

# RANGER MINI 3.0 User Manual



**RANGER MINI 3.0**

**AgileX Robotics Team**

**USER MANUAL V.1.0.0 2024.06**

## Document version

No.	Version	Date	Edited by	Reviewer	Notes
1	V1.0.0	2024/6/25	Cynthia		First version

Before using the robot, any individual or organization must read and understand the manual. If you have any questions about it, please do not hesitate to contact us at [support@agilex.ai](mailto:support@agilex.ai). It is very important that you should follow and implement all instructions and guidelines in this manual. Please pay extra attention to the warnings.

# Important Safety Information

This manual does not cover the design, installation, and operation of a robotic application, nor does it include any equipment that may affect the safety of a robotic system. A robot system that uses the RANGER MINI 3.0 should be designed and used in compliance with the safety requirements and other standards of the corresponding countries.

Any users of the RANGER MINI 3.0 should comply with laws and regulations of relevant countries and ensure that there are no obvious hazards in the application of the RANGER MINI 3.0. This includes but is not limited to the following:

## Effectiveness and responsibility

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Do a risk assessment of the robotic system that uses the RANGER MINI 3.0.

The risk assessment should include additional safety equipment to other machinery.

Please ensure that the equipment of the whole robotic system, including software and hardware, are designed, and installed correctly.

- The RANGER MINI 3.0 is not an autonomous mobile robot with anti-collision, anti-fall, biological approach warning, and other safety functions. These safety functions are expected to be developed and assessed by system integrators and end customers under relevant safety regulations and laws to ensure there are not any major dangers and potential safety hazards in their practical applications.
- Read all technical documents: including the risk assessment and this manual.
- Know the possible safety risks before using the RANGER MINI 3.0.

## Use Environment

- For the first use, please read this manual carefully to understand the basic operation and operating specifications. Remote control operation should be in a relatively open area. The RANGER MINI 3.0 does not have any automatic obstacle avoidance sensors.
- Please use the RANGER MINI 3.0 under the ambient temperature of -10 °C~40°C.
- The RANGER MINI 3.0's waterproof and dustproof level is IP54 if it is not customized.

## Check

- Make sure each device is fully charged.  
Make sure the RANGER MINI 3.0 has no obvious abnormalities.  
Make sure the remote control has sufficient battery power.

# Precautions

## Operation Precautions

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Ensure that the surrounding area is relatively open when operating the RANGER.

Please do remote control within sight.

The maximum load of the RANGER MINI 3.0 is 100 KG. Please ensure that the payload does not exceed 100 KG when using.

When installing external equipment on the RANGER MINI 3.0, Please ensure their centroid location is at the RANGER MINI 3.0's center of rotation.

- Please charge the RANGER MINI 3.0 in time after low-battery alarm.
- When the RANGER MINI 3.0 is abnormal, please stop using it immediately to avoid secondary injury.

When the RANGER MINI 3.0 is abnormal, please contact the technical support immediately, and do not handle it without professional suggestion.

- Please use the RANGER MINI 3.0 in an environment that does not exceed its IP protection level.
- Do not push the RANGER MINI 3.0 directly.
- The current of the tail extension power supply does not exceed 15A, and the total power does not exceed 720w.

## Battery

The battery of RANGER MINI products is not fully charged when it leaves the factory. The specific battery voltage and power can be displayed through vol and batt on the RANGER MINI remote control.

Please do not charge the battery after it is exhausted, please charge it in time when the low battery of the RANGER MINI remote control is less than 15%

Static storage conditions: The optimal storage temperature is -10°C~40°C. When the battery is not in use, it must be charged and discharged once every month, and then stored at full voltage. Do not store the battery Place in fire, or heat the battery. Do not store batteries at high temperatures.

Charging: You must use the matching lithium battery charger for charging. Do not charge the battery below 0°C. Do not use non-original standard batteries, power supplies, and chargers.

## Usage environment

- The operating temperature of RANGER MINI is -10°C~40°C, please do not use it in an environment where the temperature is lower than -10°C and higher than 40°C
- Do not use it in an environment with corrosive or flammable gases or near flammable substances.
- Please do not use it around heating elements such as heaters or large winding resistors
- RANGER MINI is waterproof and dustproof rated IP54
- It is recommended that the altitude of the use environment should not exceed 1000M
- It is recommended that the temperature difference between day and night in the use environment does not exceed 25°C

## Safety

If you have any questions about the use process, please follow the relevant instruction manual or consult relevant technical personnel.

Before using the equipment, pay attention to the on-site conditions to avoid improper operation that may cause personal safety problems.

- In case of emergency, press the emergency stop button to power off the equipment.
- Do not modify the internal equipment structure without technical support and permission
- When the equipment is abnormal, please stop using it immediately to avoid secondary injury
- When an abnormality occurs in the equipment, please contact the relevant technical personnel and do not handle it without authorization.

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## 1 Introduction to the RANGER MINI 3.0

The RANGER MINI 3.0 is a programmable omnidirectional UGV (UNMANNED GROUND VEHICLE), which is a chassis with a modular design. Compared with the four-wheel differential chassis, the RANGER MINI 3.0 has obvious advantages when running on ordinary cement roads and asphalt roads. It not only has higher speed and load capacity, but also reduces the wear and tear on the structure and tires. It is also more stable and safer. Compared with Ackermann chassis, the RANGER MINI3.0 not only reduces the turning radius, but also can turn at 0 angle. The RANGER MINI 3.0 combines the advantages of differential chassis and Ackermann chassis, which is suitable for various complex terrains. What's more, it can be equipped with stereo cameras, LiDAR, GNSS, IMU, manipulators and other equipment to be applied in fields such as unmanned inspection, security, scientific research, exploration and logistics.

### 1.1 Product List

Name	Quantity
RANGER MINI 3 body	×1
Battery charger (AC 220V)	×1
Aviation plug male (4Pin)	×1
FS remote controller (optional)	×1
USB to CAN communication module	×1

## 1.2 Specifications

Type	Items	Parameters
Mechanical	Dimensions (mm)	720×500×345
	Axle Track (mm)	494
	Front/rear track (mm)	364
	Total weight (Kg)	75
	Battery type	Lithium iron phosphate
	Battery parameters	48V24AH
	Power drive motor	350W×4
	Steering drive motor	100W×4
	Parking type	Electronic brake
	Steering type	4 wheels steering
	Suspension	Independent suspension
	Steering motor reduction ratio	1:51
	Steering motor encoder	Dual Encoder
	Drive motor reduction ratio	1:4.428
	Drive motor sensor	Encoder
Perfomation	IP grade	IP54

	Maximum speed (km/h)	7.2
	Minimum turning radius (mm)	0mm (Spin mode) 810mm (Ackermann model)
	Maximum climbing ability (°)	15° (25kg)
	Crossing width	120mm
	Ground clearance (mm)	105
	Maximum endurance (h)	7
	Maximum travel (km)	35
	Charging time (h)	1.5
	Working temperature (°C)	-10~40
Control	Control mode	Remote control mode Command control mode
	Remote controller	2.4G/limit distance 100M
	Communication Interface	CAN

### 1.3 Required for Development

The RANGER MINI 3.0 can be equipped with FS remote control when buying. Users can use it to control the 4WD chassis, complete mode switching, movement and steering. The RANGER MINI 3.0 has a standard CAN (Controller Area Network) communication interface to facilitate secondary development.

## 2 Basic Introduction

This part is a basic introduction to the RANGER MINI 3.0, mobile robot chassis. After reading this part, users and developers can have an overall understanding about it. As shown in Figure 2.1 below, it is an overview of the RANGER MINI 3.0,.

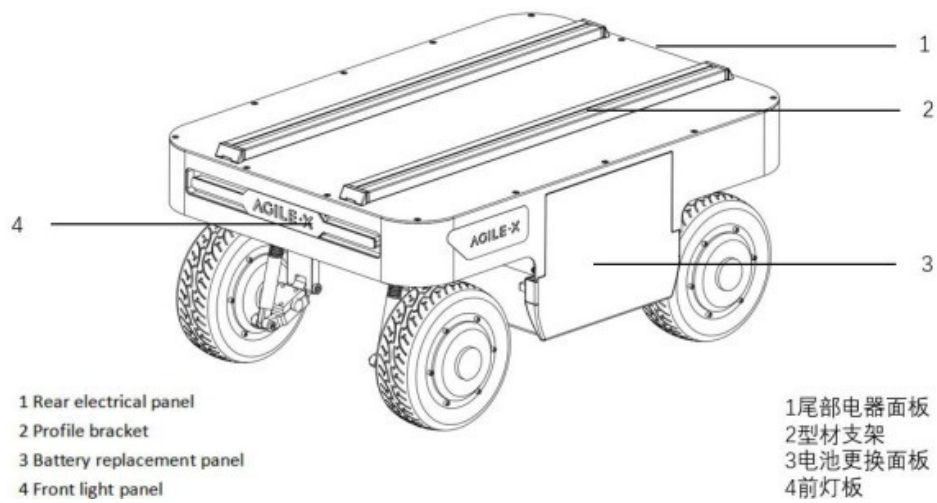


Figure 2.1 Overview of the RANGER MINI 3.0

The RANGER MINI 3.0 is based on a modular and intelligent design concept. It adopts a composite design of solid tires and swing arms on the power module, and has a powerful hub motor, which makes the RANGER MINI 3.0 swift passing ability and ground adaptability. It can move flexibly on different ground. The hub motor does not require complicated transmission design, making the RANGER MINI 3.0 smaller and more flexible. An open electrical interface and communication interface are configured at the rear of the RANGER MINI 3.0, which is convenient for users to carry out secondary development. The electrical interface adopts aviation waterproof connectors, which is not only conducive to the expansion and use, but also allows the RANGER MINI 3.0 to be used in some harsh environments. A standard aluminum extension bracket is installed on the RANGER MINI 3.0, which is convenient for users to carry external equipment.

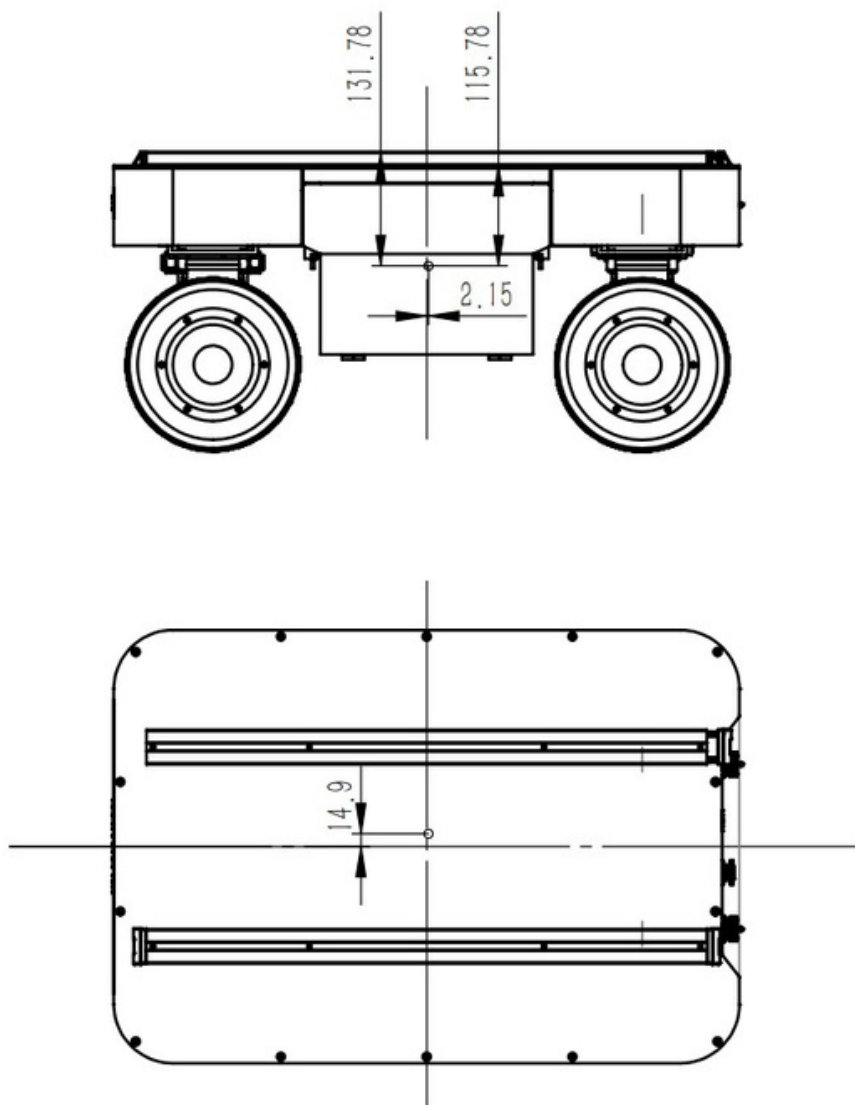


Figure 2.2 Gravity center of RANGER MINI 3.0

## 2.1 Status of the RANGER MINI 3.0

The user can check the status of the RANGER MINI 3.0 through its CAN message. Please refer to Table 2.1 for specific status.

Status	Description
Current Voltage	The current battery voltage and power can be viewed through vol and batt on the remote controller.
Low Voltage Warning	When the SOC (State of Charge) of the battery is lower than 15% through BMS feedback, the front and rear lights of the RANGER MINI 3.0 will flash as a reminder. When the battery power is detected lower than 10%, the chassis will actively cut off the power supply for external equipment and driver to protect the battery. At this time, the chassis will not move and accept external command control.



Detailed Status Information	Check by CAN message
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Table 2.1 Status Description Table for the RANGER

## 2.2 Description of Electrical Interfaces

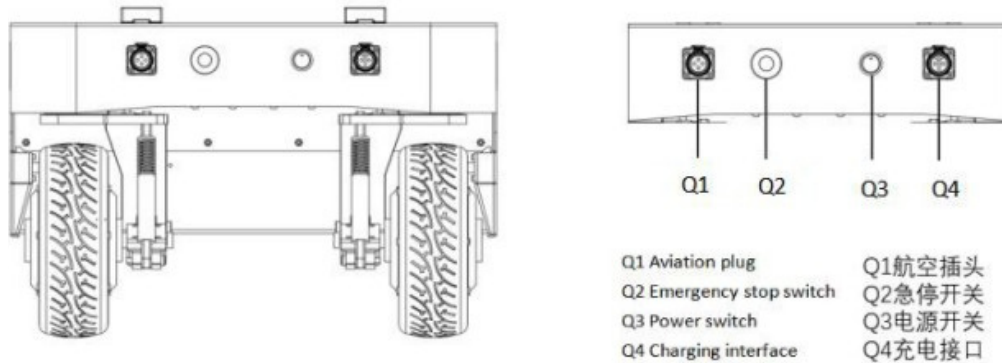
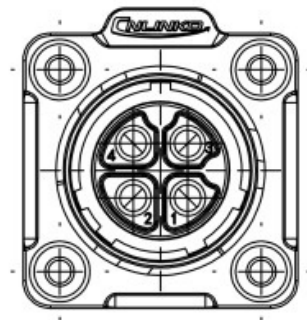


Figure 2.2 Back View of the RANGER MINI 3.0

The RANGER MINI 3.0 has a circular connector for expansion at its rear. The interface can be used to provide power for external equipment (the load current cannot exceed 15 A, and the voltage range is 46~50 V) and transfer information through its CAN communication interface. Its pins

are defined in the figure below. Please note that its power supply is subject to internal control. When the battery voltage is lower than the safe level, it will actively cut off the power supply. Therefore, users need to pay attention to the low voltage alarm of the RANGER MINI 3.0 before reaching the critical voltage. Do not forget to charge the RANGER MINI 3.0 after use.



Pin Number	Pin Type	Function and Definition	Note
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1	Power supply	VCC	Positive terminal. The voltage range is 46~50 V The load current cannot exceed 15 A.
2	Power supply	GND	Negative terminal
3	CAN	CAN_H	CAN H (High)
4	CAN	CAN_L	CAN L (Low)

Figure 2.3 Pin descriptions of the circular connector

## 2.3 Remote Control Instructions



Figure 2.4 Introduction of the remote control

As shown in the figure above, the functions of the buttons are defined as follows: SWB is the control mode, switch to the top is the command control mode, dialed to the middle or down is the remote control mode; SWA is the light control switch, dialed to the bottom is to turn off the light (need SWB first enters the remote control mode); SWC controls the parking mode. When SWC is turned to the bottom, it is the parking mode, and the four-wheel four-steering is X-shaped at this time Locking.

SWD is the switch for Motion mode:

Moving SWD to the top is front and rear Ackerman mode (the left joystick controls the speed, and the right joystick controls the steering angle) + spin mode (the left joystick does not move, the right joystick controls the spin direction)

Moving SWD to the bottom is the tilt motion mode: the left joystick controls the speed, and the right joystick controls the steering angle (the maximum angle is 90°, which makes the RANGER MINI 3.0 move laterally);

#### **Voltage/current drive mode switching:**

Firstly, switch SWC to the bottom to let the robot enter parking mode. Then switch SWB to the bottom, and then switch SWC to the top to exit the parking mode.

#### **Zero point calibration:**

SWA=DOWN; SWB=UP; SWD=DOWN;

The four positions of the left joystick represent the four corresponding steering motors(For example: Left move to upper right refers to calibrate the upper right steering motor, and upper left refers to the upper left steering motor).

The right joystick adjusts the angle in the left and right directions.

And the left roller can adjust the positions in two directions cumulatively.

SWC is the sensitivity adjustment: DOWN→coarse adjustment MID→middle adjustment UP→fine adjustment

key1: Set the current position as zero point.

Pressing KEY1 in any case = forcibly clear all errors of the RANGER MINI 3.0.

**Attention! To be used only in special cases where safety is guaranteed.**

POWER is the power button. Press and hold it to power on.

### **Basic operation process of remote control:**

**Before starting, you need to ensure that the wheels and chassis of RANGERMINI are parallel and facing forward.**

After starting the RANGERMINI 3.0 mobile robot chassis normally, start the remote controller, switch the SWB to remote control mode, and then control the movement of the RANGERMINI platform through the remote controller.

### **Remote control battery replacement instructions:**

The FS remote control uses 5(AA) batteries as its energy supply. When the remote control display interface Remoter is relatively low, it means that the battery power of the remote control is too low. At this time, you need to open the battery cover on the back of the remote control and replace the battery.

## **3 Usage and Development**

This part mainly introduces the basic operation and usage of the RANGER MINI 3.0, and how to carry out secondary development through the external CAN interface and the CAN bus protocol.

### **3.1 Operation**

## Check

Check the RANGER MINI 3.0 status

Check whether there is any obvious abnormality in the RANGER MINI 3.0; if so, please contact after-sales support;

When using it for the first time, check whether the e-stop switch(Q2) in the rear electrical panel is pressed, if pressed, please release it.

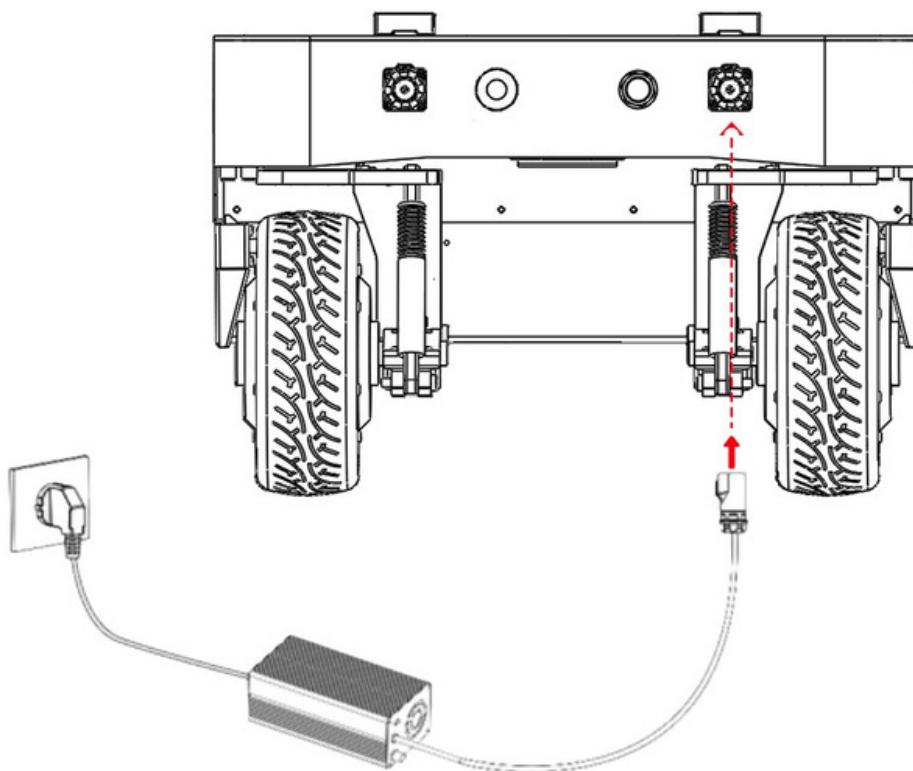
**PAY ATTENTION:** After the emergency stop button is released, you need to manually press key1 to clear the emergency stop error in remote control mode. In command mode, you need to clear the emergency stop error through the clear error command.

## Power on and off

The Q3 button on the tail is a switch button. When pressed, the power is turned on and the robot is powered on.

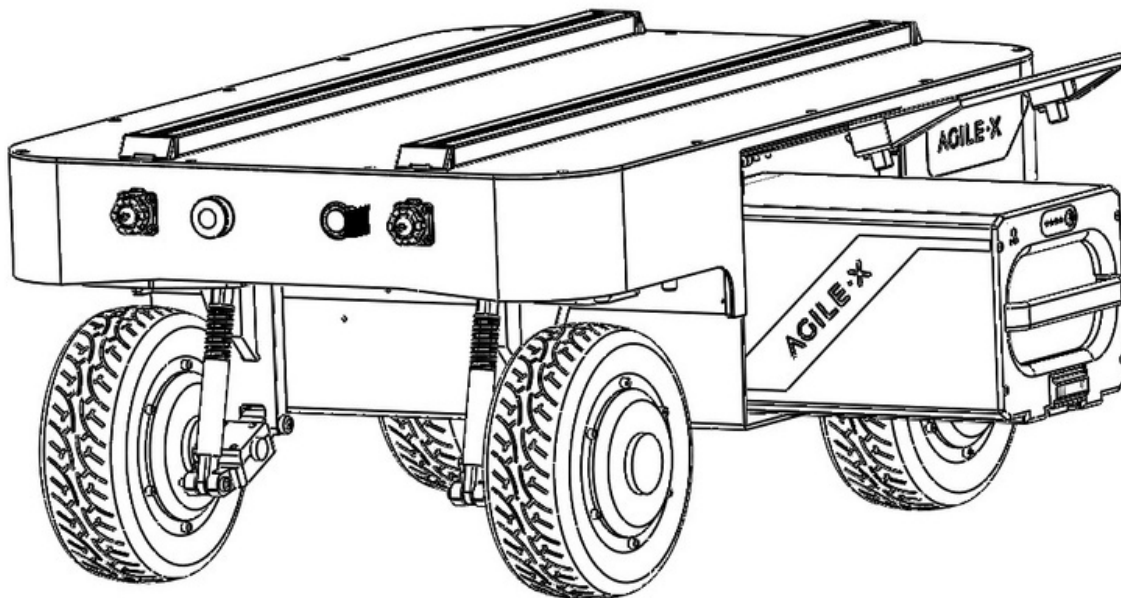
## Charge

Check the battery voltage, the normal voltage range is 45-54V, if the front light flashes, it means the battery voltage is too low, please charge it in time. This product is equipped with a 10A charger by default. Insert the plug of the charger into the Q4 charging socket on the back of the chassis, connect the charger to the power supply, and turn on the switch on the charger to enter the charging state.



### Battery replacement

RANGERMINI is equipped with a 48v24ah battery. During operation, when the battery power is too low, we can open the battery panel on the right side to quickly replace the battery.



## Connection of the CAN Cable

The 4WD chassis is shipped with an circular connector male head. The definition of its lines can refer to the figure below:



Figure 3.1 Overview of the circular connector

## Implementation of CAN command control

Start the RANGER MINI 3.0 normally, turn on the remote control, and then switch the SWB to the command control mode (move SWB to the top). At this time, the RANGER MINI 3.0 will accept commands from the CAN bus, and the host can also analyze the status of the RANGER MINI 3.0 using the feedbacked real-time data through the CAN bus. Refer to the CAN communication protocol for details. (By default, when the chassis is started and the remote control is not started.)

## 3.2 CAN Communication Protocol

The CAN communication protocol in this product is CAN2.0B standard, its communication baud rate is 500 K, and its message format is the MOTOROLA format. Through the external CAN interface, users can switch the control model and control the linear speed and steering angle of the RANGER. The RANGER MINI 3.0 will real-time feedback the current movement status information (including the integrated movement information of the vehicle and the detailed movement information of each wheel) and the system status information (including self-diagnostic error codes).

Command	System Status Feedback Command			
Node for sending	Node for receiving	ID	Period (ms)	Receive timeout (ms)
Drive-by-wire chassis	Decision-making and control unit	0x211	20ms	None
Data length	0x08			
Byte	Meaning	Data type	Note	
byte [0]	Current vehicle status	unsigned int8	0x00 The system is normal 0x02 The system is abnormal	
byte [1]	Control mode	unsigned int8	0x00 Standby mode 0x01 Command control mode 0x03 Remote control mode	
byte [2]	High order byte of battery voltage	unsigned int16	Actual voltage X 10 (the unit is 0.1 V)	
byte [3]	Low order byte of battery voltage			

byte [4]	Highest order byte of error message	unsigned int32	Refer to the error message table for details
byte [5]	High order byte of error message		
byte [6]	Low order byte of error message		
byte [7]	Lowest order byte of error message		

Table 1 Error message table

Error message		
Byte	Bit	Meaning
byte [4]	bit [0]	Reserved, the default value is 0.
	bit [1]	Reserved, the default value is 0.
	bit [2]	Reserved, the default value is 0.
	bit [3]	Reserved, the default value is 0.
	bit [4]	Reserved, the default value is 0.
	bit [5]	Reserved, the default value is 0
	bit [6]	Reserved, the default value is 0
	bit [7]	Reserved, the default value is 0
byte [5]	bit [0]	Right front steering zero point calibration status (0: unfaulty; 1: faulty)