

V1.0

The background of the cover features a light gray grid. Overlaid on the grid are two line art illustrations. The upper illustration is a top-down view of a quadcopter drone with four propellers. The lower illustration is a side view of a robot arm with a camera lens and a sensor array. The text is positioned in the lower right area of the cover.

ROBOMASTER 2022
YOUTH CHAMPIONSHIP
ROBOT BUILDING
SPECIFICATIONS MANUAL

Prepared by the RoboMaster Organizing Committee
Released in December, 2021

Using this Manual

Legend

 Prohibitions	 Important notes	 Hints and tips	 Definitions and references
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Release Notes

Date	Version	Changes
Dec 20, 2021	V1.0	First release

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1. Foreword

Participating robots are required to meet all specifications described in this document, or they will not pass the Pre-Match Inspection. If any safety incident has occurred due to a violation of rules, the RoboMaster Organizing Committee (“RMOC”) reserves the right to hold the violating party legally responsible. Any dispute arising from this Specifications 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.

2. Technical Specifications

2.1 General Technical Specifications

2.1.1 Energy Source



- The use of combustion engines, explosives, hazardous chemicals, etc. is forbidden
 - Connection to mains electricity is prohibited in the Competition Area.
-

S1 Robots can be powered only by electricity.

S2 The battery product designated for use in this competition season is the RoboMaster S1 Intelligent Battery manufactured by SZ DJI Technology Co., Ltd. (except for Aerial Robots).



In order to ensure the safety of the competition, the Referee System used in this competition season can only be used after communicating with the RoboMaster S1 Intelligent Battery. Therefore, this battery has been selected as the designated battery product.

S3 The battery capacity of robots must satisfy the requirements of the building parameters for each robot.

2.1.2 Wireless Equipment

S4 Robots (except for Aerials) cannot carry any wireless equipment other than the Referee System Module.

2.1.3 Optical Equipment

S5 Robots must not be mounted with any illuminants other than those on the Referee System Module.

2.1.4 Vision Feature

On both sides of the Referee System Armor Module there must be clear LED 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 interferences around the venue.

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

S6 The Armor Module cannot be blocked.

S7 The recognition of visual tags by Armor Modules must not be interfered with by any means.



Armor visual tags include armor light bars and armor stickers.

S8 The robot must not be painted with patterns that are the same or similar to the visual tags on the Referee System.

2.1.5 Visual tag

S9 Standards cannot carry any visual tags, while Engineers and Aerials may only carry visual tags marked with “R”.

S10 The effective size of any **visual tag** carried by a robot must not exceed 75mm*75mm.

S11 The white frames of visual tags must remain visible to ensure stable visual recognition.

S12 Visual tags shall be made of hard and non-reflective materials, to avoid robots not being able to recognize the visual tags due to deformity or reflection.

2.1.6 Robot Numbering

During the pre-match inspection and competition, the RMOC staff will provide robots with their corresponding number stickers according to the robot numbering rules. For details on robot numbering, please refer to the [RoboMaster 2022 Youth Championship Rules Manual](#) (Chapter 1). Please see “Appendix 1 Drawings of Number Stickers”.

The following specifications must be followed when attaching a number sticker on a robot:

S13 The number sticker must correspond to the robot’s number according to the rules, and the digits and symbols must be pointing in the correct direction with no visible air pockets.

S14 Apart from the number stickers provided by the RMOC, no robot may carry any pattern similar to the number stickers on its Armor Module or other external structures.

S15 At least one number sticker must be clearly visible when the robot is viewed in a direct line of sight from any angle at a height of 350 mm from the ground.

S16 The kidney-shaped number sticker (see “ Appendix 1 Drawings of Number Stickers”) must be pasted on the kidney-shaped area formed by the armor lights.

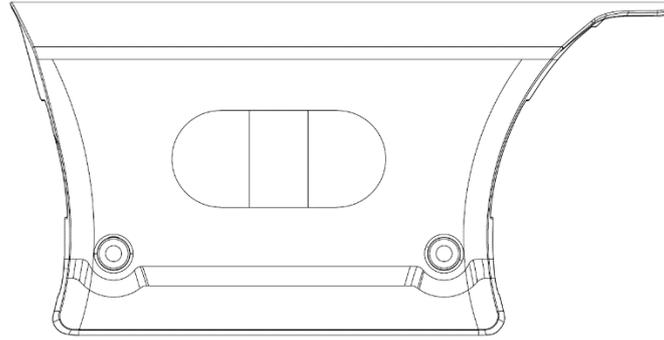


Figure 2-1 The location for the kidney-shaped number sticker

2.1.7 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:

S17 The lines of the robot must be neat and not exposed. Exposure that is unavoidable requires line protection using materials such as drag chains and cable managers.

S18 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.

S19 Fishing nets shall not be used as aesthetic design materials.

S20 Avoid sharp structures that may damage the site or harm any person.

Gloss:

S21 The gloss for where the robot's exterior armor surface is at a distance of no more than 50 mm from the edge of the Armor Module's LED lights must not exceed 20 Gs.

Paint Color:



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

S22 The proportion of the red or blue area on the exterior of a robot must not exceed 10%, with any single area unit smaller than 6 cm².

S23 A single 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 40mm*40mm. The school badges or team badges must be displayed prominently on a robot, and their distance to the Armor Module lights must not be less than 50 mm. In the case of non-compliance with the specifications, the pre-match inspector will require the team to correct

the positions or sizes of the school or team badges.

S24 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 exterior armor and conduct reliability tests, to avoid any violation of rules caused by breakage of the exterior armor from battles in the Competition Area.

2.1.8 Launching Mechanism

S25 Teams must use the official Launching Mechanism with the Speed Monitor Module.



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

S26 The robot shall be put on the ground horizontally with the barrel parallel to the ground, and the initial distance from the barrel’s axis to the ground must not exceed 19cm.

S27 The modification of Launching Mechanisms is strictly prohibited.

2.1.9 Miscellaneous

S28 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.

S29 Robots must not cause any bodily harm to any person.

S30 Only Engineers may be mounted with a grabbing mechanism.

2.2 Robot Technical Specifications

2.2.1 Standard Robot

The building parameters for Standard are as follows:

Table 2-1 Standard Building Parameters

Item	Limit	Remarks
Maximum Total Power Supply Capacity (Wh)	26	-

Item	Limit	Remarks
Maximum Power Supply Voltage (V)	12.6	-
Launching Mechanism	No more than one Launching Mechanism can be installed.	-
Projectile Supply Capability	Can only receive projectiles	-
Maximum Weight (kg)	8	Including the Referee System's weight
Maximum Size (mm, L*W*H)	400*400*400	Its orthographic projection on the ground should not exceed a 400*400 rectangle
Referee System	Front Armor Module, Left Armor Module, Right Armor Module, Rear Armor Module, Video Transmitter Module, Motion Control Module, and Speed Monitor Module (already included in the official Launching Mechanism)	-



L*W*H: Length*Width*Height

2.2.2 Engineer Robot

The building parameters for Engineer Robots are as follows:

Table 2-2 Engineer Robot Building Parameters

Item	Limit	Remarks
Maximum Total Power Supply Capacity (Wh)	26	-
Maximum Power Supply Voltage (V)	12.6	-
Launching Mechanism	No Launching Mechanism can be installed	-
Grabbing Mechanism	<ul style="list-style-type: none"> ● The Grabbing Mechanism cannot damage Battlefield Components. In particular, it cannot use serrated or sharp-edged structures to interact with projectile containers, which will cause irreversible deformation to the projectile containers. ● Engineers may only be mounted with one grabbing mechanism (the only mechanism for grabbing projectile containers and obtaining large projectiles from the Resource Island). The robot must obtain each projectile containers or large projectile using the same contact surface. <p>Example 1: If an Engineer uses a mechanical claw brought by an EP robot to grab a projectile container, then uses a rod to drop the container onto its own team’s robot or the battlefield (with the rod’s contact surface touching the container), the Engineer will be deemed as having two grabbing mechanisms.</p> <p>Example 2: If an Engineer uses a mechanical claw brought by an EP robot to grab a projectile container, then uses another mechanical claw to grab a large projectile (with the other claw’s contact surface touching the large projectile), the Engineer will be deemed as having two grabbing mechanisms.</p>	-
Maximum Weight (kg)	10	Including the Referee System’s weight

Item	Limit	Remarks
Maximum Initial Size (mm, L*W*H)	450*450*350	Its orthographic projection on the ground should not exceed a 450*450 square area
Maximum Expansion Size (mm, L*W*H)	650*650*650	Its orthographic projection on the ground should not exceed a 650*650 square area
Referee System	Front Armor Module, Left Armor Module, Right Armor Module, Rear Armor Module, Video Transmitter Module, and Motion Control Module	-



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

2.2.3 Aerial Robot

The building parameters for Aerial Robots are as follows:

Table 2-3 Aerial Robot Building Parameters

Item	Limit	Remarks
Maximum Total Power Supply Capacity (Wh)	4.2	Teams should reasonably evaluate and fully test whether the propulsion system and power supply system of an Aerial can meet the requirements of loading and combat, to prevent safety incidents or accidents during the competition.

Item	Limit	Remarks
Maximum Power Supply Voltage (V)	4.35	-
Propeller Guard	Rotor blades must not be exposed.	-
Positioning	Must possess a positioning function	Able to position location and height indoors
Maximum Weight (kg)	0.2	-
Maximum Size (mm, L*W*H)	180*180*150	Its orthographic projection on the ground should not exceed a 180*180 square area
Referee System	No Referee System installed	-
Motor	<ul style="list-style-type: none"> ● Type: Coreless Motor ● Qty.: Maximum 4 	-
Maximum Size of Rotor Blades (inch)	4	-

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 the information of each participating robot such as its HP level, and transmits the real-time information to the competition's engine. It also automatically determines the outcome of the competition, ensuring the fairness of the competition.

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
Video Transmitter Module	The Video Transmitter Module consists of a Smart Central Control and a camera, and is connected to the client in the Operator Room via a wireless network. 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.
Speed Monitor Module	<p>The Speed Monitor Module is used to detect the initial firing speed and frequency of projectiles.</p> <hr/> <p> The Speed Monitor Module is already built into the Launching Mechanism, and need not be mounted separately by teams.</p>
Armor Module	The Armor Module is a robot's damage sensor system for detecting the projectile attacks received by the robot.
Motion Control Module	The Motion Control Module connects the Armor Module, power source, and Video Transmitter Module hub, and is able to transmit the Operator's commands to the robot through the UART interface.

3.2 Configuration of Robot Referee System

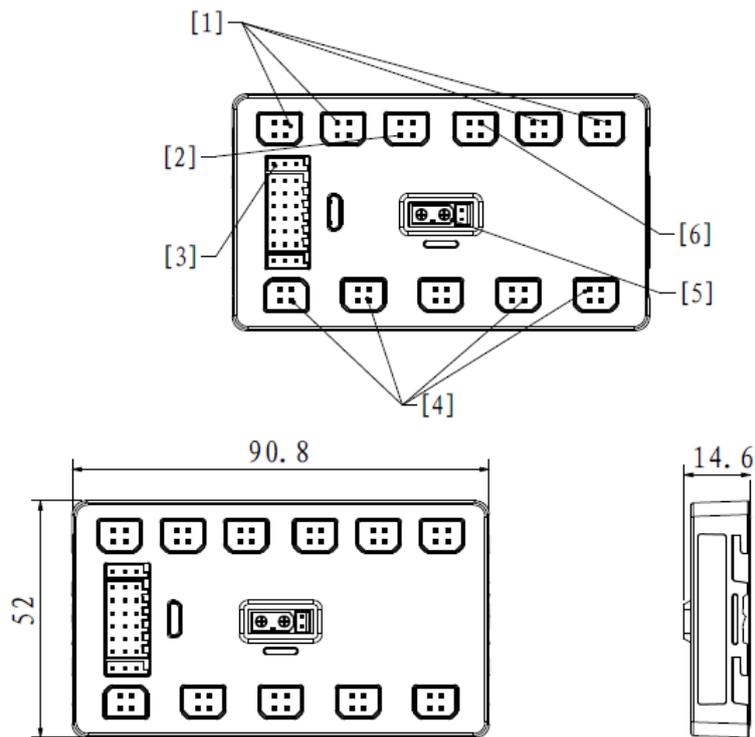
The configuration of Referee System Modules for each robot is as follows:

Table 3-2 Configuration of Robot Referee System Modules

Type Qty.	Motion Control Module	Armor Module	Video Transmitter Module	Speed Monitor Module
Standard	1	4	1	1
Engineer	1	4	1	0
Aerial	0	0	0	0

3.3 Installation of Motion Control Module

Refer to the size of the Motion Control Module, and pre-allocate a mounting area on the robot.



- [1] M BUS interface
- [2] CAN BUS interface for Smart Central Control
- [3] UART interface
- [4] CAN BUS interface for Armor Module
- [5] POWER interface
- [6] CAN BUS interface for Launching Mechanism

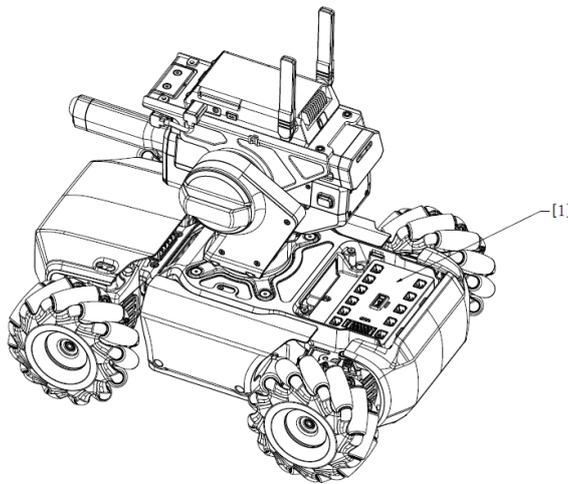
Figure 3-1 Motion Control Module



The CAN BUS interfaces on each Referee System Module are equivalent interfaces. The installation methods described in this document are suggestions only. You may choose to connect the devices in any suitable way as required by actual operation.

3.3.1 Installation Steps

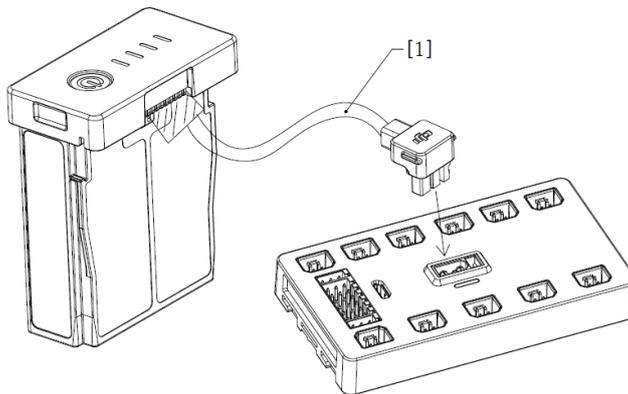
1. Fix the Motion Control Module in place on the corresponding location on the robot.



[1] Motion Control Module

Figure 3-2 Motion Control Module Installation Diagram

2. Use the power adapter from the package and connect the Motion Control Module to the battery.



[1] Power adapter cable

Figure 3-3 Motion Control Module Cabling Diagram

3.3.2 Installation Requirements

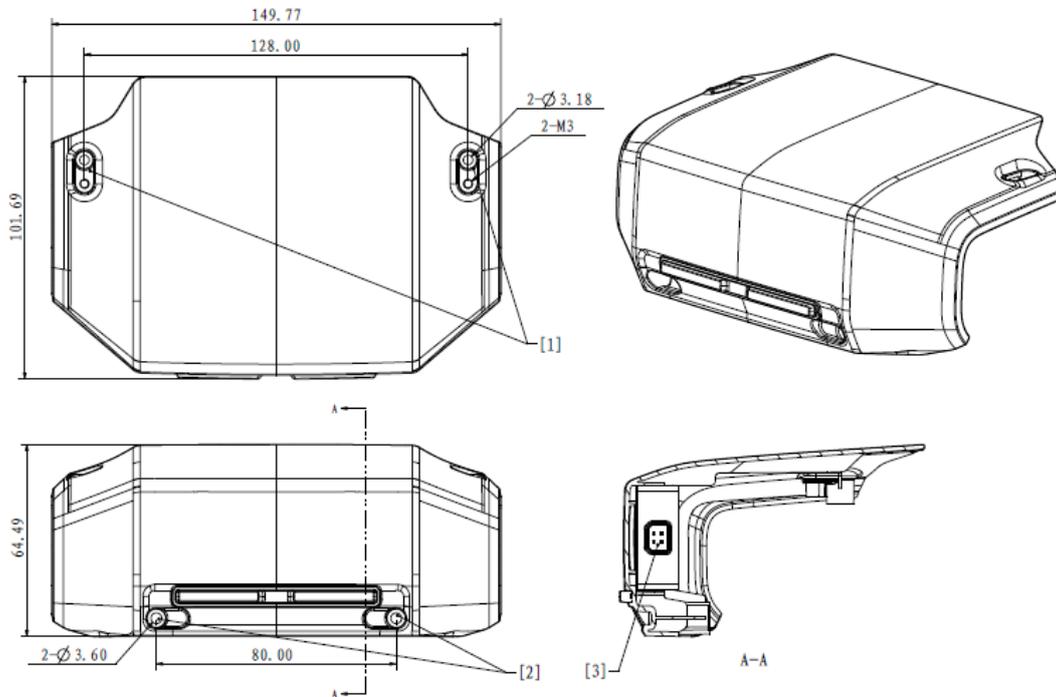
The installation requirements for the Motion Control Module are as follows:

S31 Ensure the upper surface of the Motion Control Module is level and facing upwards when the robot is in normal working condition.

S32 Ensure the Motion Control Module is fixed securely inside the robot, with no relative movement when in motion.

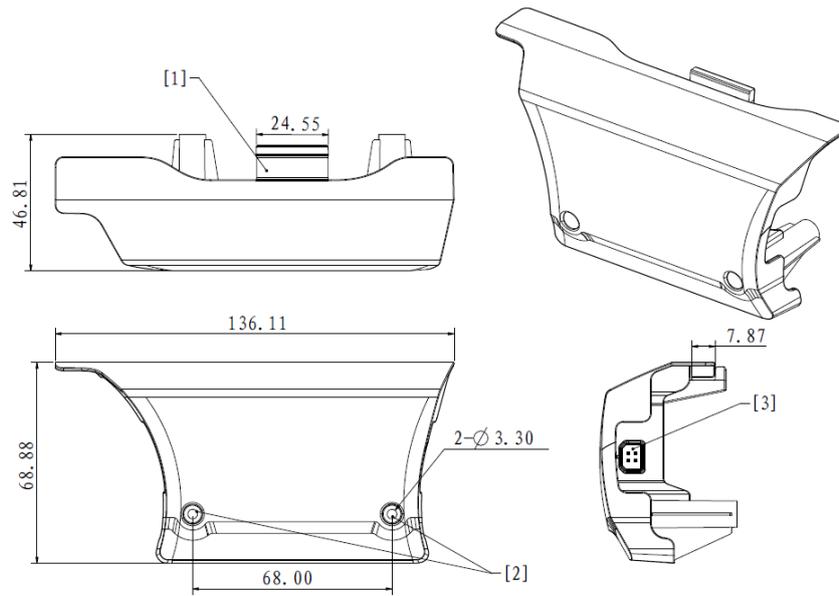
3.4 Armor Module Mounting Specifications

The Armor Module consists of the Front, Right, Left and Rear Armor Modules, as shown below:



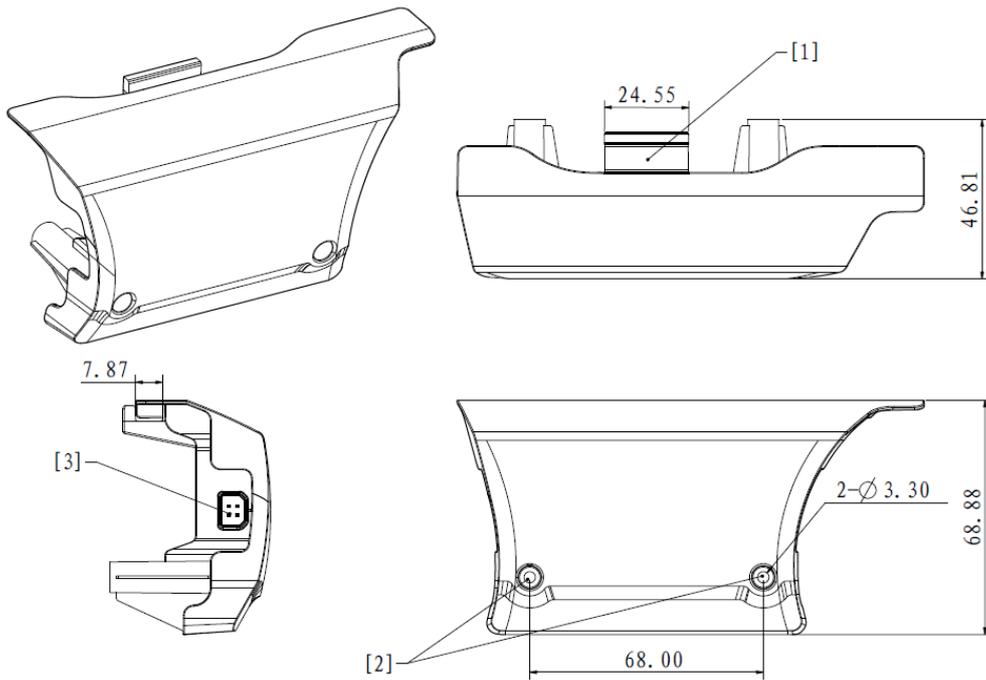
[1] Top mounting holes [2] Side mounting holes [3] Armor interface

Figure 3-4 Front Armor Module Diagram



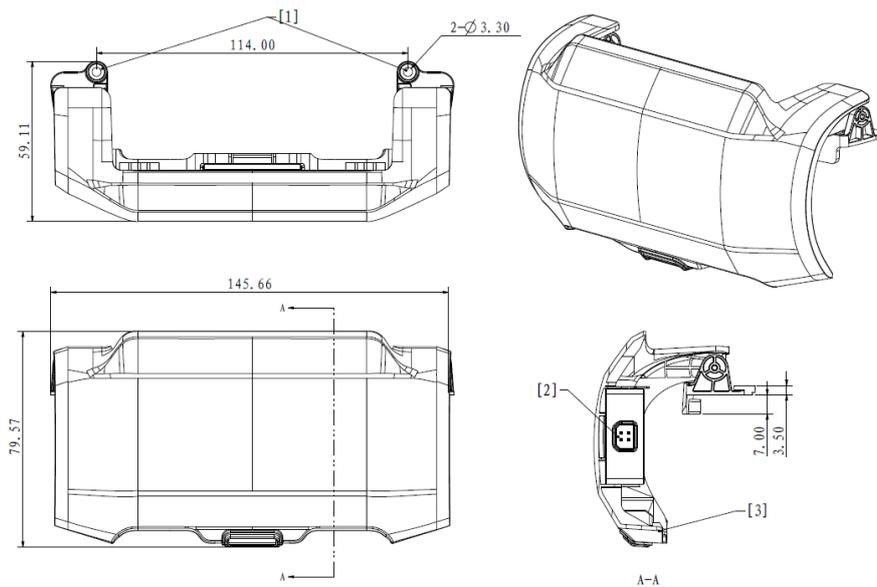
- [1] Auxiliary mounting groove [2] Mounting holes [3] Armor interface

Figure 3-5 Right Armor Module Diagram



- [1] Auxiliary mounting groove [2] Mounting holes [3] Armor interface

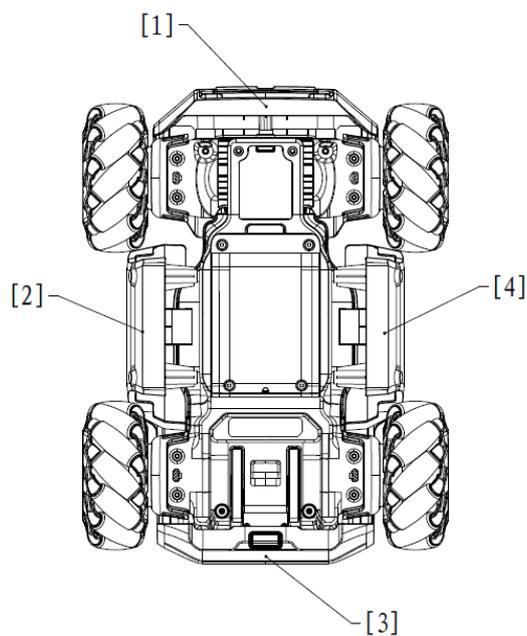
Figure 3-6 Left Armor Module Diagram



[1] Mounting holes [2] Armor interface [3] Flexible buckle

Figure 3-7 Rear Armor Module Diagram

3.4.1 Installation Steps



[1] Front Armor Module [2] Right Armor Module [3] Rear Armor Module [4] Left Armor Module

Figure 3-8 Armor Module Mounting Diagram

Use the data cable provided in the package to connect each Armor Module to the CAN BUS interface of the Motion Control Module.

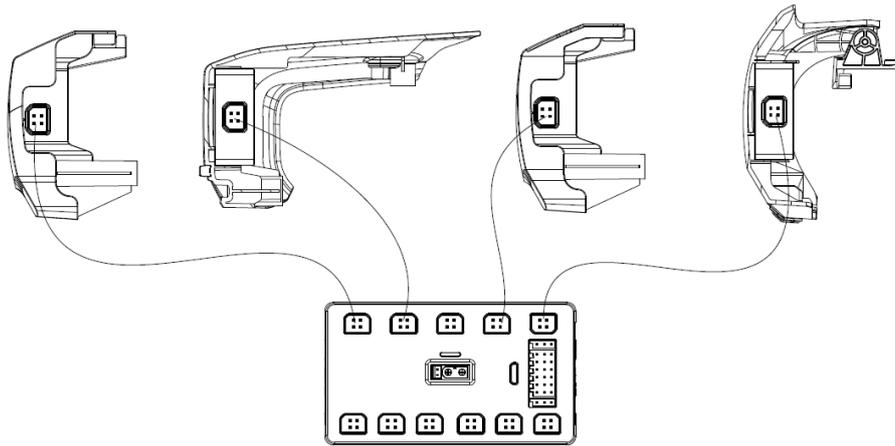


Figure 3-9 Armor Module Cabling Diagram

3.4.2 Installation Requirements

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



When designing the structure of a robot, sufficient consideration must be given to the level of impact received by the Rear Armor. If impact on the Rear Armor causes the buckle to fall off and block the Armor, penalties will be imposed by the referee as per the competition rules.

S33 It is forbidden to block the areas within 90° from the left, right, top and bottom edges of the attack surfaces on the Front and Rear Armor Modules of a robot. It is forbidden to block the areas within 50° from the left and right edges and 75° from the top and bottom edges of the attack surfaces on its Left and Right Armor Modules.

S34 For an Engineer Robot, its Front Armor can be blocked but only by the necessary parts of its projectile-grabbing mechanism.

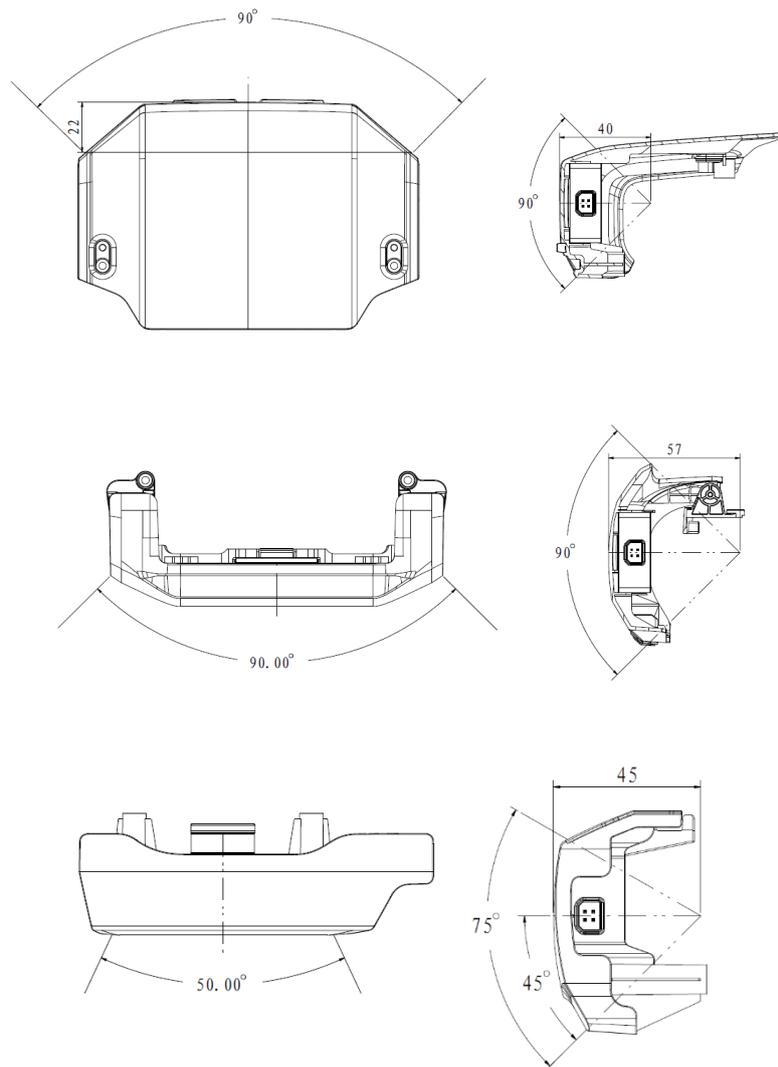
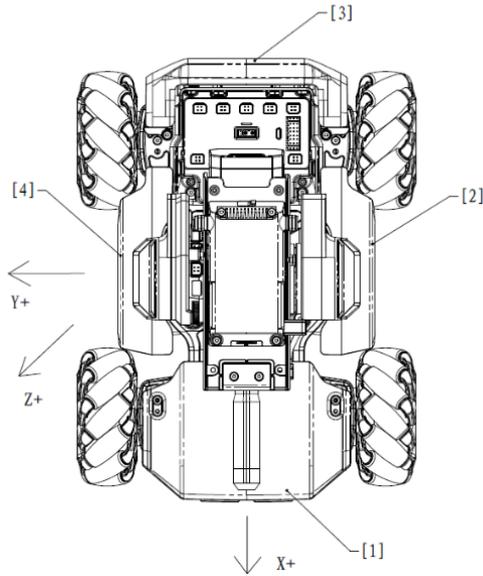


Figure 3-10 Armor Module Mounting Diagram

3.4.3 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:

Based on the robots' Armor Module mounting requirements, the coordinates of a robot are established using the positive front-facing direction of the robot's Video Transmitter Module at the start of the match as the X-axis positive direction, and the positive direction pointing towards the earth's center as the Z-axis positive direction. 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] Front Armor Module [2] Left Armor Module [3] Rear Armor Module [4] Right Armor Module

Figure 3-11 Armor Module ID Configuration Diagram

Table 3-3 Robot Armor Module ID Configuration

Axis	Module ID
X	<ul style="list-style-type: none"> ● Positive direction: Front ● Negative direction: Rear
Y	<ul style="list-style-type: none"> ● Positive direction: Right ● Negative direction: Left

3.4.4 Mounting Specifications

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:

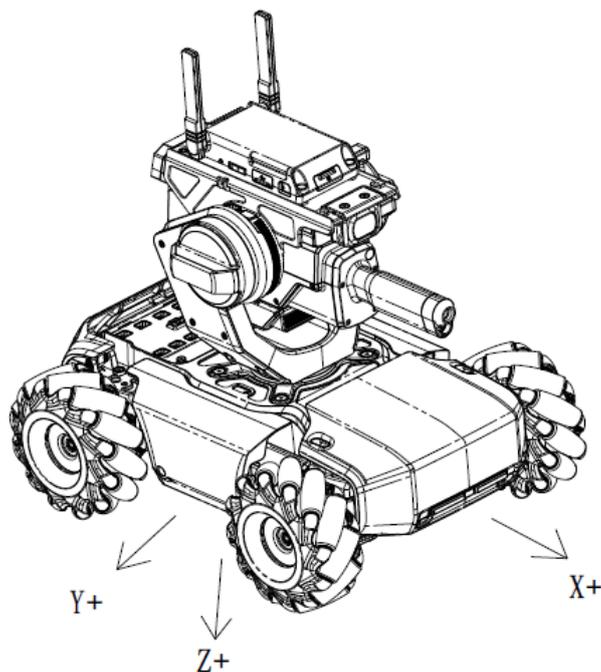


Figure 3-12 Robot Coordinate System

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 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

S35 When an Armor Module is mounted on a robot, the Armor Module must be connected firmly. The LED plane of the Armor Module must be perpendicular to the XY plane, so that the normal vector line of the impact surface plane of the Armor Module is perpendicular to the negative Z-axis line. The two lines of the LED on the Armor Module must be kept parallel to the XY plane. Define the projection of the normal vector of the mounted Armor Module's attack surface on the XY plane as the direction vector of the Armor Module. The direction vectors of the four Armor Modules must be in a one-to-one correspondence to the positive X-axis, negative X-axis, positive Y-axis, and negative Y-axis of the robot's body coordinate system, and the angular error between a direction vector and its corresponding coordinate axis cannot exceed 5° .

S36 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 central point line of the Armor Modules mounted on the X-axis and the geometric central point line of the Armor Modules mounted on the Y-axis should be perpendicular to each other. The offset of the Armor Modules from the geometric center of the robot must not exceed 50 mm on the X or Y-axis.

Rigid Connection

S37 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.

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 Armor Modules are as follows:

S38 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.

S39 Before and after the transformation of any Ground Robot, the distance between the lower edges of its Armor Modules and the ground must be within 30 mm – 50 mm.

3.5 Video Transmitter Module Mounting Specifications

The Video Transmitter Module consists of a Smart Central Control, camera cable, and camera, as shown below:

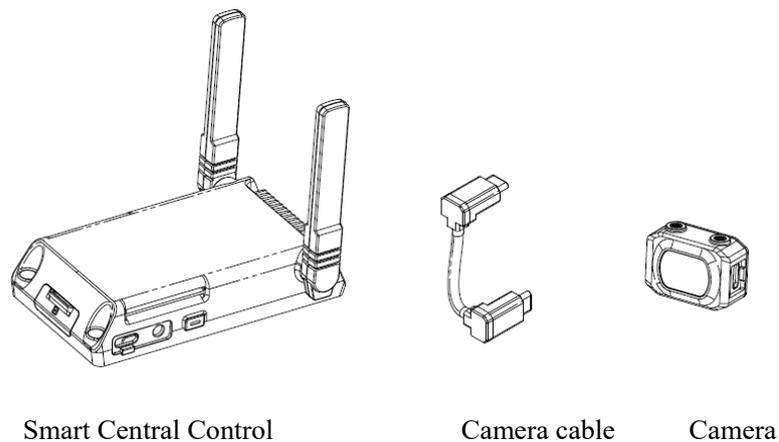
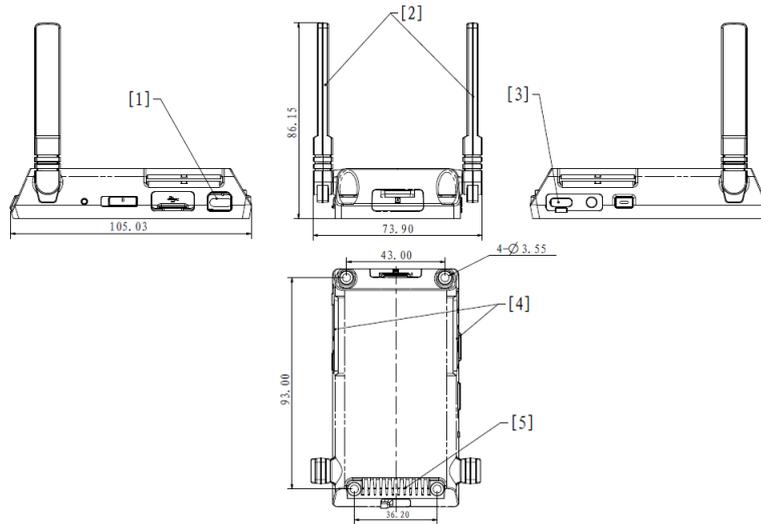


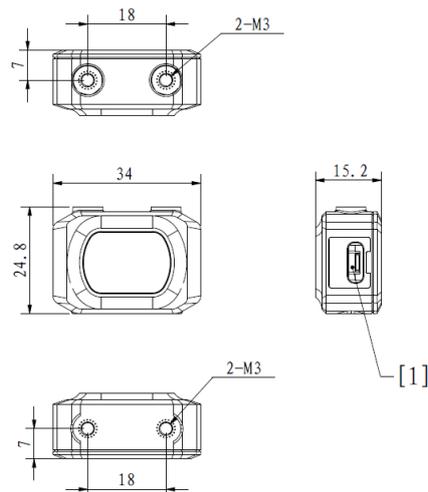
Figure 3-13 Video Transmitter Module Diagram

Drill preformed mounting holes at the necessary positions according to the size and mounting interface of the Video Transmitter Module.



- [1] CAN BUS interface [2] Antenna [3] Camera Module interface
 [4] Air Inlet [5] Air Outlet

Figure 3-14 Smart Central Control Diagram

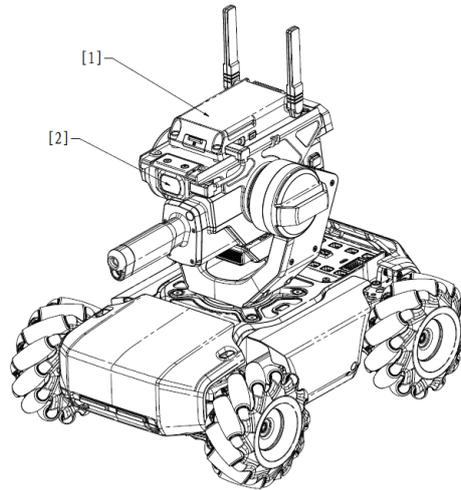


- [1] CAN BUS interface for Motion Control Module

Figure 3-15 Camera Diagram

3.5.1 Installation Steps

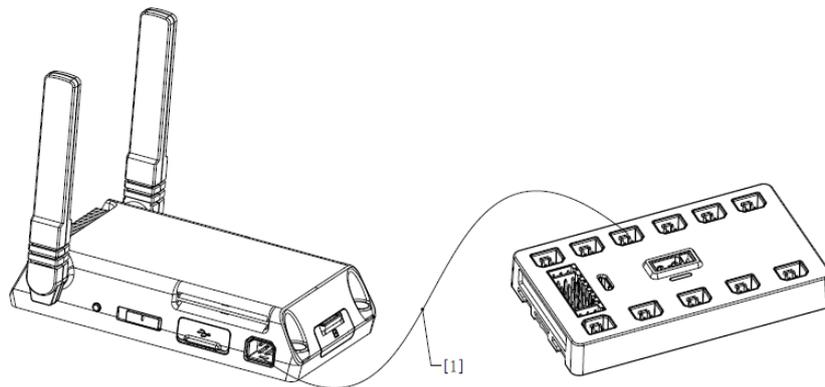
1. Fasten the Smart Central Control at the appropriate position using four M3 screws.



[1] Smart Central Control [2] Camera

Figure 3-16 Video Transmitter Module Mounting Diagram

2. Connect the Smart Central Control and camera using the camera cable.
3. Connect the Smart Central Control and the Motion Control Module using the data cable from the package.



[1] Data cable

Figure 3-17 Smart Central Control Cabling Diagram

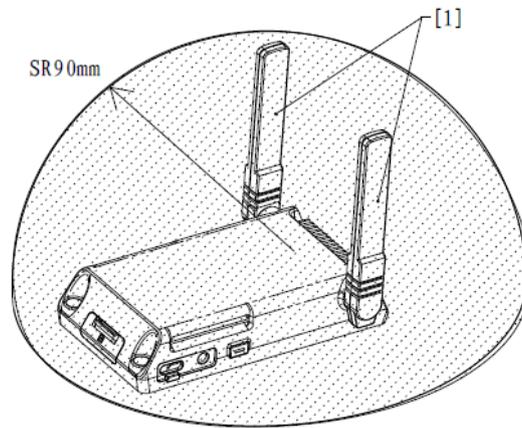
3.5.2 Installation Requirements

The installation of the Smart Central Control must comply with the following requirements. Any installation that fails to follow the requirements may result in reduced image quality of the video transmitter, or even operational malfunction.

S40 The air inlet and outlet of the Smart Central Control cannot be blocked.

S41 As the Smart Central Control's antenna is located at the top of the Module, the top should not be blocked by any metal.

S42 As shown on the mounting diagram for the Smart Central Control, no motor or any other device that may cause electromagnetic interference is allowed within a 90mm hemisphere from the central point of the Smart Central Control, to avoid any interference with the camera's video transmission signals. The specific mounting position and angles can be confirmed by checking the quality of receiver images.



[1] Antenna

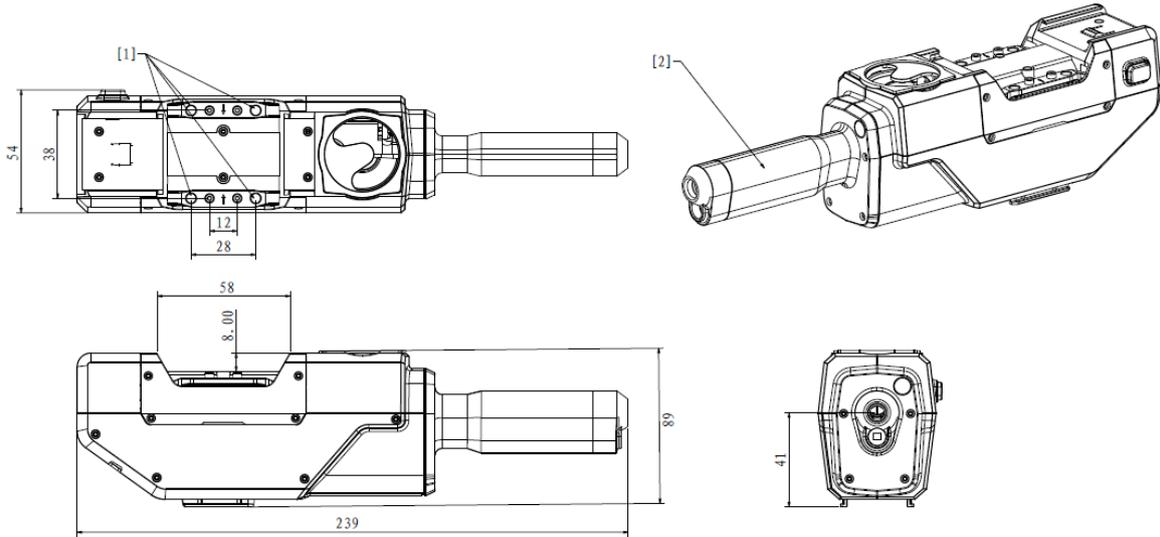
Figure 3-18 Smart Central Control Mounting Positions Diagram

S43 The longest side of the robot's camera shall be parallel to the horizontal plane of the robot's chassis.

3.6 Speed Monitor Module Mounting Specifications

The Speed Monitor Module is already built into the Launching Mechanism, as shown below:

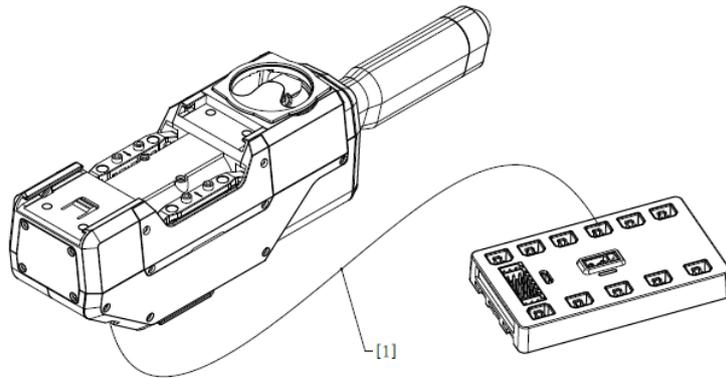
1. Fasten the Launching Mechanism at the appropriate position using four M3 screws.



[1] M3 mounting holes [2] Speed Monitor Module

Figure 3-19 Launching Mechanism Diagram

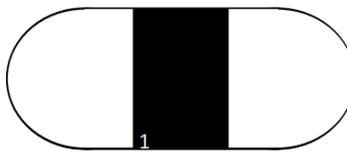
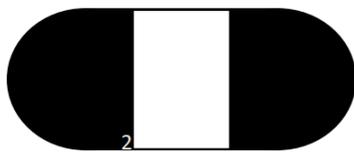
2. Connect the Launching Mechanism to any CAN BUS interface or any other equivalent interface on the Motion Control Module.

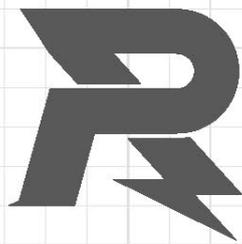


[1] Launching Mechanism data cable

Figure 3-20 Launching Mechanism Cabling Diagram

Appendix 1 Drawings of Number Stickers





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