Figure 3-4 Graph of Main Controller Module mounting position

S54 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.

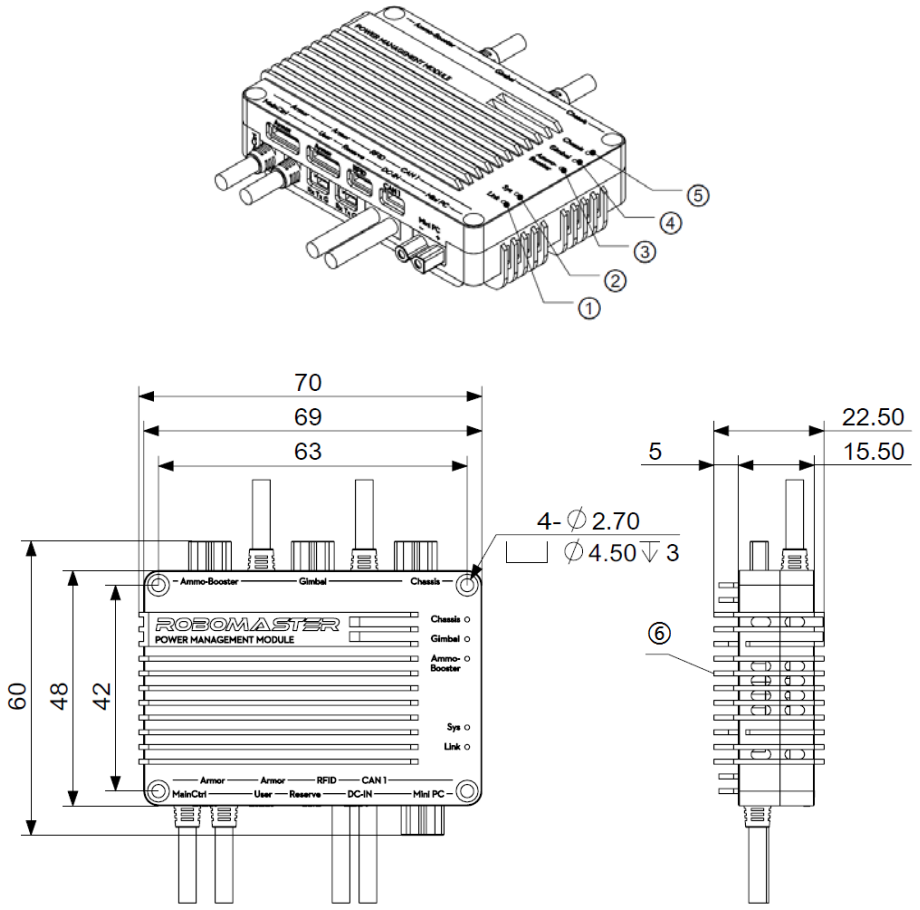
S55 The mounting position of a Main Controller Module must make it easy for personnel to operate the keyboard,

check information on the screen, and upgrade firmware.

S56 After being mounted on a Sentry Rail, the Main Controller Module of Sentry should also not be blocked by the Rail.

3.4 Mounting Power Management Module

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



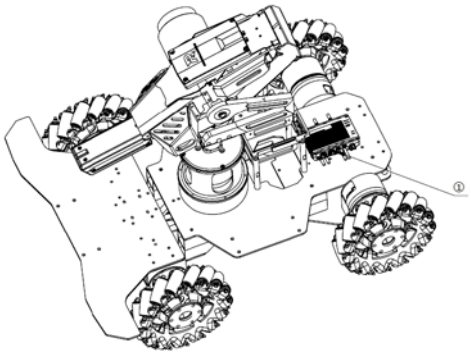
[1] Connection Status Indicator [2] System Status Indicator [3] Launching Mechanism Power Output Indicator

[4] Gimbal Power Output Indicator [5] Chassis Power Output Indicator [6] Bottom Mounting Surface

Figure 3-5 Power Management Module Graph

3.4.1 Mounting Steps

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



[1] Power Management Module

Figure 3-6 Power Management Module Mounting Graph

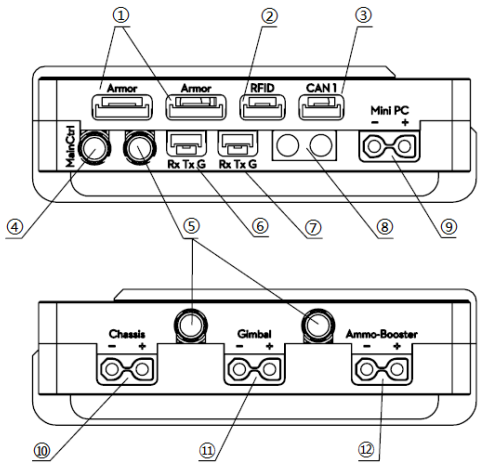
2. Carefully differentiate between the ports on the Power Management Module to ensure correct cabling. The chassis power supply for all Ground Robots must be connected to the “Chassis” port of the Power Management Module, while the gimbal power supply must be connected to the “Gimbal” port. The Launching Mechanism power supply for Aerial and Sentry must be connected to the "Ammo-Booster" port on the Power Management Module.

   For a robot without a power limit, if the maximum continuous current of the chassis or gimbal power supply exceeds 10A, it can be powered by the robot’s battery and controlled using a relay. The relay must be powered by the corresponding interface to ensure that after the robot is defeated, the Referee System can control the power to all devices connected to the “Referee System Power Port (Output)”. Otherwise, it would be considered cheating.

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

   - The circuit board related to the chassis power supply must be independent of the gimbal and Launching Mechanism power supply. A circuit board powered through the “Chassis” port on the Power Management Module cannot be connected to other power ports on the Power Management Module.
   - All chassis-related circuits of a robot must be clearly laid out. A referee may conduct random inspections on a robot after a match, and, where required, the team must cooperate in the random inspection and disassemble the relevant robot parts to show the relevant circuits. It is 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.



[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, Video Transmitter, and Light Indicator; the metal ring of the aviation plug is silver in color)

[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 Graph

3.4.2 Mounting Requirements

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

S57 The status indicators of the Power Management Module are not blocked.

S58 Each port on the Power Management Module is protected, to prevent damage by projectiles. However, the outer casing cannot be completely wrapped, so as to ensure good heat dissipation.

S59 Do not use glue such as 3M glue to secure the Power Management Module.

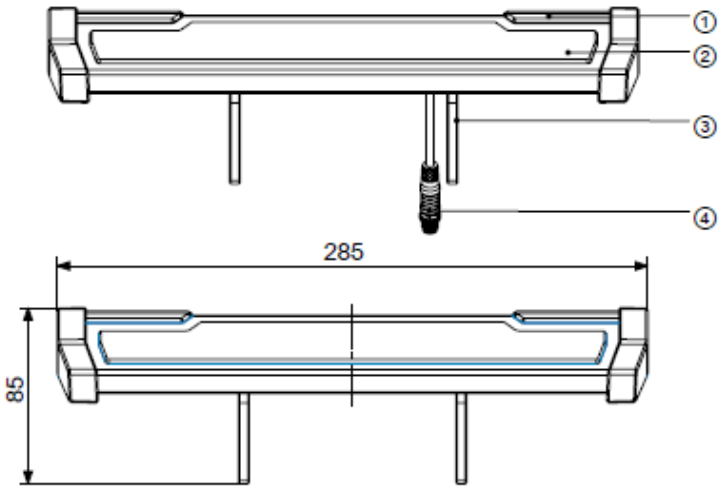
S60 For a robot with a power limit, the electric power for the power limiting mechanism must not bypass the monitoring of the Power Management Module.

- 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. Specifically, the maximum continuous payload for each single circuit connected to the no. 10 “Chassis” and no. 11 “Gimbal” ports is 10A, and the longest duration for its peak value of 30A is 500ms. For the 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. 2 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°.

3.5 Mounting Light Indicator Module

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



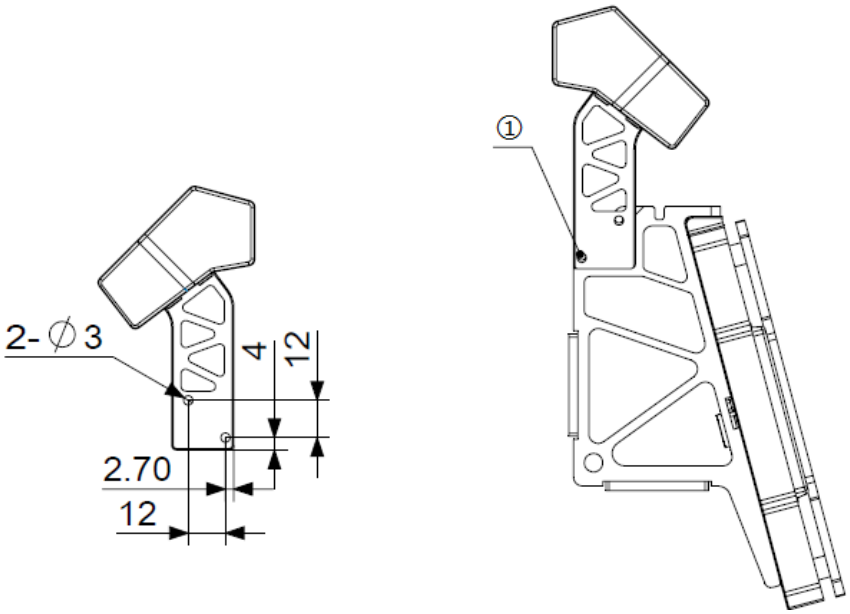
[1] Auxiliary Light Bar [2] Main Light Bar [3] Mounting bracket [4] Aviation plug

Figure 3-8 Light Indicator Module Graph

3.5.1 Mounting 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 Sentry is different. A mounting bracket must be used to mount the Light Indicator Module onto Sentry through the mounting holes on the side or the screw holes on the bottom.



[1] Screw Hole Mounting Position

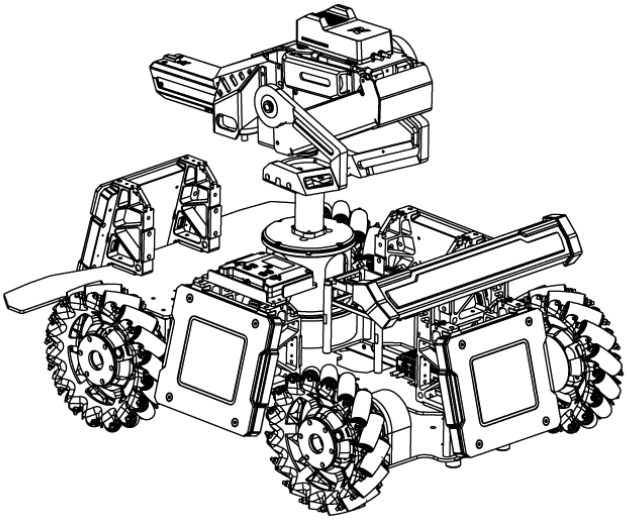


Figure 3-9 Light Indicator Module Mounting Graph

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.

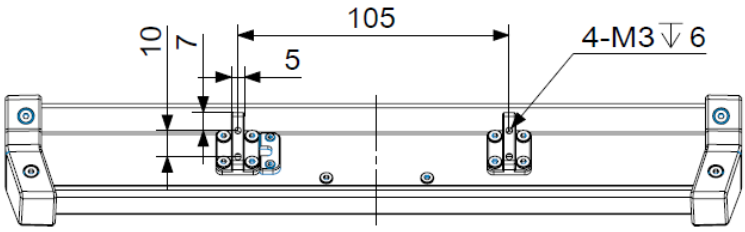
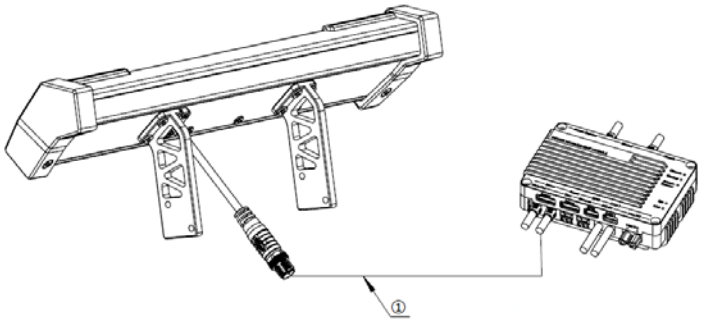


Figure 3-10 Graph of Bottom of Light Indicator Module

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 3-11 Light Indicator Module Cable Connection Graph

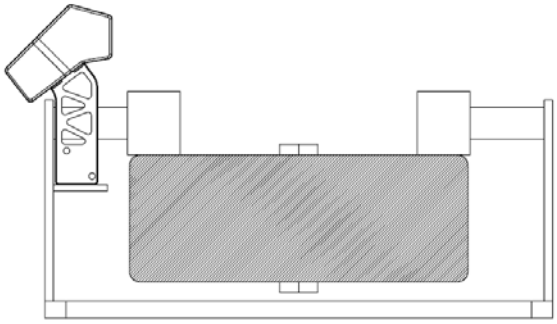
3.5.2 Mounting Requirements

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

S61 The connection cables of the left and right auxiliary light bars are parallel to the ground.

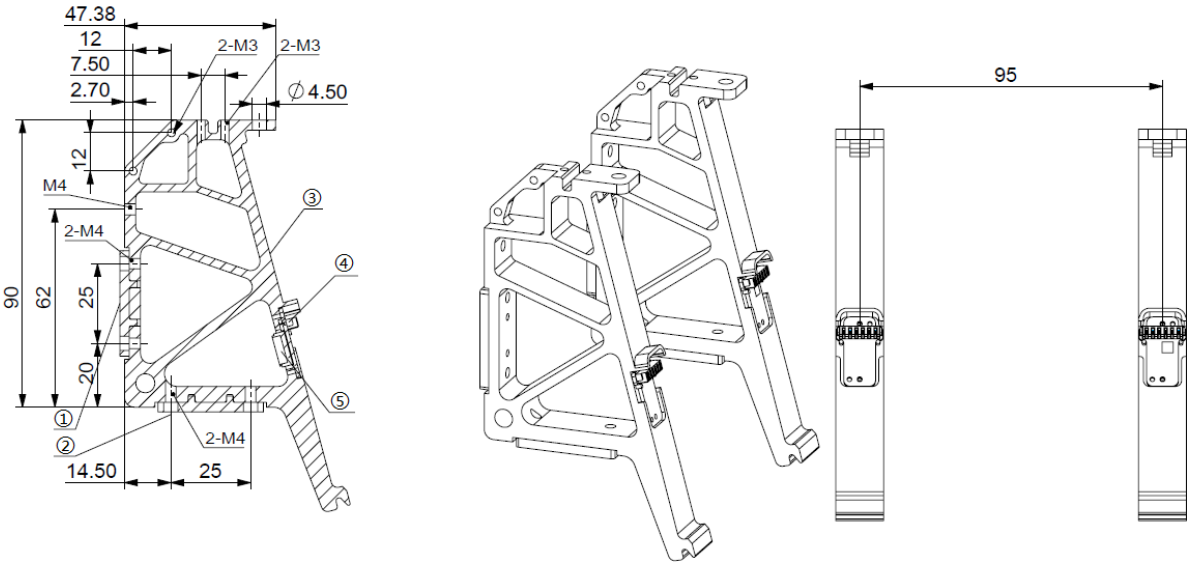
S62 The main and auxiliary light bars should be fully visible from at least one viewing angle.

- When installing the Light Indicator Module of Standard, the main light bar must be higher than the upper edge of the Armor Module.
- 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 bars) are above the top surface of the rail, as shown below.



3.6 Mounting Armor Module

An Armor Module is mounted on a robot using an armor support frame. Only Type A Armor Support Frame is used the RM2020 Competition, as shown below:

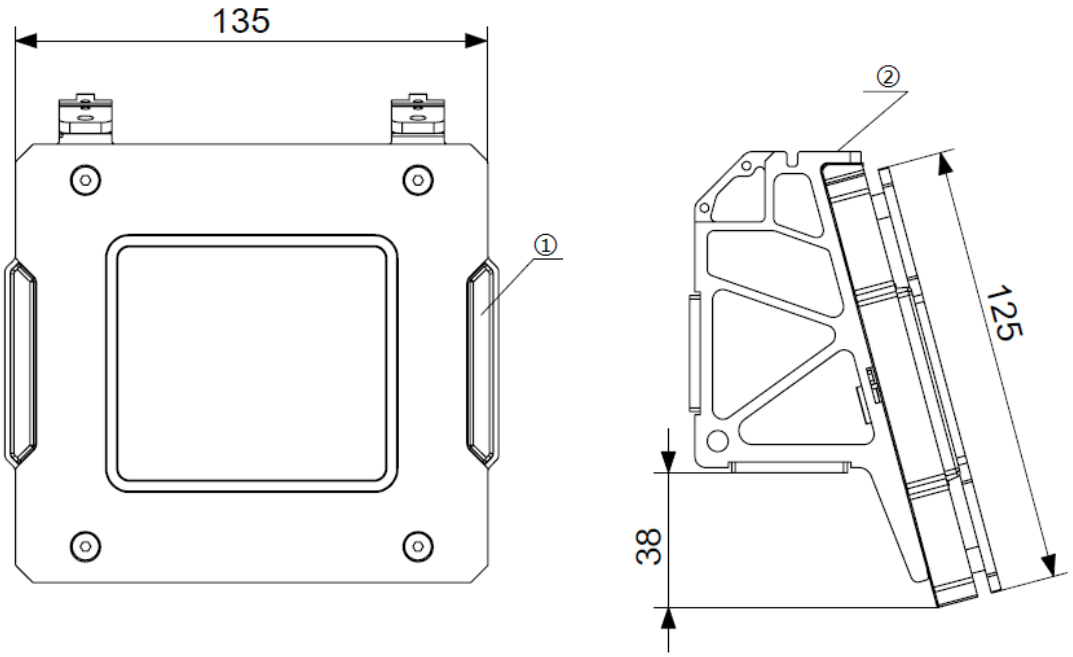


[1] Back Mounting Surface [2] Bottom Mounting Surface [3] Armor Module Mounting Surface

[4] Electrical Connection Point [5] JST 6-pin Port

Figure 3-12 Graph of Type A Armor Support Frame

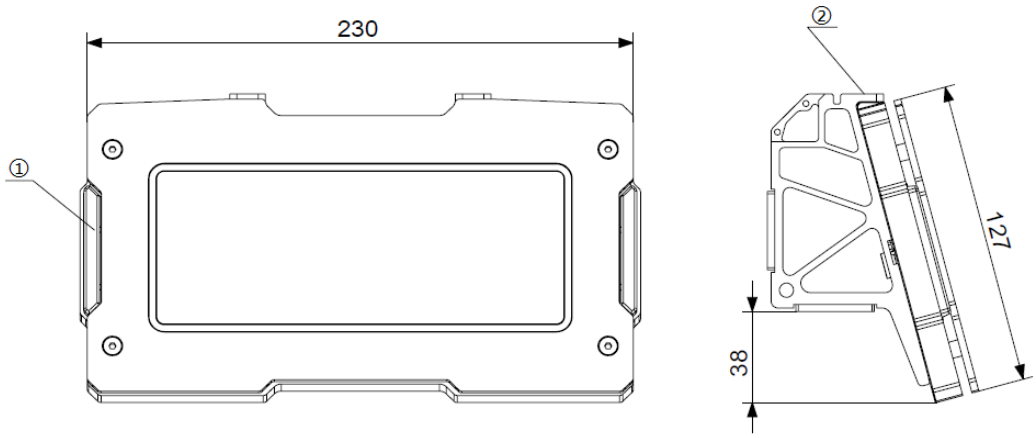
The Small Armor Module is shown in the figure below:



[1] Side Light Bar [2] The top is secured with vertical M4 screws

Figure 3-13 Small Armor Module Graph

The Large Armor Module is shown in the figure below:



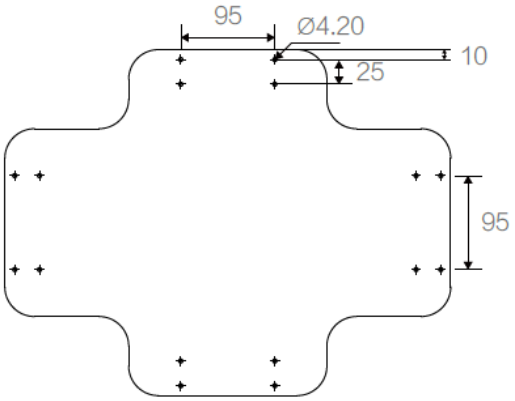
[1] Side Light Bar [2] The top is secured with vertical M4 screws

Figure 3-14 Large Armor Module Graph

3.6.1 Mounting Steps

Standard, Engineer, and Hero Armor Modules:

Using the dimensions shown in the figure below as a reference, drill in mounting holes on the chassis. Keep the sizes and the positions of the four mounting holes consistent.



1. Secure Armor Support Frame A on the chassis using M4 screws. Each Armor Support Frame must be secured using two screws. The mounting steps are as follows:

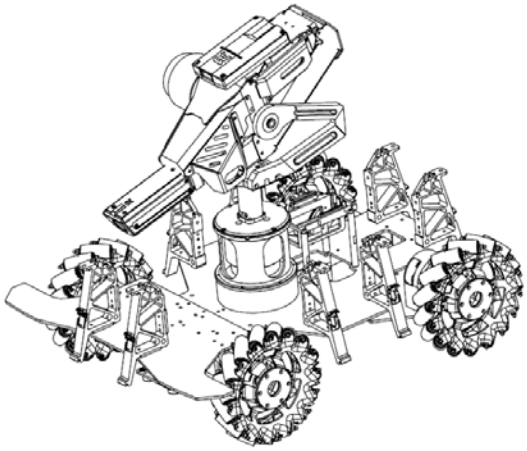
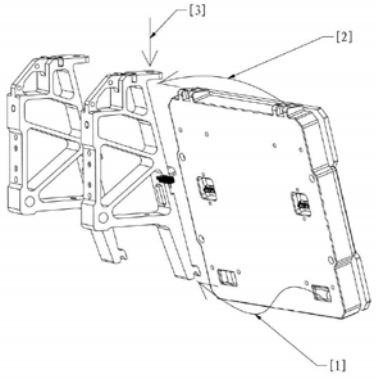


Figure 3-15 Mounting Graph for Armor Support Frame A

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

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.



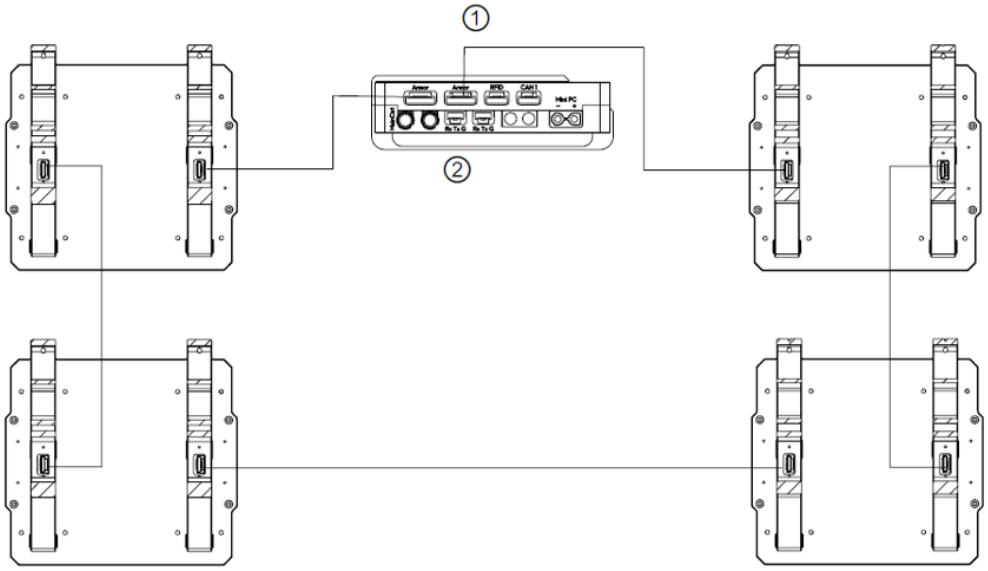
[1] Insert the lower slot of the Armor Module into the lower buckle of the Armor Support Frame

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

[3] Secure with screws

Figure 3-16 Armor Module Mounting Graph

3. Use the 6-pin cable provided in the package to connect the Armor Modules in series to the Armor Module port of the Power Management Module. The two 6-pin ports of the Armor Support Frame are equivalent ports. The number of Armor Modules in series on the two 6-pin ports of the Power Management Module should preferably be equally distributed, to divide the current on the ports evenly.



[1] Power Management Module [2] 2:1 ratio

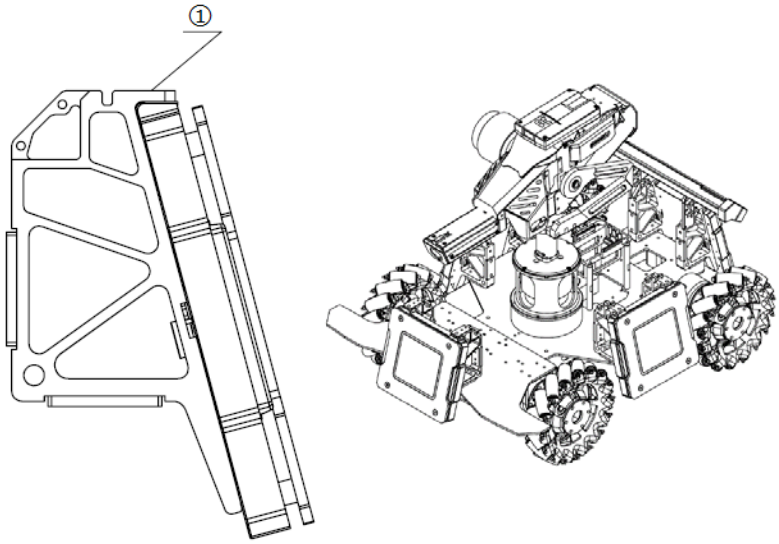
Figure 3-17 Armor Module Cable Connection Graph

3.6.2 Mounting Requirements

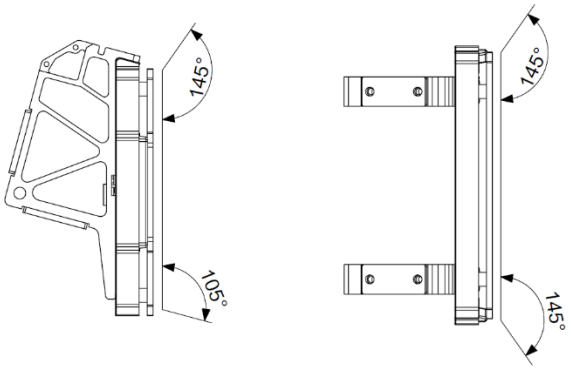
The mounting of an Armor Module must meet the following requirements:

Standard, Engineer and Hero Armor Modules:

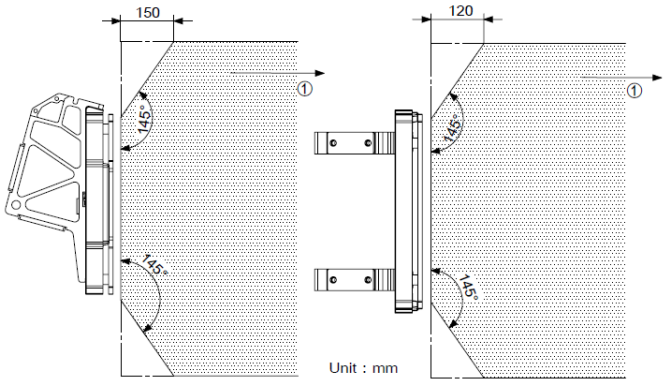
S63 The lower 105° area, and the upper, left and right 145° areas of the impact surface on the Armor Modules of Standard and Hero must not be blocked.



[1] The top is secured with vertical M4 screws



S64 The lower 105° area of the impact surface of an Engineer's Armor Module must not be blocked, and the vertical distance between the outer edge of the robot and the lower edge of the Armor Module must be smaller than 100 mm. The upper, left and right 145° areas of at least 3 Armor Modules must not be blocked. Only the 145° area of the impact surface of one Armor Module is allowed to be blocked, at a vertical distance of 150 mm away and horizontal distance of 120 mm away. The grey areas shown below are not allowed to be blocked.



[1] Extended Infinitely

Sentry:

Using the dimensions shown in the figure below as a reference, drill in mounting holes on the chassis. Keep the sizes and the positions of the four mounting holes consistent.

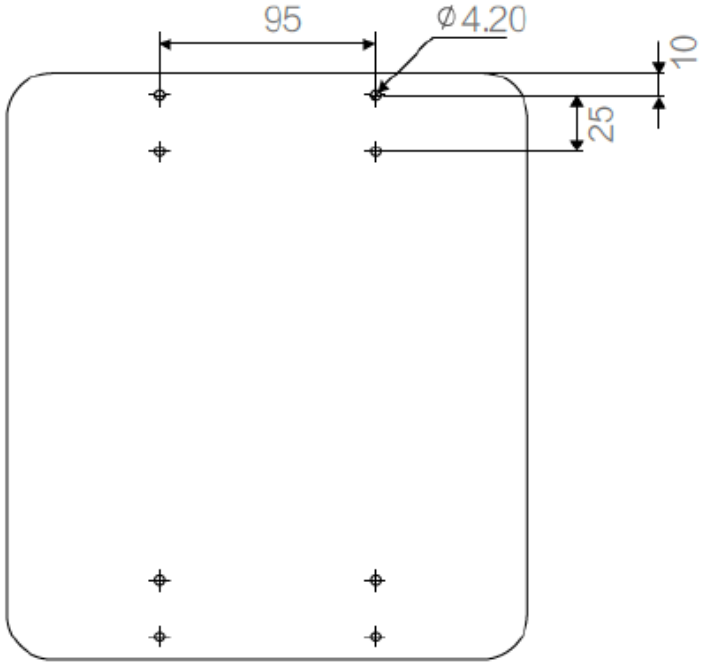


Figure 3-18 Graph for built-in mounting holes on chassis

1. Secure Armor Support Frame A on the chassis using M4 screws. Pay attention that the threaded hole is on the bottom.

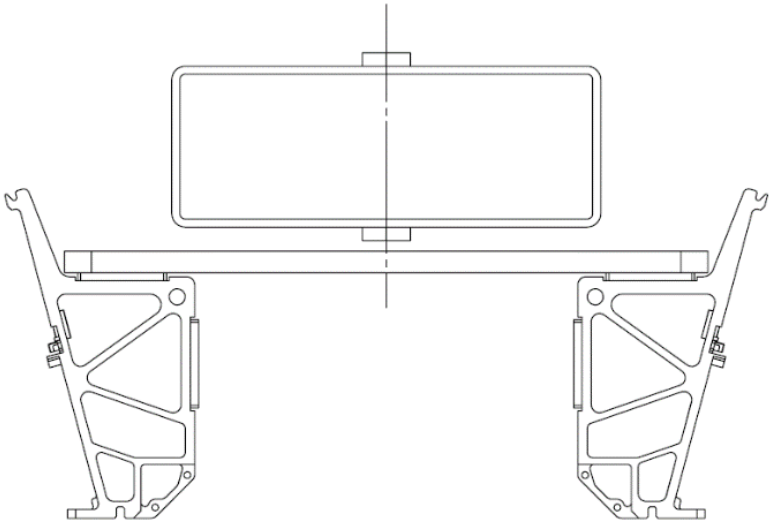


Figure 3-19 Sentry Armor Support Frame Mounting Graph

2. Mount the Large Armor Module on the Armor Support Frame, and secure with M4 screws. The threaded hole at the top of the Armor Support Frame is not perpendicular to its bottom surface. When installing the Armor

Support Frame correctly, the threaded hole at the bottom should be perpendicular to a horizontal surface. The 145° area of the impact surface on the Armor Module must not be blocked.

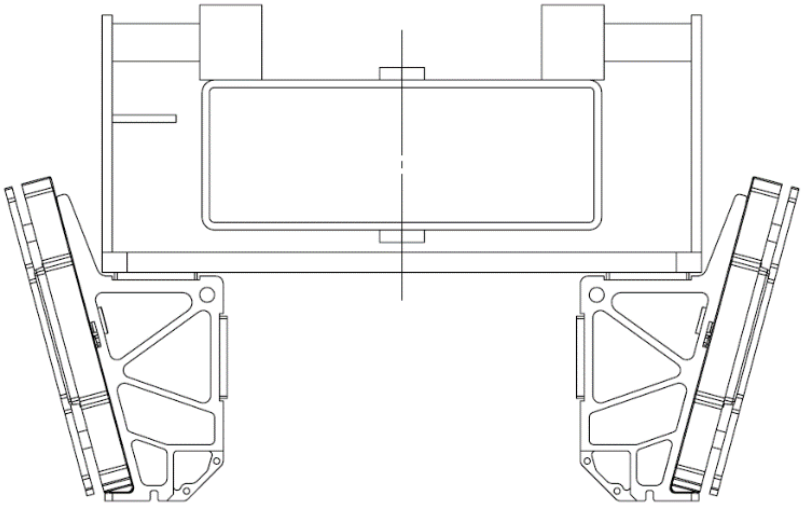


Figure 3-20 Sentry Armor Module Mounting Graph

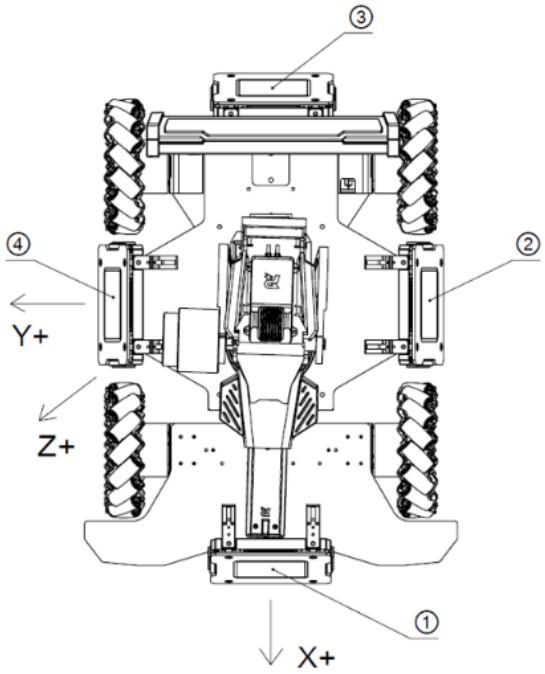
⚠ When the Sentry is mounted onto the linear section of the Sentry Rail, the long edge of its Large Armor Module should be parallel to the linear section of the Sentry Rail; the upper edge of the Armor Module is within ±100 mm of the plane of the Sentry Rail's top surface on which it is located. The impact surface of the Armor Module 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.

3.6.3 ID Number Configuration

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

Standard, Hero, and Engineer

Based on the Armor Module mounting requirements for Standard, Hero and Engineer, the coordinates of the robot are established using the front heading of the robot's Video Transmitter Module (Transmitter) at the start of the match, as the X-axis positive direction on the robot's coordinates, and the Z-axis positive direction pointing towards the earth's center. After entering the Module Armor ID configuration mode, tap the X-axis positive direction, Y-axis negative direction, X-axis negative direction and Y-axis positive direction, to complete all the Armor Module ID configurations for the robot. The ID configuration for Armor Modules is shown below:



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

Figure 3-21 Armor Module ID Configuration Graph for Standard, Hero and Engineer

Table 3-3 Robot Armor Module ID Configuration

Axis	Module ID
X	• Positive direction: 0 • Negative direction: 2
Y	• Positive direction: 3 • Negative direction: 1

Sentry

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

3.6.4 Mounting Specification

In the following section, the robot's body coordinate system is a standard Cartesian coordinate system with X-, Y- and Z-axes, and the coordinate origin is the robot's center of mass, as shown in the following figure:

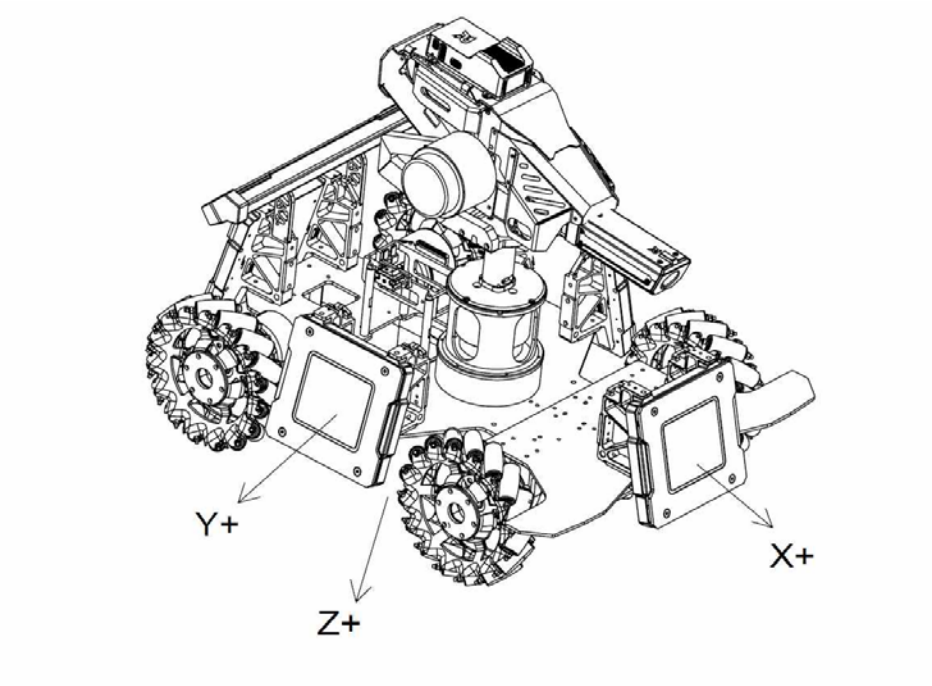


Figure 3-22 Robot Coordinate System Graph

The kinematic equations of the robot should be based on the Cartesian coordinate system. If a robot's kinematic model is established using a non-Cartesian coordinate system, the body coordinate system is defined as follows: The direction vector of a projectile launched by the robot's largest-caliber Launching Mechanism in its initial state projected onto the XY plane is the X-axis. Based on the X-axis and the Z-axis pointing towards the earth's center, the Y-axis is generated according to the right-hand rule, and the origin is the robot's center of mass.

Mounting the Armor Module

When an Armor Module is mounted on a robot, the force-bearing surface of the Armor Module and the Armor Module Support Frame must be connected firmly together. The bottom connecting surface of the Armor Module Support Frame must be parallel to the XY plane, so that the acute angle between the normal vector of the plane on which the force-bearing surface of the Armor Module lies and the straight line in the negative direction of the Z-axis is 75°. The two sides of the Armor Module without indicator lights should be parallel to the XY plane. Define the projection of the normal vector of the plane (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 unit vectors of the direction vectors of the four Armor Modules must be equal to 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 angular error between the direction vector and the corresponding coordinate axis vector cannot exceed 5°).

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 Armor Modules mounted on the X- and Y-axes are allowed to deviate from the geometric center by ±50 mm.

Rigid Connection

A mounted Armor Module 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°.

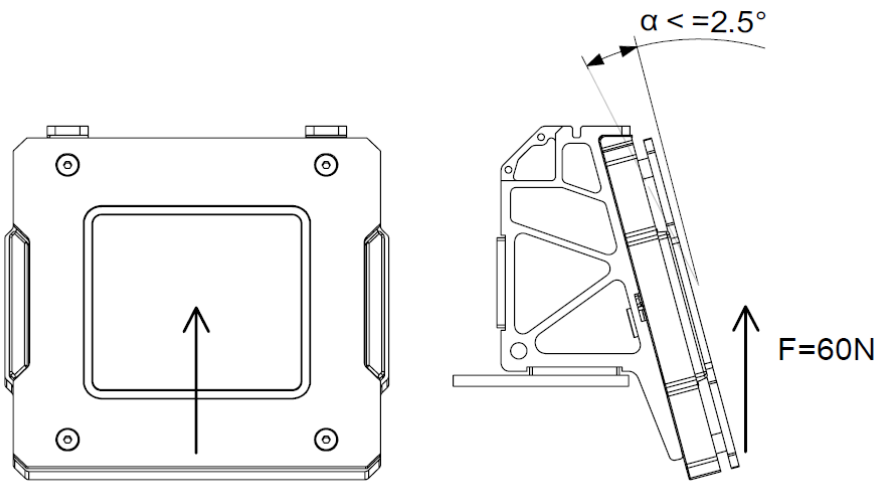


Figure 3-23 Graph of Application of Force on Armor Module

Robot Transformation

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, the requirements for the Armor Module are as follows:

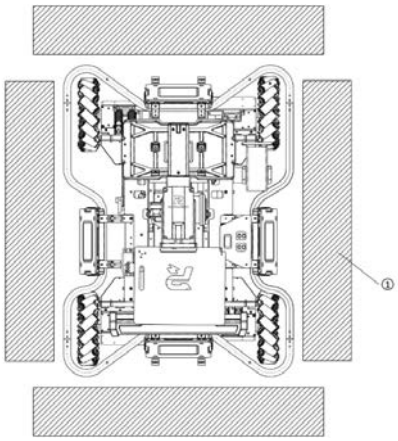
- At no time can any Armor Module move continuously and reciprocally with respect to the robot's center of mass as a whole, and the short-term movement speed must not exceed 0.5 m/s.
- For Standard, the height of the lower edge of its Armor Module from the ground before and after transformation must be within the range of 60 mm - 150 mm.
- For Engineer, the altitude of the lower edge of its Armor Module from the ground must be within the range of 60 mm – 400 mm before and after transformation. The relative position between the geometric center point of the four Armor Modules and the horizontal plane of the center axis of the barrel of any Launching Mechanism when it is horizontal cannot be changed during the competition.
- For Hero, the altitude of the lower edge of its Armor Module from the ground must be within the range of 60 mm – 200 mm before and after transformation. The relative position between the geometric center point of the four Armor Modules and the horizontal plane of the center axis of the barrel of any Launching Mechanism when it is horizontal cannot be changed during the competition.

- For Hero and Engineer, the height difference between the lower edges of any two Armor Modules must not exceed 100 mm.
- For Sentry, 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 it is located. The height of the armor plate relative to the rail plane must not be changed. Any horizontal movement relative to the structure used to mount the robot on the rail is not allowed, either.

Armor Module Protection

S65 Teams should design safety rods for Standard, Engineer and Hero to reduce any damage caused by collision of Armor Modules.

When a robot is mounted with a safety rod 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:



[1] Wall

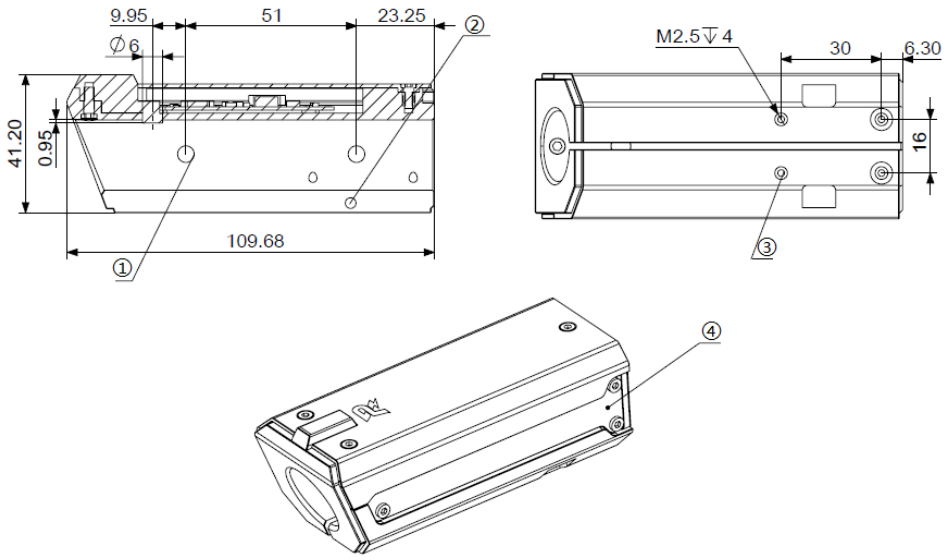
Figure 3-24 Robot Protection Graph

- Self-designed protective case cannot have any contact with the Armor Modules provided by the RMOC.
- Do not modify or decorate the Armor Modules.
- Connect the robots reasonably based on their design and ensure that the cables are connected securely to prevent damage and wear.

3.7 Mounting Speed Monitor Module

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

Speed Monitor Module (17mm projectile):



[1] Phototube

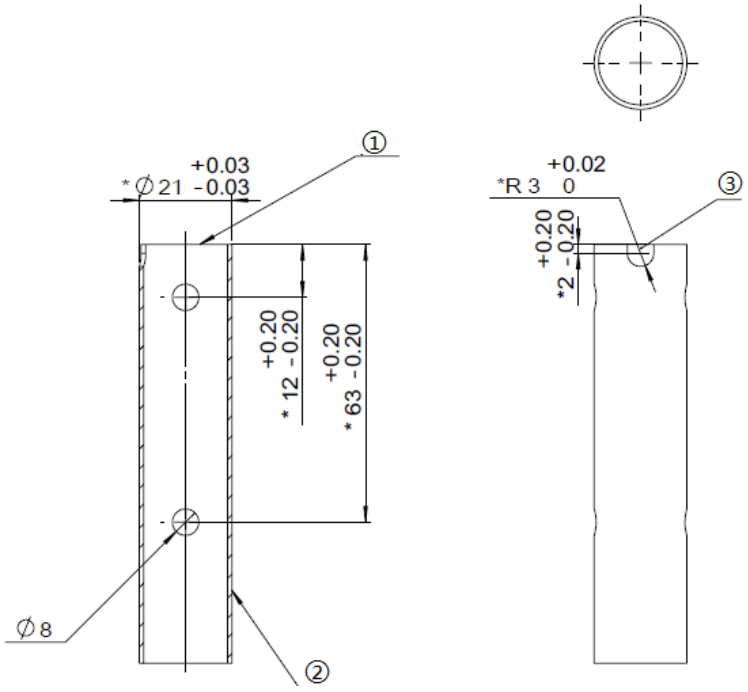
[2] Barrel Clamping Screw Hole

[3] M2.5 Mounting Screw Hole for Laser Sight 4

[4] LED Light Indicator

Figure 3-25 Speed Monitor Module (17 mm projectile) Graph

17mm barrel size restrictions:



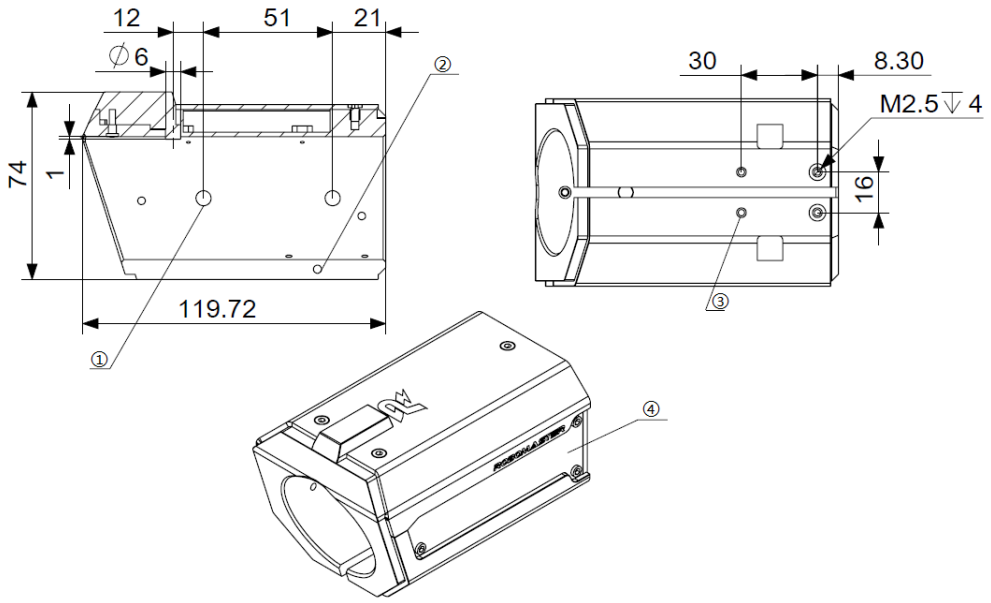
[1] Barrel

[2] * Wall thickness must be no less than 1 mm

[3] The U-shaped groove must face upward after installing the barrel

Figure 3-26 17mm Barrel Graph

42mm Speed Monitor Module:

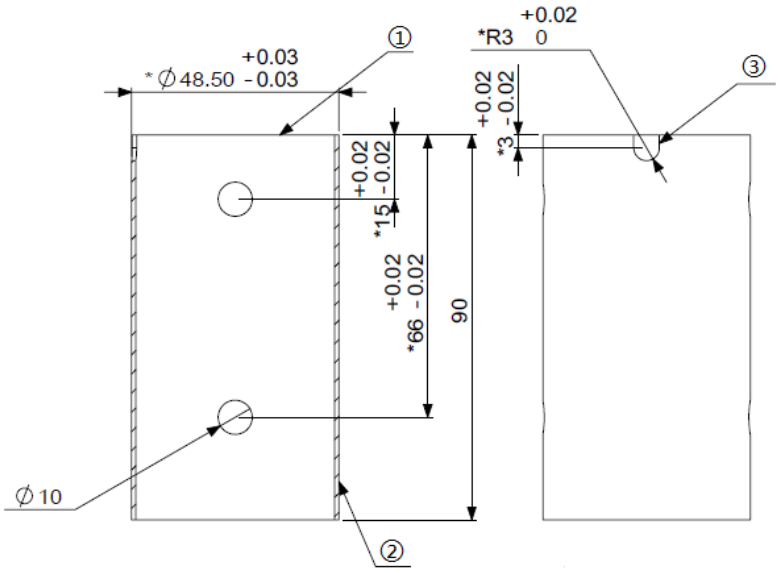


[1] Phototube [2] Barrel Clamping Screw Hole

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

Figure 3-27 42mm Speed Monitor Module Graph

42mm barrel size restrictions:



[1] Barrel [2] * Wall thickness must be no less than 1 mm

[3] The U-shaped groove must face upward after installing the barrel

Figure 3-28 42mm Barrel Graph

Production requirements for 17mm and 42mm barrels:

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

3.7.1 Mounting Steps

1. Place the Speed Monitor Module on the barrel so that the cylindrical step is aligned with the U-shaped groove of the barrel, and the connecting end faces the Main Controller Module.
2. Insert M3 screws through the screw holes in the rear of the Speed Monitor Module to clamp the barrel.
3. Connect the Speed Monitor Module with the Speed Monitor Module aviation socket on the Power Management Module using an aviation connector cable. The completed mounting is shown in the figure below:

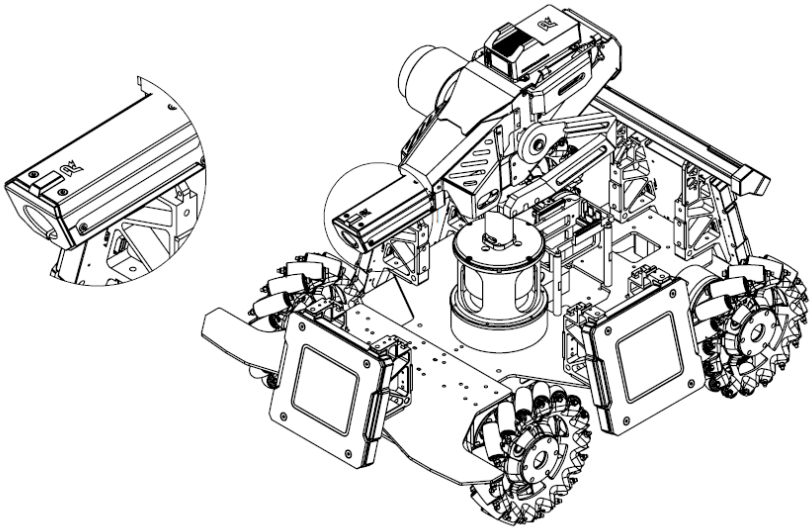


Figure 3-29 Speed Monitor Module Mounting Graph

3.7.2 Mounting Requirements

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

S66 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.

S67 The logo of a Speed Monitor Module when being installed must face upwards.

S68 A Speed Monitor Module contains a magnetometer, which is sensitive to electromagnetic environments. Therefore, no large magnetic conductive materials (iron barrels, heat transfer fans on the Transmitter of the Video Transmitter Module, friction wheel motors, etc., are forbidden in [1] in the figure below) should be placed within an area measuring 70mm in diameter with the logo as the center.

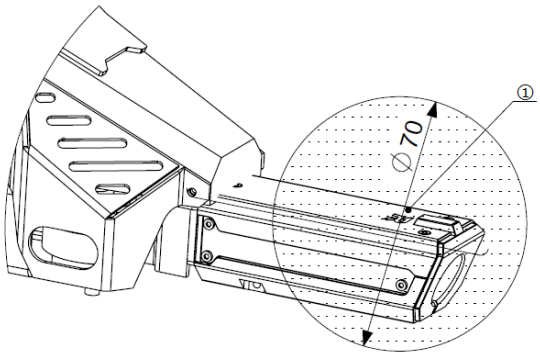


Figure 3-30 Speed Monitor Module Mounting Specification Graph

- Four M2.5 screw holes should be available to install the RoboMaster Laser Sight or the laser sight prepared by your own team.
- Do not look directly at the laser without eye protection. Safety goggles are recommended during operation.
- Do not block the phototube holes. Otherwise the initialization of the Speed Monitor Module may fail.
- Note that the Speed Monitor Module should be firmly secured to ensure that the module and the barrel do not move relative to each other during movements of the robot.
- The aviation connector cable of the Speed Monitor Module is close to the friction wheel. The cable should be protected from wear when used.
- Apart from two Speed Monitor Modules blocking each other, the blocked area for the light effects on both sides of the robot's Speed Monitor Module must be smaller than 1/5 of the area of the LED light bar.

3.7.3 Mounting Specification

To improve the aiming accuracy of robots, two securing methods for Speed Monitor Modules (17mm projectile) may be applied on the basis of the existing mounting specifications for Speed Monitor Modules (17mm projectile), as described below:

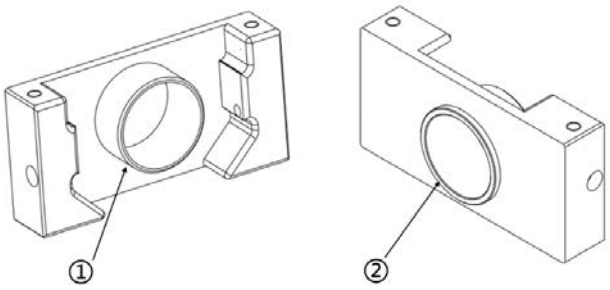
The three securing methods, including the Speed Monitor Module (17mm projectile) securing method described above, meet the mounting specifications for Speed Monitor Modules (17mm projectile). Teams may choose to adopt any one of the securing methods.

3.7.3.1 Securing Method 1

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 barrel.

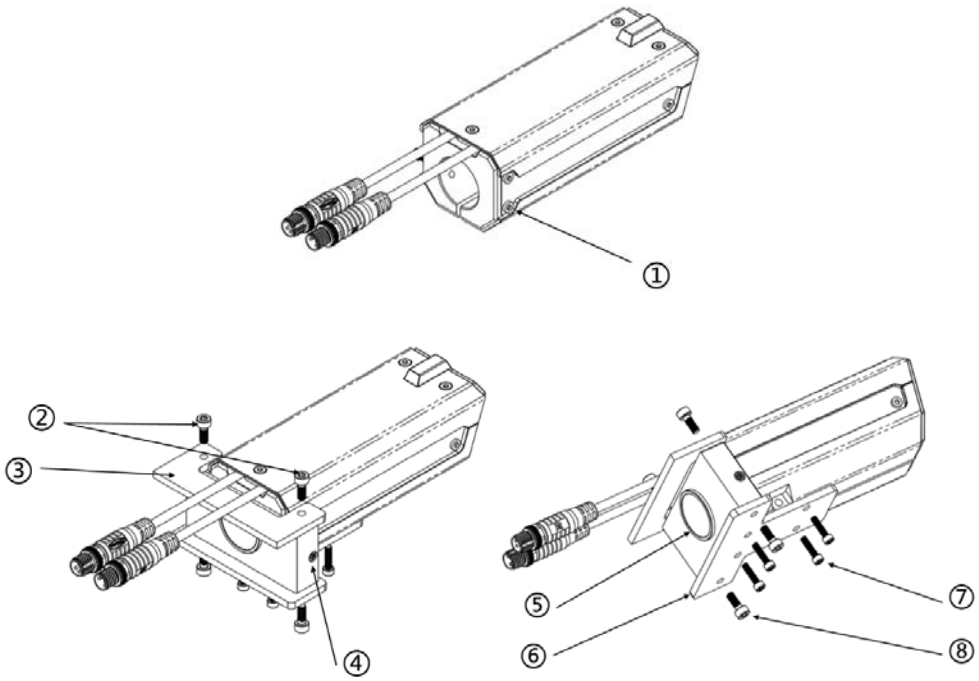
See Appendix 1 - Drawing of Transfer Block for Speed Monitor Module (17mm projectile) for the drawing of a transfer block. Its 3D model can be downloaded from the Speed Monitor Module product page on RoboMaster's official website as a reference.

The reference graph for a transfer block is shown below:



[1] Front Protrusion [2] Back Protrusion

Figure 3-31 17mm Transfer Block Graph



[1]	M2.5 Securing Screw for LED Light Bar	[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 Screws [8] M3 Screws

Figure 3-32 Graph for Securing Method for 17mm Transfer Block

Mounting Steps for Securing Method 1:

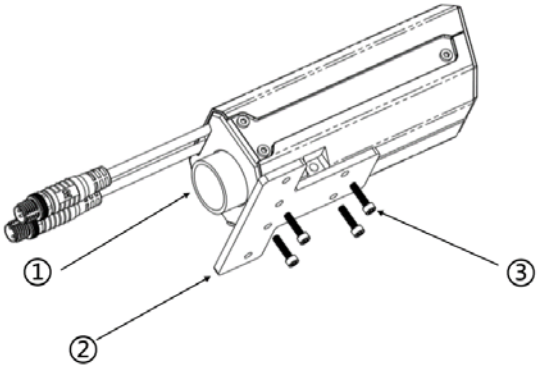
1. Remove the M2.5 screw on each LED light bar on both left and right of the Speed Monitor Module. The position of one side is as shown in [1] in the figure below.
2. Use two M2.5 x14 screws to secure the transfer block on the Speed Monitor Module, through the securing holes on both left and right sides (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.

⚠

- The back 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 to be removed as in Step 1 to secure the transfer block and the Speed Monitor Module, 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.

3.7.3.2 Securing Method 2

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



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

Figure 3-33 17mm Short Barrel Mounting Graph

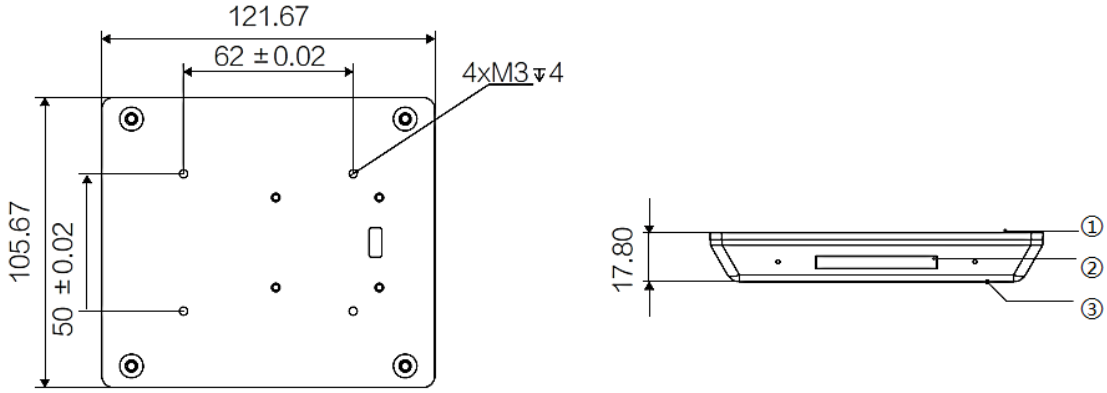
Mounting Steps for Securing Method 2:

1. Insert the Speed Monitor Module into the short barrel.
2. Use four M2.5 screws to secure the robot's original board part 1 on the bottom of the Speed Monitor Module.

- The length of the Speed Monitor Module's barrel inserted must not be more than 23 mm, to avoid blocking the speed-monitoring phototube.
- The outer diameter of the barrel should preferably be kept within the range of 21 mm +0.05. A barrel diameter that is too small will create a bigger gap between the outer wall of the barrel 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, therefore increasing 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.

3.8 Installing the RFID Interaction Module

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

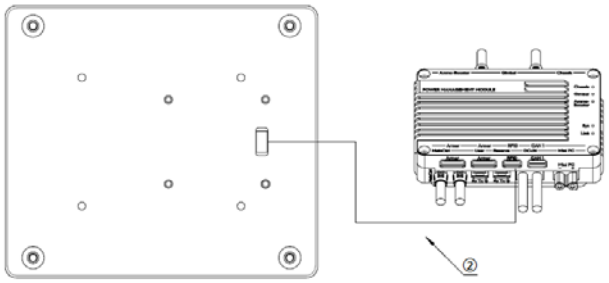


[1] Back [2] LED Light Indicator [3] Front

Figure 3-34 RFID Interaction Module Graph

3.8.1 Mounting Steps

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



[1] 4-pin Cable

Figure 3-35 RFID Interaction Module Cable Connection Graph

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

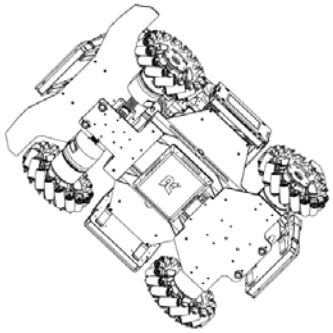


Figure 3-36 RFID Interaction Module Mounting Graph

3.8.2 RFID Interaction Module Card

RFID Interaction Module Cards are functional cards to unlock levels and tools. They are buried 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 bonuses.

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

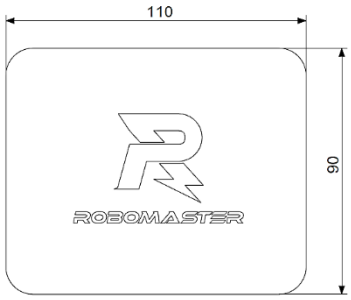
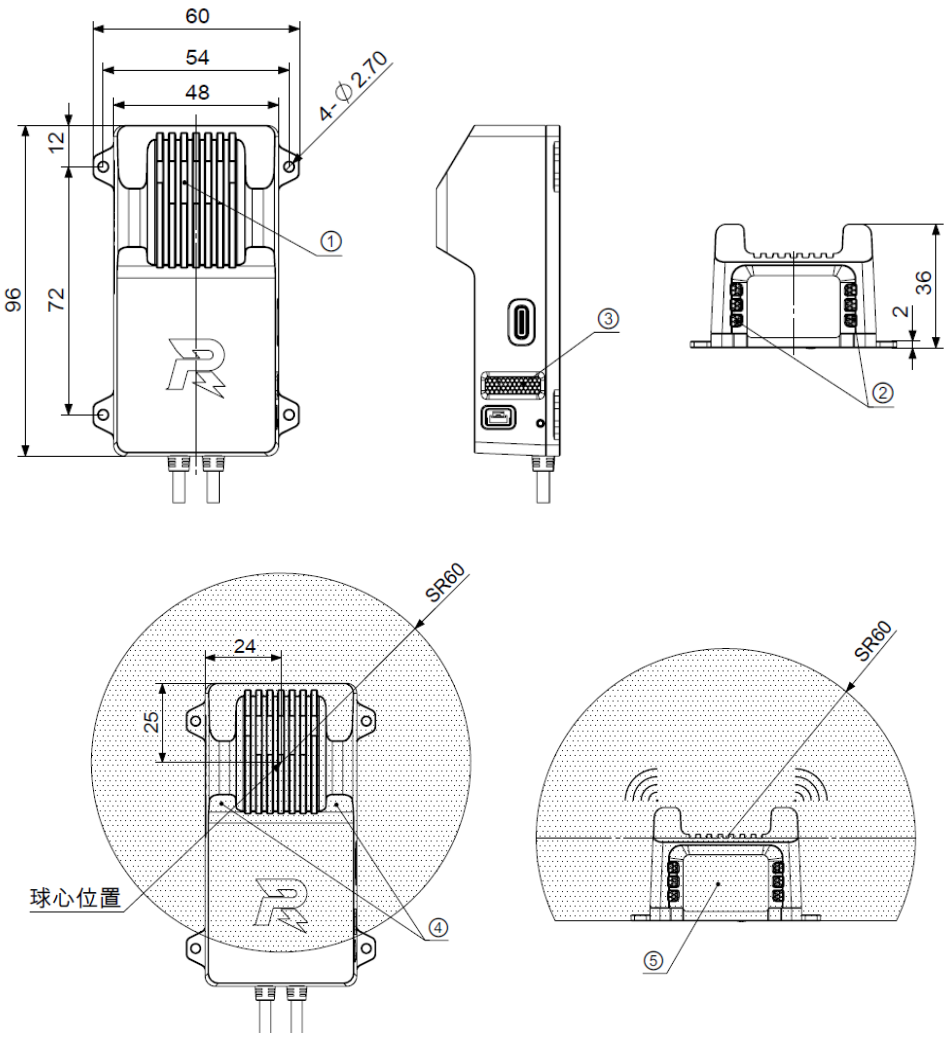


Figure 3-37 RFID Interaction Module Card Graph

⚠ Ensure that the logo side of the RFID Interaction Module is not blocked by any metal objects, and that the side without a logo is free of interference from strong currents or high-frequency signals (such as motor cables, RoboMaster Center Board and CAN cables). The effective detection distance of the RFID Interaction Module is 100 mm (±5%). The actual detection distance after mounting is subject to testing. If the effective detection distance has reduced, please check whether the module is installed properly.

3.9 Video Transmitter Module (Transmitter) Mounting Specification

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



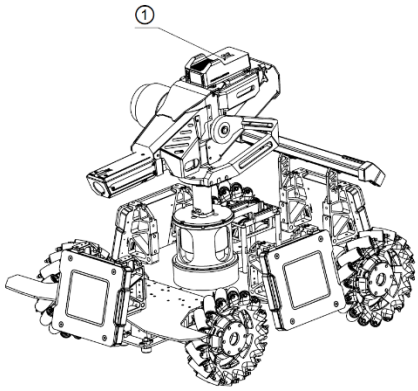
[1] Air Inlet [2] Air Inlet [3] Air Outlet

[4] Antenna [5] Camera

Figure 3-38 Video Transmitter Module (Transmitter) Graph

3.9.1 Mounting Steps

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



[1] Video Transmitter Module (Transmitter)

Figure 3-39 Video Transmitter Module (Transmitter) Mounting Graph

2. Use an aviation connector cable to connect the aviation plug of the Camera Video Transmitter Module (Transmitter) to the aviation plug on the Video Transmitter port on the Power Management Module.

3.9.2 Mounting 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.

S69 When mounting, the inlet and outlets of the Transmitter must not be blocked.

S70 As the Transmitter's antenna is located at the top of the Module, the top should not be blocked by any metal.

S71 The circular center of the mounting should be the center as shown in the Video Transmitter Module (Transmitter) graph. 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.

S72 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.

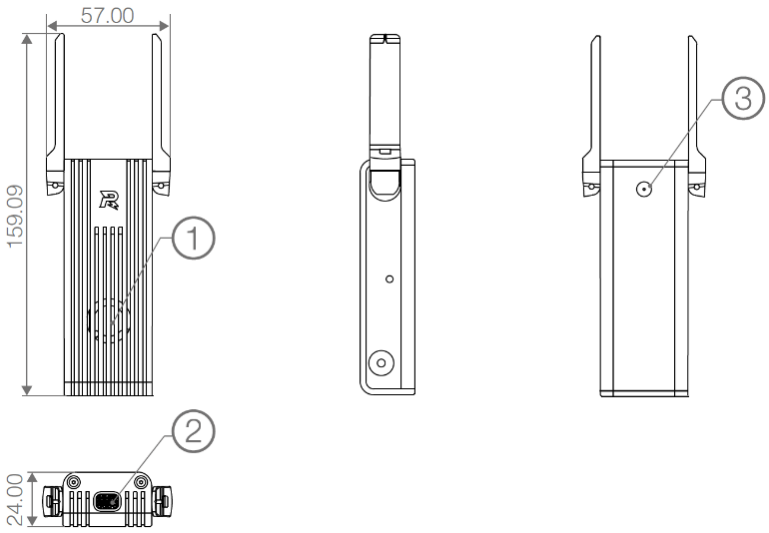
The Video Transmitter Module Receiver should be secured using self-purchased mounting clamps. The securing position can be on a monitor or other support structure. However it must be ensured the distance of the securing position is no less than 1 m from the ground and that it is not blocked by any metal.

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

The rotation angle for the antenna is 0°-190°. Please fold it gently. The distance to the antenna's center point should

preferably be ≥60 mm.

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

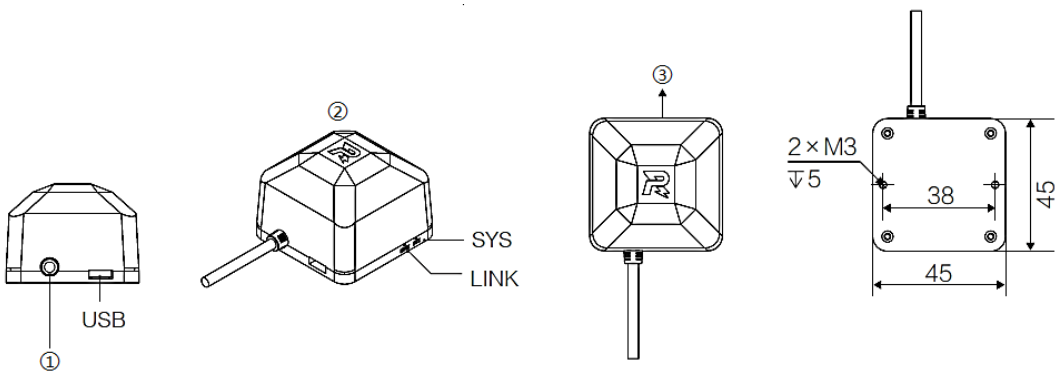


[1] Air Outlet [2] Air Inlet [3] Inch-based Threaded Hole 1/4 20×6

Figure 3-40 Video Transmitter Module (Transmitter) Graph

3.10 Mounting Positioning System Module

Drill mounting holes at specified positions according to the size of the Positioning System Module.



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

Figure 3-41 Positioning System Module Graph

3.10.1 Mounting Steps

1. Use two M3 screws to secure the Positioning System Module at a specific position. The front of the Positioning System Module must be aligned with the front of the robot, and 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:

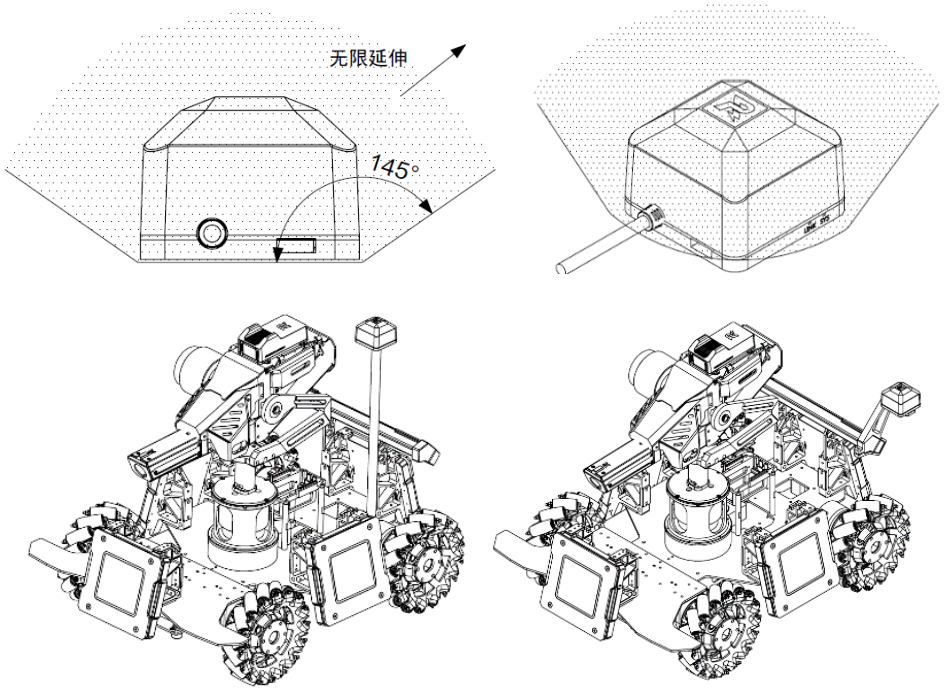
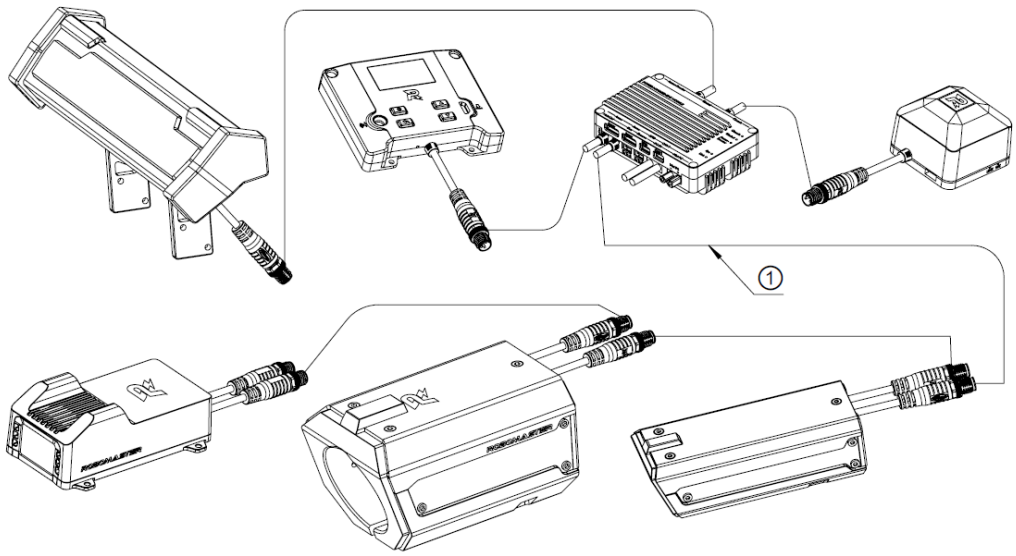


Figure 3-42 Positioning System Module Graph

> ⚠ 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.

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.



[1] Aviation Connector Cable

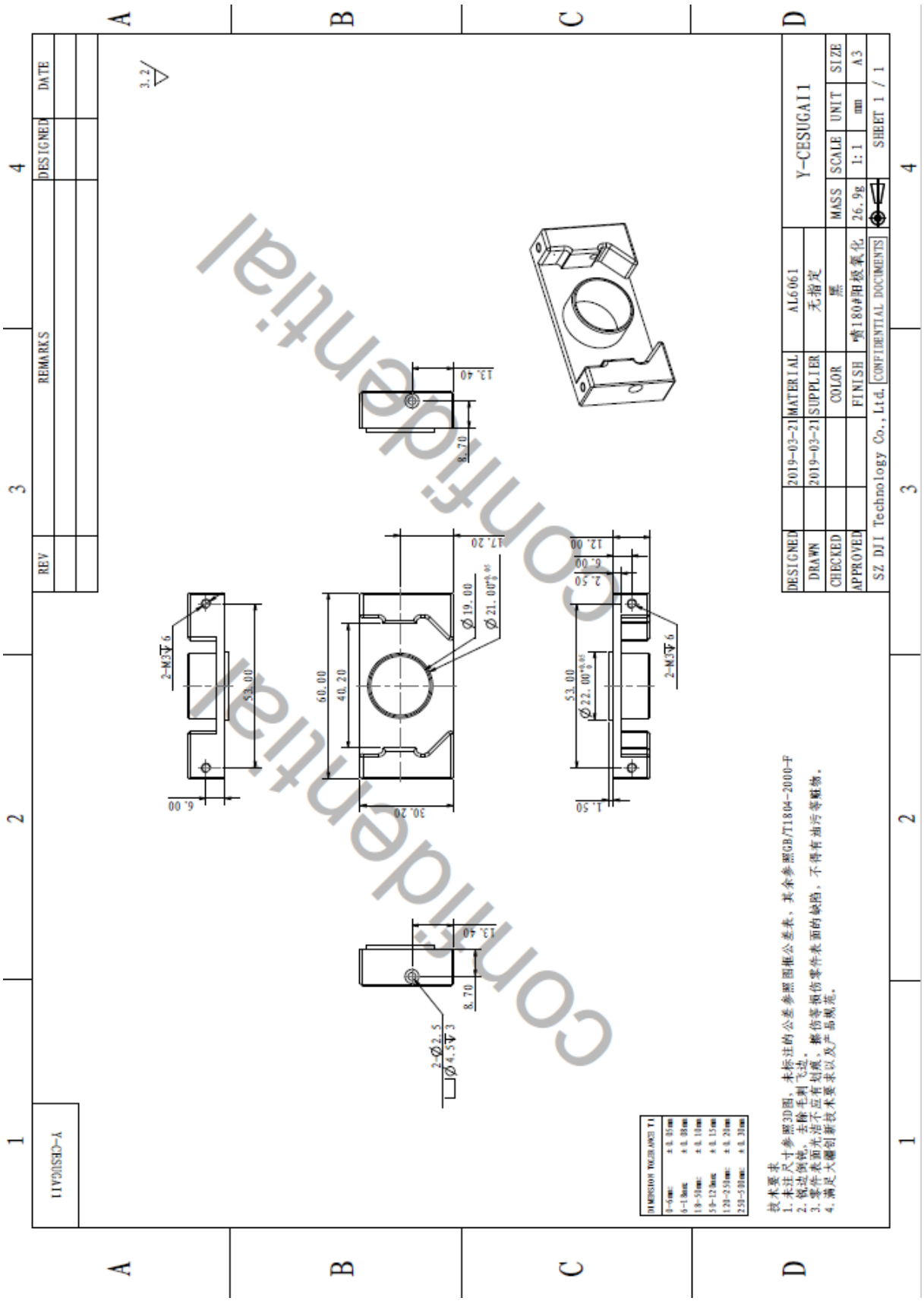
Figure 3-43 Positioning System Module Cable Connection Graph

- 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.
- The Positioning System Module must be at a distance of at least 100 mm 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.

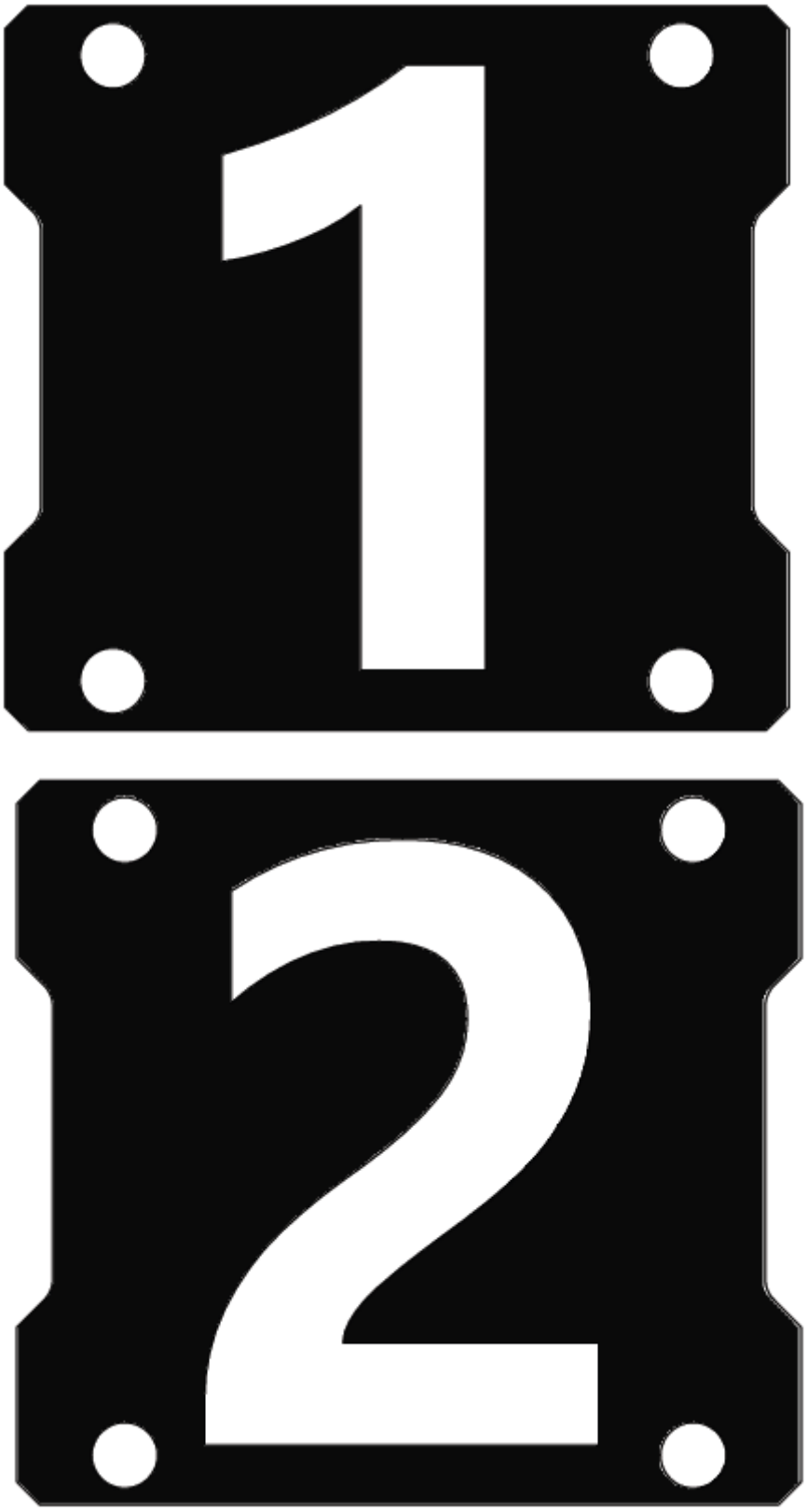
3.11 Mounting Energy-charging Device

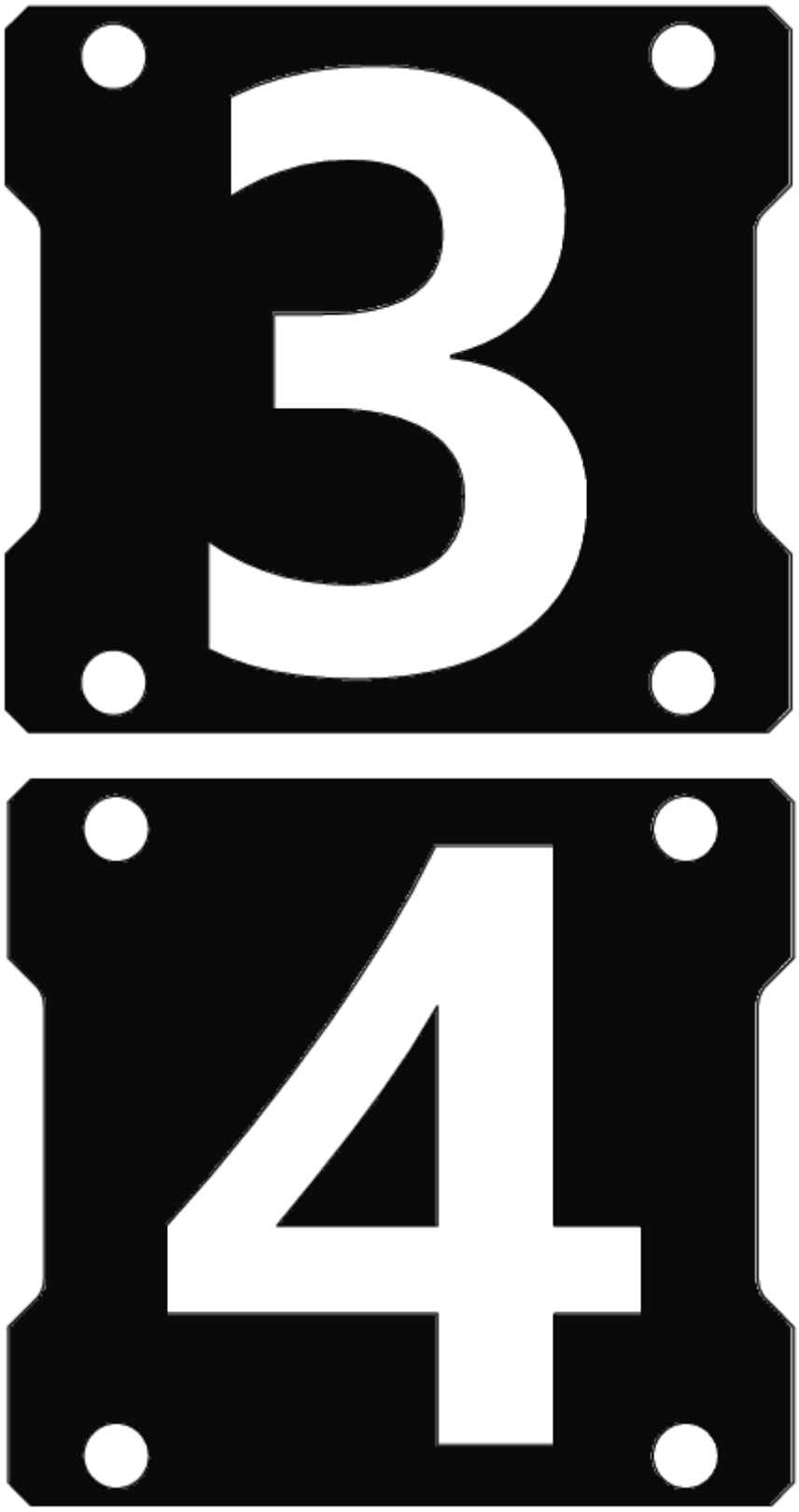
The specific drawings and mounting methods for an Energy-charging Device will be updated subsequently.

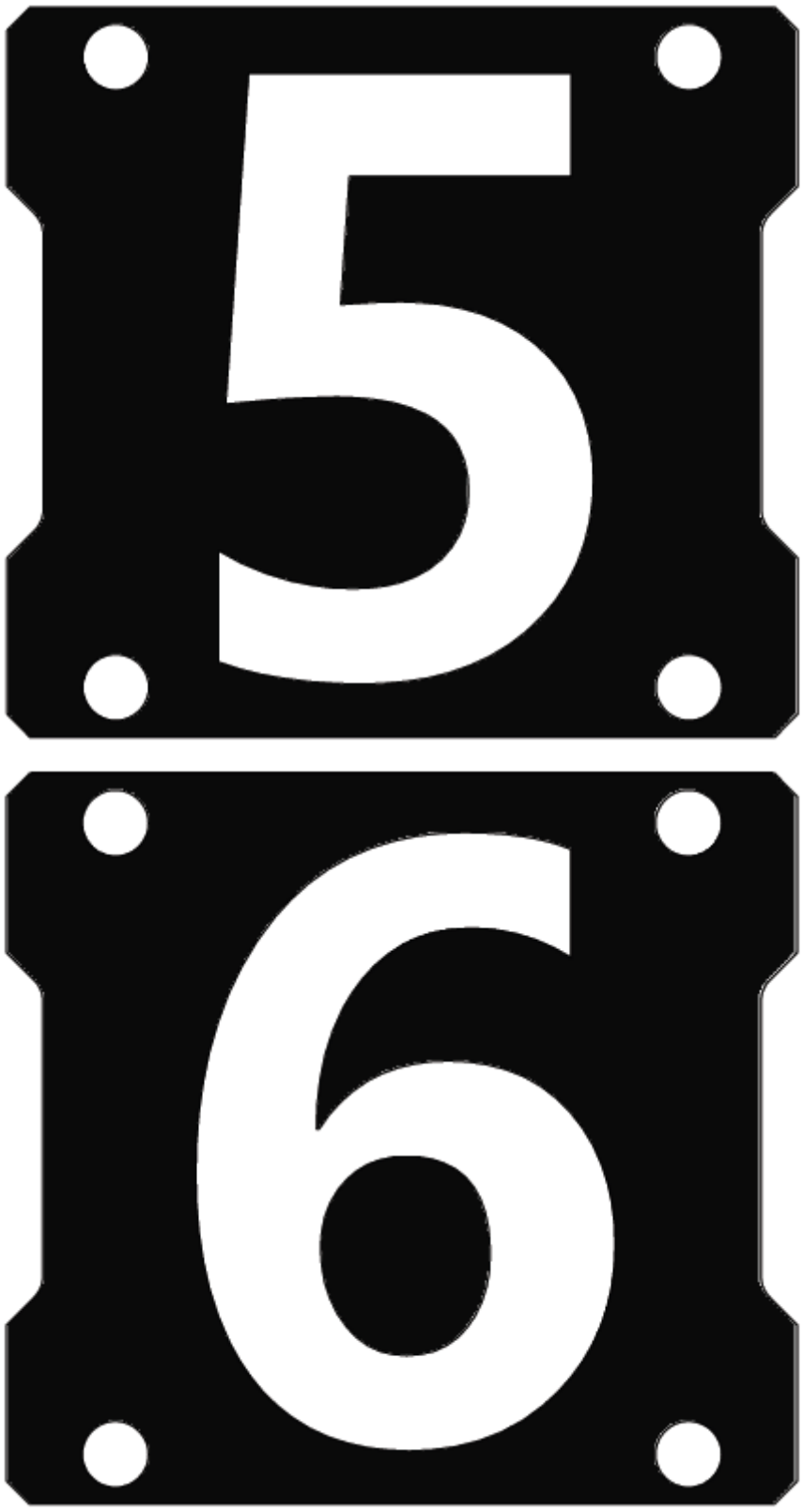
Appendix 1 Drawing of Transfer Block for Speed Monitor Module (17mm projectile)

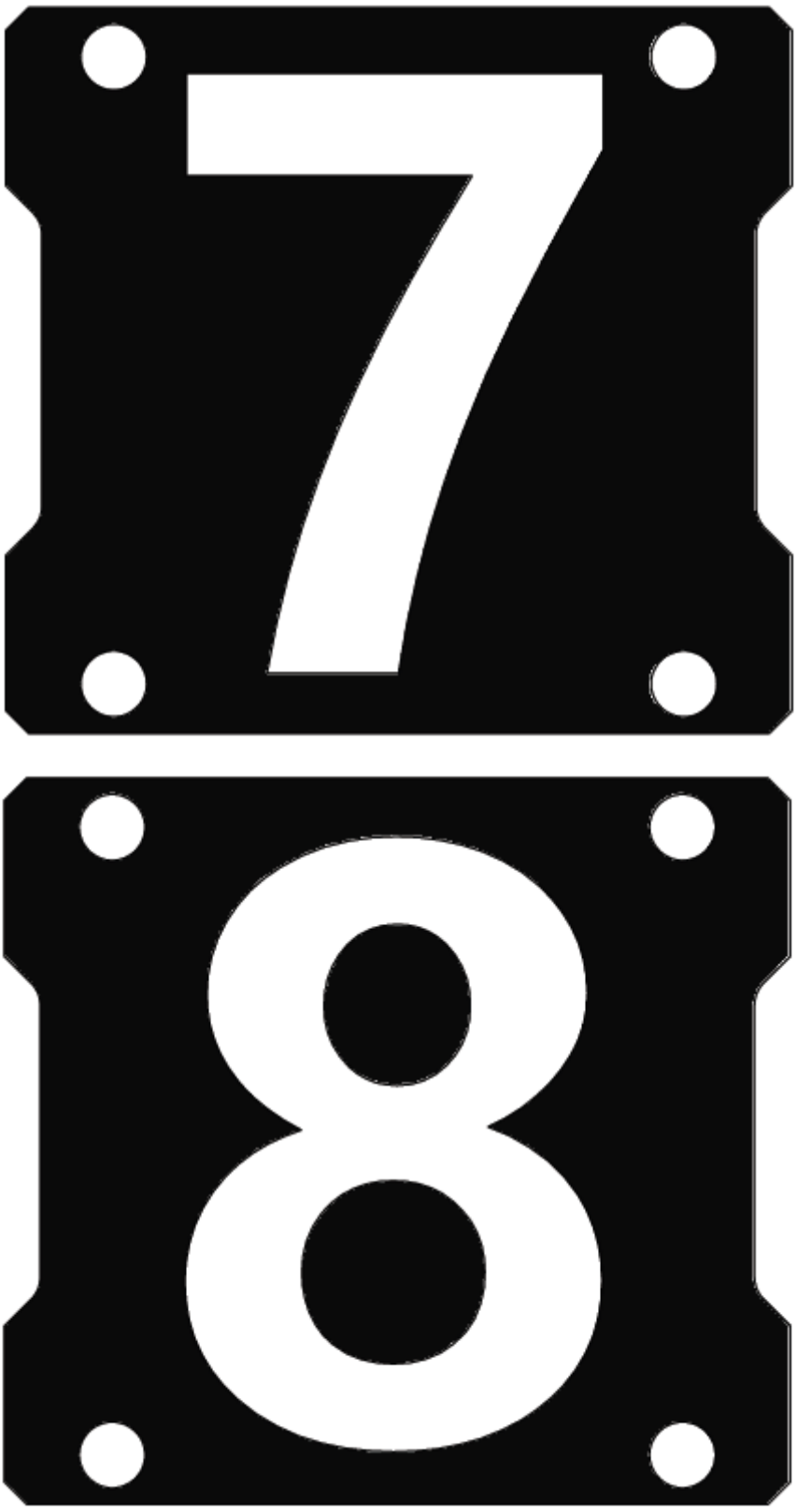


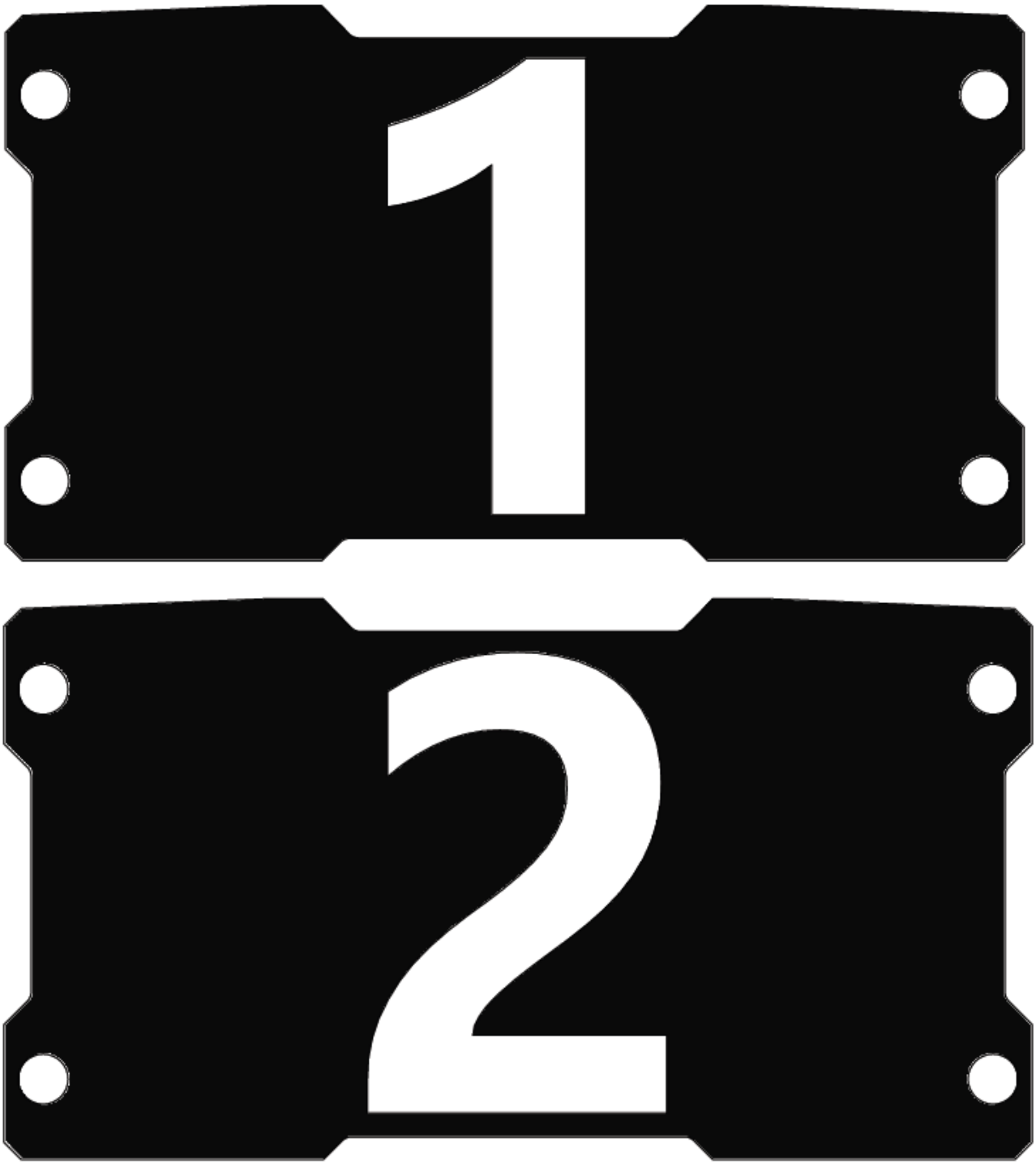
Appendix 2 Reference Drawings

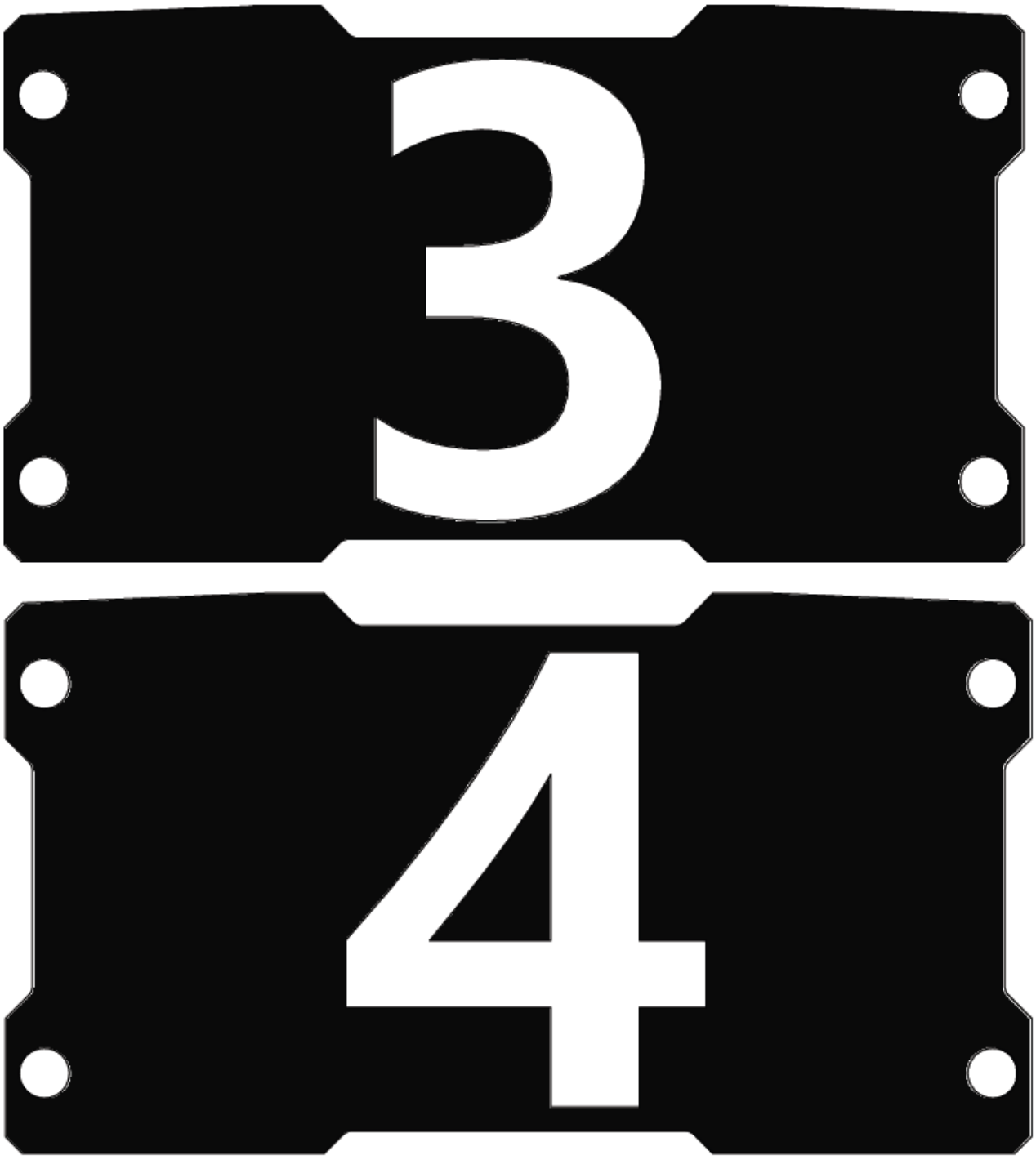


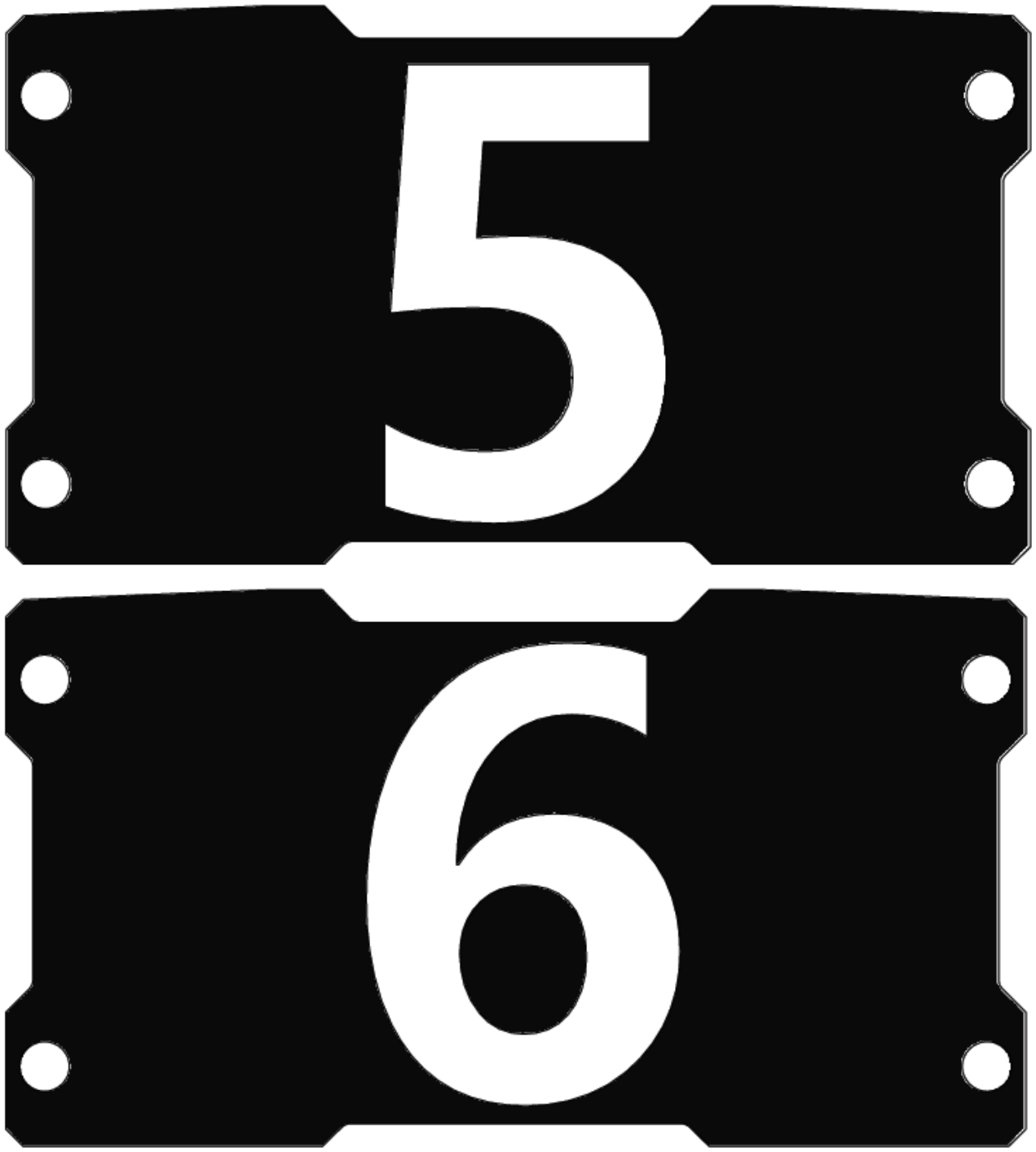


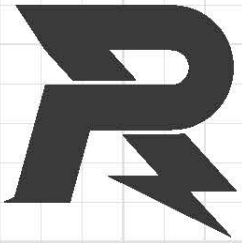












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