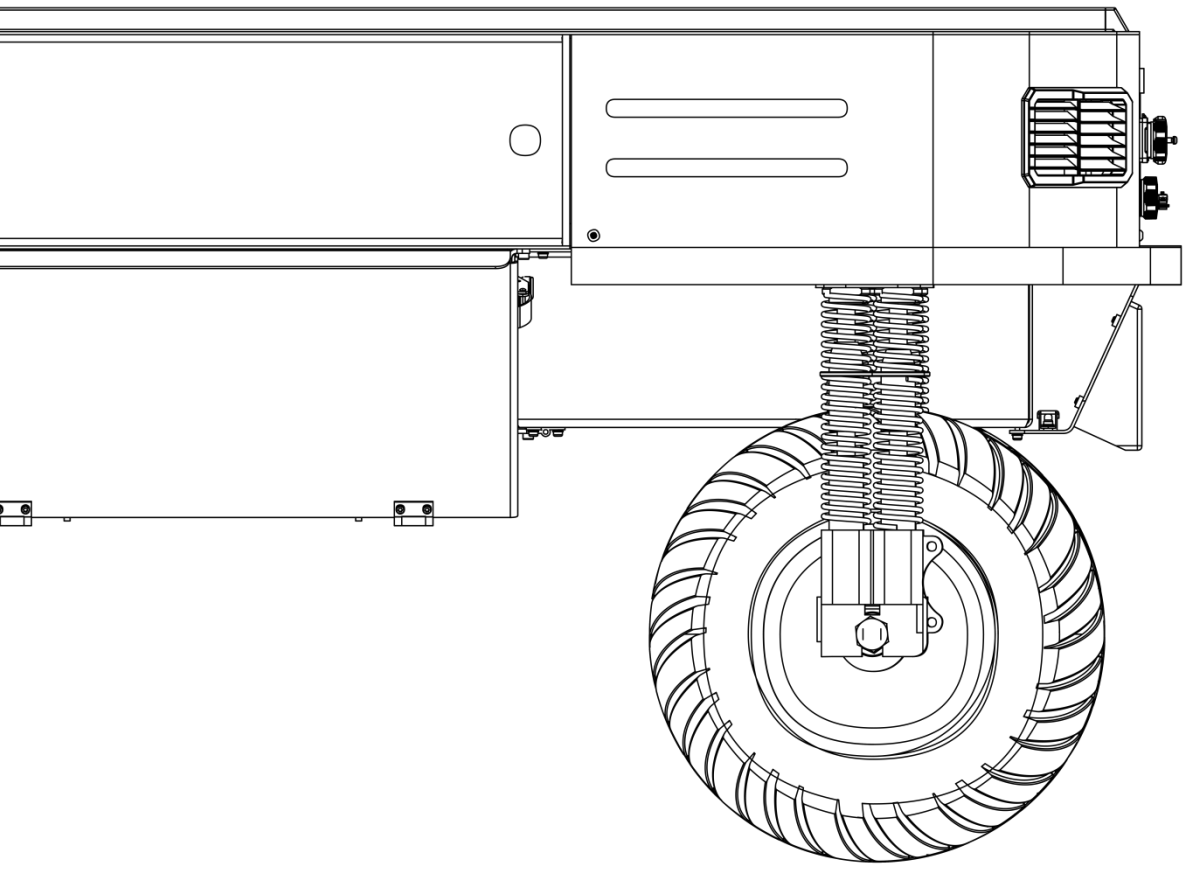
AGILE·X Robotics

RANGER
用户手册
RANGER User Manual



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RANGER 使用开发手册

RANGER User Manual

在机器人第一次通电前，任何个人或者机构在使用设备之前必须阅读并理解这些信息。有任何相关使用的疑问都可以联系我们 support@agilex.ai，必须遵守并执行本手册其他章节中的所有组装说明和指南，这一点非常重要。应特别注意与警告标志相关的文本。

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. It is very important that you should follow and implement all instructions and guidelines in this manual. Please pay extra attention to the warnings.

重要安全信息

Important Safety Information

本手册中的信息不包含设计、安装和操作一个完整的机器人应用，也不包含所有可能对这一完整的系统的安全造成影响的周边设备。该完整的系统的设计和使用需符合该机器人安装所在国的标准和规范中确立的安全要求。

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 should be designed and used in compliance with the safety requirements and other standards of the corresponding countries.

RANGER 的集成商和终端客户有责任确保遵循相关国家的切实可行的法律法规，确保完整的机器人应用实例中不存在任何重大危险。这包括但不限于以下内容

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

有效性和责任

Responsibility

对完整的机器人系统做一个风险评估。
Do a risk assessment of the robotic system that uses the RANGER.

将风险评估定义的其他机械的附加安全设备连接在一起。
The risk assessment should include additional safety equipment to other machinery.
确认整个机器人系统的外围设备包括软件和硬件系统的设计和安装准确无误。
Please ensure that the equipment of the whole robotic system, including software and hardware, are designed, and installed correctly.
本机器人不具备一个完整的自主移动机器人具备的自动防撞、防跌落、生物接近预警等相关安全功能但不局限于上述描述，相关功能需要集成商和终端客户遵循相关规定和切实可行的法律法规进行安全评估，确保开发完成的机器人在实际应用中不存在任何重大危险和安全隐患。
The RANGER 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.
收集技术文件中的所有的文档：包括风险评估和本手册。
Read all technical documents: including the risk assessment and this manual.
在操作和使用设备之前已经知晓可能存在的安全风险。
Know the possible safety risks before using the RANGER.

环境

Use Environment

首次使用，请先仔细阅读本手册，了解基本操作内容与操作规范。
For the first use, please read this manual carefully to understand the basic operation and operating specifications.
遥控操作，选择相对空旷区域使用，车上本身是不带任何自动避障传感器。
Remote control operation should be in a relatively open area. The RANGER does not have any automatic obstacle avoidance sensors.
在 0℃~40℃的环境温度中使用。

Please use the RANGER under the ambient temperature of 0 ℃~ 40 ℃.
如果车辆非单独定制 IP 防护等级，车辆防水、防尘能力为 IP22。
The RANGER's waterproof and dustproof level is IP22 if it is not customized.

检查

Check

确保各设备的电量充足。
Make sure each device is fully charged.
确保车辆无明显异常。
Make sure the RANGER has no obvious abnormalities.
检查遥控器的电池电量是否充足。
Make sure the remote control has sufficient battery power.

操作注意事项

Operation Precautions

保证操作时周围区域相对空旷。
Ensure that the surrounding area is relatively open when operating the RANGER.
在视距内遥控控制。
Please do remote control within sight.
RANGER 最大的载重为 150KG，在使用时，确保有效载荷不超过 150KG。
The maximum load of the RANGER is 150 KG. Please ensure that the payload does not exceed 150 KG when using.
RANGER 安装外部扩展时，确认扩展的质心位置，确保在旋转中心。
When installing external equipment on the RANGER, Please ensure their centroid location is at the RANGER's center of rotation.
当设备低电量报警时请及时充电。
Please charge the RANGER in time after low-battery alarm.
当设备出现异常时，请立即停止使用，避免造成二次伤害
When the RANGER is abnormal, please stop using it immediately to avoid secondary injury.
当设备出现异常时，请联系相关技术人员，请勿擅自处理。
When the RANGER is abnormal, please contact the technical support immediately, and do not handle it without professional suggestion.
请根据设备的 IP 防护等级在满足防护等级要求的环境中使用。

Please use the RANGER in an environment that does not exceed its IP protection level.
请勿直接推车。
Do not push the RANGER directly.
充电时，确保周围环境温度大于 0℃。
Ensure that the ambient temperature is above 0 °C when charging.

概述
Overview

1 RANGER 简介 Introduction to the RANGER

RANGER 是一款可编程全向型 UGV（Unmanned Ground Vehicle），它是一款采用模块化设计的底盘。相较于四轮差速底盘，RANGER 在普通水泥、柏油路上优势明显，不仅运动速度和载重能力能够更高，还减小了对结构和轮胎的磨损，而且更加稳定和安全。相较于阿克曼模型的底盘，RANGER 可以实现原地转向，具有更广泛的应用。RANGER 集差速底盘与阿克曼底盘的优点于一身，适用于多种复杂地形。同时可以搭载立体相机、激光雷达、GPS、IMU、机械手等设备，被运用到无人巡检、安防、科研、勘探物流等领域。
The RANGER 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 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 can realize in-situ steering and has a wider range of applications. The RANGER 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 性能参数 Specifications

参数类型 Type	项目 Description	指标 Parameters
机械参数 Mechanical	长×宽×高 Dimensions（mm）	1228×876×475
	轮距 Axle Track（mm）	560
	轴距 Wheel Base（mm）	890
	电机 Motor	48v 无刷有齿电机 48 v brushless toothed motor
	额定功率 Rated Power（w）	600w×4

	额定扭矩 Rated Torque (N.M)	22NM×4
性能参数 Performance	最大速度 Maximum Speed (m/s)	2.6
	运动模式 Motion Mode	四轮四转 4WD (4 Wheel Drive)
	最大越障 Maximum Obstacle Height（mm）	100（垂直障碍满载 vertical obstacles and fully loaded）
	最大爬坡 Maximum Climbing Angle（°）	10
	自重 Weight（kg）	135(单个电池 with single battery)
	载重 Maximum Load （kg）	150
	续航时间 Battery Life （h）	2-8
	充电时间 Charging Time（h）	1（单电池 with single battery）
	电池类型 Battery Type	铁锂电池 Lithium-ion battery
	单电池容量 Single Battery Capacity（ah）	24 (最多可支持四块电池 The RANGER supports up to four batteries)
	额定电压 Rated Voltage（v）	48
功能 Functional	运用场景 Application	工程勘测 Engineering Investigation
		能源巡检 Energy Inspection
		矿区运输 Mine Transportation
		智慧安防 Intelligent Security
		物流配送 Logistics
		农业运输采集 Agricultural Product Collection and Transportation

1.2 开发所需 Required for Development

RANGER 出厂时可选配 FS 遥控器，用户可以通过遥控器控制四轮四转底盘，完成模式切换、移动和转向控制。RANGER 配备了标准 CAN 通信接口，用户可以通过 CAN 接口进行二次开发。
The RANGER 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 has a standard CAN (Controller Area Network) communication interface to facilitate secondary development.

2 基本介绍 Basic Introduction

本部分内容将会对 RANGER 移动机器人底盘作一个基本的介绍，便于用户和开发者对于 RANGER 底盘有一个基本的认识。如下图 2.1 所示，为整个移动机器人底盘的概览视图。

This part is a basic introduction to the RANGER, 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.

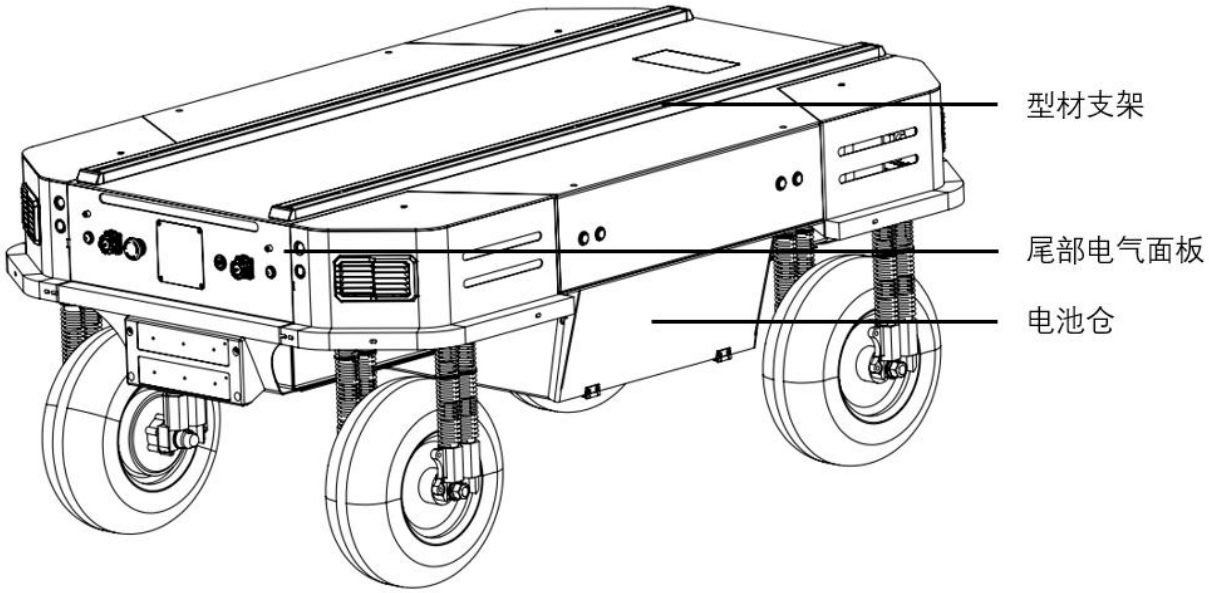


图 2.1 尾部概览视图

Figure 2.1 Overview of the RANGER

RANGER 整体上采用了模块化和智能化的设计理念，在动力模块上采用了充气轮胎胎与独立悬挂的复合设计，再加上动力强劲的轮毂电机，使得 RANGER 机器人底盘具有很强的通过性和地面适应性，可在不同的地面上灵活运动。轮毂电机的加持省去了复杂的传动设计结构，让 RANGER 更小巧、更飘逸。在 RANGER 的尾部配置了开放的电气接口和通讯接口，方便客户进行二次开发，电气接口在设计选型上采用了航空防水接插件，一方面利于用户的扩展和使用，另外一方面使得机器人平台可以在一些严苛的环境中使用。在 RANGER 顶部安装有标准铝型材扩展支架，方便用户搭载外部设备扩展使用。

The RANGER is based on a modular and intelligent design concept. It adopts a composite design of pneumatic tires and independent suspension on the power module, and has a powerful hub motor, which makes the RANGER 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 smaller and more flexible. An open electrical interface and communication interface are configured at the rear of the RANGER, 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 to be used in some harsh environments. A standard aluminum extension bracket is installed on the RANGER, which is convenient for users to carry external equipment.

2.1 状态指示 Status of the RANGER

用户可以通过 RANGER 底盘反馈的 CAN 报文来确定车体的状态。具体参数考表 2.1。
The user can check the status of the RANGER through its CAN message. Please refer to Table 2.1 for specific status.

状态 Status	描述 Description
当前电压 Voltage	当前电池电压可通过 bms 通讯反馈查看 The current battery voltage can be viewed through BMS (Battery Management System) feedback
上电显示 Powered Status	灯光亮起 Lights on indicate power is on.
低电压报警 Low Voltage Warning	当电池 BMS 通讯反馈 SOC 低于 15%，车体前后灯会闪烁进行提示。当检测到电池电量低于 10%时，四轮四转底盘为了防止电池损坏，会主动切断外部扩展供电和驱动器供电，此时底盘将无法进行运动控制和接受外部指令控制 When the SOC (State of Charge) of the battery is lower than 15% through BMS feedback, the front and rear lights of the RANGER will flash as a reminder. When the battery power is detected lower than 10%, the 4WD 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.
详细状态信息 Detailed Status Information	通过 CAN 报文查看 Check by CAN message

表格 2.1 车体状态说明表

Table 2.1 Status Description Table for the RANGER

2.2.电气接口说明 Description of Electrical Interfaces

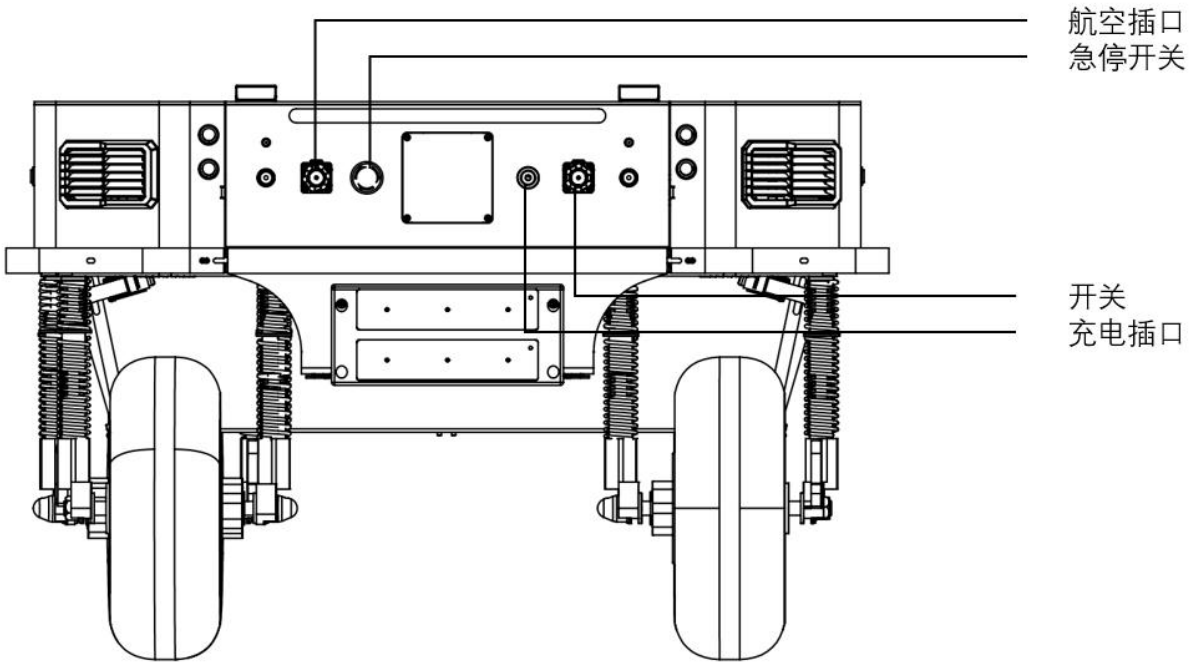


图 2.2 尾部视图

Figure 2.2 Back View of the RANGER

RANGER 底盘尾部配置有一个航空扩展接口，航空扩展接口配置了一组电源以及一组 CAN 通讯接口。便于使用者给扩展设备提供电源（负载电流不能超过 15A，电压范围 46~50V），以及通讯使用。其具体引脚定义如下图所示。 需要注意的是，这里的扩展电源受内部控制，当电池电压低于安全电压会主动切断供电，所以用户需要注意，在达到 临界电压前 RANGER 底盘平台会发出低电压报警通知，用户在使用过程中注意充电。

The RANGER 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 before reaching the critical voltage. Do not forget to charge the RANGER after use.

引脚编号 Pin Number	引脚类型 Pin Type	功能及定义 Function and Definition	备注 Note
1	电源 Power supply	VCC	电源正，电压范围 46~50V, Positive terminal. The voltage range is 46~50 V 负载电流不能超过 15A。 The load current cannot exceed 15 A.
2	电源 Power supply	GND	电源负 Negative terminal
3	CAN	CAN_H	CAN 总线高 CAN Hi (High)
4	CAN	CAN_L	CAN 总线低 CAN Lo (Low)

图 2.3 尾部航空接口引脚说明图

Figure 2.3 Pin descriptions of the circular connector

2.3.遥控说明 Remote Control Instructions

图 2.4 遥控器示意图

Figure 2.4 Introduction of the remote control

如上图，按键的功能定义为：SWB 为控制模式选择拨杆，拨至最上方为指令控制模式，拨至中间或下方为遥控控制模式；SWA 为灯光控制开关，拨到下方为关闭灯光（需 SWB 先进入遥控模式）；SWC 为超声波避障使能开关，拨到中间为打开超声避障功能；

As shown in the above figure, the functions of the buttons are as follows: SWB is the control mode switching stick, whose moving to the top is the command control mode, and moving to the middle or bottom is the remote control mode; SWA is the light control switch, whose moving to the bottom is to turn off the light (SWB needs to be moved to the middle or bottom first.); SWC is the ultrasonic obstacle avoidance enabling switch, and the ultrasonic obstacle avoidance function is turned on when it is held in the middle position;

SWD 为底盘运动模式设置开关：

SWD is the switch for Motion mode:

SWD 拨到上为①前后阿克曼+②自旋模式 ①左摇杆控制速度，右摇杆控制转角；②左摇杆不动，右摇杆左右方向控制自旋；
Moving SWD to the top is ① front and rear Ackerman mode (the left joystick controls the speed, and the right joystick controls the steering angle) + ② spin mode (the left joystick does not move, the right joystick controls the spin direction)
SWD 拨到下为斜移模式：左摇杆控制速度，右摇杆控制转角（最大角度 90°即为横移）；
Moving SWD to the bottom is the oblique 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 move laterally);
SWA 拨到下 + 左滚轮滑到最下 + 按下 KEY1 = 进入转向自动校准程序；
Moving SWA to the bottom + scrolling the left scroll wheel to the bottom + pressing KEY1 = entering into the automatic steering calibration procedure;
SWA 拨到下 + 左滚轮滑到最上 + 按下 KEY1 = 设置当前位置为转向零点；
Moving SWA to the bottom + scrolling the left scroll wheel to the bottom top + press KEY1 = setting the zero point of the steering angle;
任何情况下按下 KEY1 = 强制清除底盘所有错误 注意!！仅在确保安全的特殊情况下可使用
Pressing KEY1 in any case = forcibly clear all errors of the RANGER. Attention! To be used only in special cases where safety is guaranteed.
POWER 为电源按钮，同时按住即可开机 。
POWER is the power button. Press and hold it to power on.
遥控控制基本操作流程：
Basic operation process of remote control:
正常启动 RANGERMINI 移动机器人底盘后，启动遥控器，将 SWB 切换为遥控控制模式，即可通过遥控器控制 RANGERMINI 平台运动。
After the RANGER is turned on normally, start the remote control, switch the SWB to the remote control mode, and then the movement of the RANGER can be controlled by the remote control.

3 使用和开发 Usage and Development

本部分主要介绍 RANGER 平台的基本操作与使用，介绍如何通过外部 CAN 口，通过 CAN 总线协议来对 RANGER 进行二次开发。
This part mainly introduces the basic operation and usage of the RANGER, and how to carry out secondary development through the external CAN interface and the CAN bus protocol.

3.1 使用与操作 Operation

检查 Check

- **检查 RANGER 状态 Check the RANGER status**

检查 RANGER 是否有明显异常；如有，请联系售后支持；
Check whether there is any obvious abnormality in the RANGER; if so, please contact after-sales support;

初次使用时确认尾部电气面板中电源开关是否被按下，如按下，请按下后释放，则处于释放状态，此时 RANGER 处于断电状态。
When using it for the first time, check whether the power switch in the rear electrical panel is pressed, if pressed, please press it, and then release it. At this time, the power switch is released, and the RANGER is powered off.

- **启动和关机 Power on and off**

尾部标有“STOP”标志的开关为急停开关，顺时针旋转可解除急停，按下为急停模式。
The switch marked with "STOP" at the rear of the RANGER is an emergency stop switch. Pressing it will stop the RANGER immediately and turning it clockwise will exit the emergency stop mode.

充电 Charge

检查电池电压，正常电压范围为 46~50V,如有“滴-滴滴...”连续蜂鸣器声音，表示电池电压过低，请及时充电。
Check the battery voltage. The normal voltage range is 46~50 V. If there is a continuous buzzer sound "Beep, beep", it indicates that the battery voltage is too low, please charge it in time.

本产品默认随车配备一个 10A 的充电器，将充电器的插头插入底盘充电插口，将充电器连接电源，将充电器上的开关打开，即可进入充电状态。
This product is equipped with a 10A charger by default. To Charge the RANGER, please insert the plug of the charger into its charging socket, connect the charger to the power supply, and turn on the switch on the charger.

CAN 线的连接 Connection of the CAN Cable

四轮四转底盘随车发货提供了 1 个航空插头公头，线的定义可参考下图：
The 4WD chassis is shipped with an circular connector male head. The definition of its lines can refer to the figure below:

图 3.1 航空插头示意图

Figure 3.1 Overview of the circular connector

CAN 指令控制的实现 Implementation of CAN command control

正常启动 RANGER 底盘，打开遥控器，然后将控制模式切换至指令控制，即将遥控器 SWB 模式选择拨至最上方，此时 RANGER 底盘会接受来自 CAN 接口的指令，同时主机也可以通过 CAN 总线回馈的实时数据，解析当前底盘的状态，具体协议内容参考 CAN 通讯协议。(默认在启动底盘不启动遥控器的时候)

Start the RANGER 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 will accept commands from the CAN bus, and the host can also analyze the status of the RANGER using the feedbacked real-time data through the CAN bus. Refer to the CAN communication protocol for details. (The RANGER powering on and the remote control powering off is the default.)

3.2 CAN 接口协议 CAN Communication Protocol

本产品中 CAN 通信标准采用的是 CAN2.0B 标准，通讯波特率为 500K，报文格式采用 MOTOROLA 格式。通过外部 CAN 总线接口可以进行控制模型切换和控制底盘移动的线速度以及转向角；底盘会实时反馈当前的运动状态信息（包括经过整合处理的整机运动信息和各个轮子的详细运动信息）以及系统状态信息（包含自诊断错误码）。

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 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).

指令名称 Command	系统状态回馈指令 System Status Feedback Command			
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x211	20ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	当前车体状态 Current vehicle status	unsigned int8	0x00 系统正常 The system is normal	
			0x02 系统异常 The system is abnormal	
byte [1]	模式控制 Control mode	unsigned int8	0x00 待机模式 Standby mode	
			0x01 CAN 指令控制模式 Command control mode	
			0x03 遥控模式 Remote control mode	
byte [2]	电池电压高八位 High order byte of battery voltage	unsigned int16	实际电压 X 10 (精确到 0.1V) Actual voltage X 10 (the unit is 0.1 V)	
byte [3]	电池电压低八位 Low order byte of battery voltage			
byte [4]	故障信息最高位 Highest order byte of error message	unsigned int32	详见故障信息说明表 Refer to the error message table for details	
byte [5]	故障信息次高位			

	High order byte of error message		
byte [6]	故障信息次低位 Low order byte of error message		
byte [7]	故障信息最低位 Lowest order byte of error message		

故障信息说明表

Error message table

故障信息说明 Error message		
字节 Byte	位 Bit	含义 Meaning
byte [4]	bit [0]	右前转向伺服报警（0:无故障 1：故障） Right front steering servo warning (0: unfaulty; 1: faulty)
	bit [1]	右后转向伺服报警（0:无故障 1：故障） Right rear steering servo warning (0: unfaulty; 1: faulty)
	bit [2]	左后转向伺服报警（0:无故障 1：故障） Left rear steering servo warning (0: unfaulty; 1: faulty)
	bit [3]	左前转向伺服报警（0:无故障 1：故障） Left front steering servo warning (0: unfaulty; 1: faulty)
	bit [4]	保留，默认 0 Reserved, the default value is 0.
	bit [5]	保留，默认 0 Reserved, the default value is 0
	bit [6]	保留，默认 0 Reserved, the default value is 0
	bit [7]	保留，默认 0 Reserved, the default value is 0
	bit [0]	右前转向零位校准状态（0:无故障 1：故障） Right front steering zero point calibration status (0: unfaulty; 1: faulty)

byte [5]	bit [1]	右后转向零位校准状态（0:无故障 1：故障） Right rear steering zero point calibration status (0: unfaulty; 1: faulty)
	bit [2]	左后转向零位校准状态（0:无故障 1：故障） Left rear steering zero point calibration status (0: unfaulty; 1: faulty)
	bit [3]	左前转向零位校准状态（0:无故障 1：故障） Left front steering zero point calibration status (0: unfaulty; 1: faulty)
	bit [4]	转向校准超时（0:无故障 1：故障） Steering calibration timeout (0: unfaulty; 1: faulty)
	bit [5]	触边防撞，(0:正常 1：触发停机) Safety edge collision status, (0: normal; 1: triggered, the chassis should be stopped immediately.)
	bit [6]	保留，默认 0 Reserved, the default value is 0
	bit [7]	保留，默认 0 Reserved, the default value is 0
byte [6]	bit [0]	驱动器状态错误（0：无故障 1：故障） driver status (0: unfaulty; 1: faulty)
	bit [1]	上层通讯连接状态（0： 无故障 1： 故障） Communication connection status with upper layer (0: unfaulty; 1: faulty)
	bit [2]	5 号电机驱动器通讯故障（0:无故障 1：故障） No. 5 motor driver communication status (0: unfaulty; 1: faulty)
	bit [3]	6 号电机驱动器通讯故障（0:无故障 1：故障） No. 6 motor driver communication status (0: unfaulty; 1: faulty)
	bit [4]	7 号电机驱动器通讯故障（0:无故障 1：故障） No. 7 motor driver communication status (0: unfaulty; 1: faulty)
	bit [5]	8 号电机驱动器通讯故障（0:无故障 1：故障） No. 8 motor driver communication status (0: unfaulty; 1: faulty)

	bit [6]	过温保护（0:无故障 1：故障） over temperature protection status (0: normal; 1: triggered)
	bit [7]	过流保护（0:无故障 1：故障） Overcurrent protection status (0: normal; 1: triggered)
byte [7]	bit [0]	电池欠压故障（0:无故障 1：故障） Battery undervoltage status (0: normal; 1: triggered)
	bit [1]	超声波避障，（0:正常 1：触发避障） Ultrasonic obstacle avoidance status (0: normal; 1: triggered)
	bit [2]	遥控器失联保护（0： 无故障 1： 故障） Remote control lost connection protection status (0: normal; 1: triggered)
	bit [3]	1 号电机驱动器通讯故障（0:无故障 1：故障） No. 1 motor driver communication status (0: unfaulty; 1: faulty)
	bit [4]	2 号电机驱动器通讯故障（0:无故障 1：故障） No. 2 motor driver communication status (0: unfaulty; 1: faulty)
	bit [5]	3 号电机驱动器通讯故障（0:无故障 1：故障） No. 3 motor driver communication status (0: unfaulty; 1: faulty)
	bit [6]	4 号电机驱动器通讯故障（0:无故障 1：故障） No. 4 motor driver communication status (0: unfaulty; 1: faulty)
	bit [7]	保留，默认 0 Reserved, the default value is 0

运动控制回馈帧指令包含了当前车体的运动线速度、转向角度回馈

The motion control feedback frame includes the current linear speed and steering angle of the vehicle.

协议具体内容如下

The details of the protocol are as follows

指令名称 Command	运动控制回馈指令 Motion Control Feedback Command

发送节点 Node for sending	接 收 节 点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x221	20ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0] byte [1]	移动速度高八位 High order byte of speed 移动速度低八位 Low order byte of speed	signed int16	实际速度 X 1000 (单位 0.001m/s) Actual speed X 1000 (the unit is 0.001 m/s)	
byte [2]	保留 Reserved		0X00	
byte [3]	保留 Reserved	-	0X00	
byte [4]	保留 Reserved	-	0X00	
byte [5]	保留 Reserved	-	0X00	
byte [6] byte [7]	转角高八位 High order byte of steering angle 转角低八位 Low order byte of steering angle	signed int16	实际内转角 X 100 (单位 0.01°) Actual steering angle X 100 (the unit is 0.01 °)	

运动控制帧包含了线速度控制指令、转角控制指令，其具体协议内容如下：

The motion control frame includes the linear speed control command and the steering angle control command. The details of the protocol are as follows:

指令名称 Command			控制指令 Control Command	
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
决策控制单元 Decision-making and control	底盘节点 Node for the	0x111	20ms	500ms

unit	chassis			
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0] byte [1]	线速度高八位 High order byte of linear speed 线速度低八位 Low order byte of linear speed	signed int16	车体行进速度，单位 mm/s(有效值+ -2500，当转向角度>20°时有效值+ -1250;在前后阿克曼和斜移模式下生效) Speed of the vehicle, whose unit is mm/s (valid value + -2500; valid value + -1250 when the steering angle > 20°; taking effect in front and rear Ackerman mode and oblique motion mode) 前进方向为正值 Forward direction is positive	
byte [2]	保留 Reserved	-	0X00	
byte [3]	保留 Reserved	-	0X00	
byte [4] byte [5]	自旋速度高八位 High order byte of spin speed 自旋速度低八位 Low order byte of spin speed	signed int16	车体运动速度，单位 mm/s(有效值+ -1000，在自旋模式下生效) Speed of the vehicle, whose unit is mm/s (valid value + -1000, taking effect in spin mode) 逆时针旋转为正值 Counterclockwise spinning is positive.	
byte [6] byte [7]	转角高八位 High order byte of steering angle 转角低八位 Low order byte of steering angle	signed int16	转向角,单位 0.01°(有效值前后阿克曼模式+ - 4000，斜移模式+ -9000，仅在前后阿克曼和斜移模式下生效) Steering angle, whose unit is	

			0.01 ° (valid value +- 4000 in front and rear Ackerman mode, valid value +- 9000 in oblique motion mode, only taking effect in front and rear Ackerman mode and oblique motion mode)

如图 3.2.1，当 RANGER 底盘处于前后阿克曼模式时，反馈的转角为（α+β）/2，负值为左转方向，正值为右转方向；反馈的速度为四轮速度平均值（即底盘运动线速度），负值为倒车，正值为前进。若需要查看各个轮子的详细　转角和速度信息，参看 0X271 和 0X281 反馈帧。

As shown in Figure 3.2.1, when the RANGER is in front and rear Ackerman mode, the feedback steering angle is (α+β)/2, left steering is negative, and right steering is positive; the feedback speed is the average value of the four wheels' speed (that is, the linear speed of the chassis), reversing is negative, and moving forward is positive. If you need to check the detailed steering angle and speed of each wheel, please refer to 0X271 and 0X281 feedback frames.

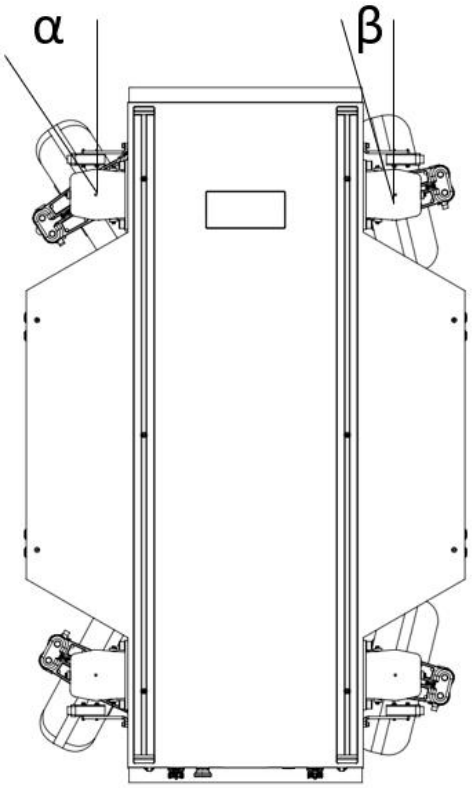


图 3.2.1ranger 阿克曼结构

Figure 3.2.1 The Ackerman structure of the RANGER

如图 3.2.2，当 ranger 处于斜移模式时，反馈的转角为（α1+α2+α3+α4）/4，负值为左转方向，正值为右转方向；反馈的线速度为四轮速度平均值，负值为倒车，正值为前进。若需要查看各个轮子的详细转角和速度信息，参看 0x271 和 0x281 反馈帧。

As shown in Figure 3.2.2, when the RANGER is in oblique motion mode, the feedback steering angle is (α1+α2+α3+α4)/4, left steering is negative, and right steering is positive; the feedback linear speed is the average value of the four wheels' speed, reversing is negative, and moving forward is positive. If you need to check the detailed steering angle and speed of each wheel, please refer to the 0x271 and 0x281 feedback frames.

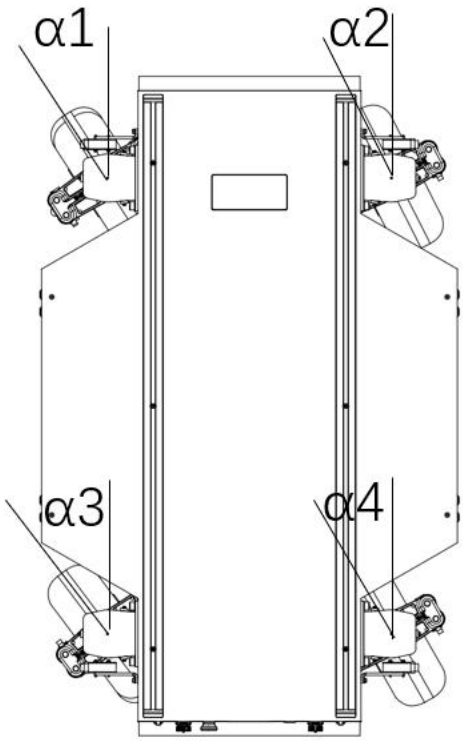


图 3.2.2ranger 斜移结构

Figure 3.2.2 Wheels control of the RANGER in oblique motion mode

当底盘处于自旋模式时，转角为定值不可控，此时转角反馈为α1、α2、α3、α4 四个实际角度的绝对值的平均值。可通过指令控制底盘自旋速度，逆时针旋转为正值。

When the chassis is in the spin mode, the steering angle is a constant value , which cannot be changed. At this time, the feedback steering angle is the average value of the absolute values of α1, α2, α3, and α4. The spinning speed of the chassis can be changed by commands, and counterclockwise spinning is positive.

模式设定帧用于设定终端的控制接口，其具体协议内容如下。

The mode setting frame is used to set the terminal control interface, and the details of the protocol are as follows.

指令名称 Command			控制指令 Control Command	
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout

决策控制单元 Decision-making and control unit	底盘节点 Node for the chassis	0x421	无 None	无 None
数据长度 Data length	0x01			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	控制模式 Control mode	unsigned int8	0x00 待机模式 Standby mode 0x01 CAN 指令模式 CAN command control mode 上电默认进入待机模式 Boot into standby mode by default	

控制模式说明：底盘在开机上电，遥控器未连接的情况下，控制模式默认是待机模式，此时底盘只接收控制模式指令，其他指令不做响应，要使用 CAN 进行控制需要先切换到 CAN 指令模式。若打开遥控器，遥控器具有最高权限，可以屏蔽指令的控制，切换控制模式。状态置位帧用于清除系统错误，其具体协议内容如下。

Control mode description: when the chassis is powered on and the remote control is not connected, the control mode is standby mode. At this time, the chassis only receives control mode commands and does not respond to other commands. To control the chassis using CAN, you need to switch control mode to CAN command control mode first. If the remote control is turned on, the remote control has the highest priority, which can block the control command and switch the control mode. The status setting frame is used to clear system errors, and the details of the protocol are as follows.

指令名称 Command Command		控制指令 Control		
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
决策控制单元 Decision-making and control unit	底盘节点 Node for the chassis	0x441	无 None	无 None
数据长度 Data length	0x01			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	错误清除指令 Error clearing command	unsigned int8	0x00 清除全部非严重故障 Clear all non-critical faults 0x01~0x08 分别对应清除 1~8	

			号电机驱动器通讯故障 Clear the communication faults of No. 1~8 motor drivers respectively 0x09 清除电池欠压故障，并尝试恢复动力电源 Clear the battery undervoltage fault and try to restore the power supply 0x0a 清除遥控信号丢失故障 Clear remote control signal loss fault 0x0b~0x0e 分别对应清除 5~8 号电机转向校准故障 Clear the steering calibration fault of No. 5~8 motors respectively 0x0f 清除过流故障 Clear overcurrent fault 0x10 清除过温故障 Clear over temperature fault

示例数据，以下数据仅供测试使用 1，

Sample data, the following data is only for testing.

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x96	0x00	0x00	0x00	0x00	0x00	0x00

2. 小车转向 10° The chassis turns 10°

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x00	0x00	0x00	0x00	0x00	0x03	0xe8

除了底盘的状态信息会进行反馈以外，底盘反馈的信息还包括四轮的转角和转速，电机的电流信息、编码器以及温度信息。

In addition to the status of the chassis itself, its feedback information also includes the steering angle and speed of the four wheels, the current of the motor, the encoder information, and the temperature information.

具体协议内容如下：

The details of the protocol are as follows:

PS：在底盘中八个电机编号对应为：右前轮 1 号，右后轮 2 号，左后轮 3 号，左前轮 4 号，右前转向 5 号，右后转向 6 号，左后转向 7 号，左前转向 8 号.

PS: The eight motor numbers of the chassis are: No. 1 is the right front wheel motor, No. 2 is the right rear wheel motor, No. 3 is the left rear wheel motor, No. 4 is the left front wheel motor, No. 5 is the right front steering motor, No. 6 is the right rear steering motor, No. 7 is the left rear steering motor, and No. 8 is the left front steering motor.

电机转速电流位置信息反馈

Feedback information of speed, current, and position of motor

指令名称 Command 电机驱动器高速信息反馈帧 High-speed feedback information frame for motor driver				
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x251~0x258	20ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0] byte [1]	电机转速高八位 High order byte of motor speed 电机转速低八位 Low order byte of motor speed	signed int16	电机当前转速 单位 RPM The current speed of the motor, whose unit is RPM (Revolutions Per Minute)	
byte [2] byte [3]	电机电流高八位 High order byte of motor current 电机电流低八位 Low order byte of motor current	signed int16	电机当前电流 单位 0.1A The present current of the motor, whose unit is 0.1 A	
byte [4] byte [5] byte [6] byte [7]	位置最高位 Highest order byte of position 位置次高位 High order byte of position 位置次低位	signed int32	电机当前位置 单位：脉冲数 The current position of the motor, whose unit is the number of pulses	

	Low order byte of position 位置最低位 Lowest order byte of position		

电机温度电压及状态反馈

Feedback of temperature voltage and status of motor

指令名称 Command frame for motor driver		电机驱动器低速信息反馈帧 Low-speed information feedback		
发送节点 Node for sending	接 收 节 点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
线控底盘 Drive-by-wire chassis	策控制单元 Decision-making and control unit	0x261~0x268	100ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	驱动器电压高八位 High order byte of driver voltage	unsigned int16	当前驱动器电压 单位 0.1V The current driver voltage, whose unit is 0.1 V	
byte [1]	驱动器电压低八位 Low order byte of driver voltage			
byte [2]	驱动器温度高八位 High order byte of drive temperature	signed int16	单位 1℃ The unit is 1 ℃.	
byte [3]	驱动器温度低八位 Low order byte of driver temperature			
byte [4]	电机温度 Motor temperature	signed int8	单位 1℃ The unit is 1 ℃.	
byte [5]	驱动器状态 Driver status	unsigned int8	详见表 2 See Table 2 for details	
byte [6]	保留 Reserved	-	0X00	

byte [7]	保留 Reserved	-	0X00

表格 2 驱动器状态 Table 2 Driver status

字节 Byte	位 Bit	含义 Meaning
byte[5]	bit[0]	电源电压是否过低（0：正常 1：过低） Power supply voltage status (0: normal; 1: too low)
	bit[1]	电机是否过温（0：正常 1：过温） Motor temperature status (0: normal; 1: over temperature)
	bit[2]	驱动器是否过流（0：正常 1：过流） The current status of the driver(0: normal; 1: over-current)
	bit[3]	驱动器是否过温（0：正常 1：过温） Driver temperature status (0: normal; 1: over temperature)
	bit[4]	传感器状态（0：正常 1：异常） Sensor status (0: Normal; 1: Abnormal)
	bit[5]	驱动器错误状态（0：正常 1：错误） Driver status (0: Normal; 1: Abnormal)
	bit[6]	驱动器使能状态（0：使能 1：失能） Drive enable status (0: enable; 1: disable)
	bit[7]	保留 Reserved

四轮转角反馈 Steering angle feedback of four wheels

指令名称 Command		四轮转角信息反馈帧 Information feedback frame of four wheels' steering angle		
发送节点 Node for sending	接 收 节 点 Node for receiving	ID	周期（ms） Period	接收超时(ms) Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x271	20ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	

byte [0] byte [1]	5 号转向转角高八位 High order byte of steering angle of No. 5 motor 5 号转向转角低八位 Low order byte of steering angle of No. 5 motor	signed int16	当前转角 单位 0.01° The Current steering angle, whose unit is 0.01 °
byte [2] byte [3]	6 号转向转角高八位 High order byte of steering angle of No. 6 motor 6 号转向转角低八位 Low order byte of steering angle of No. 6 motor	signed int16	当前转角 单位 0.01° The Current steering angle, whose unit is 0.01 °
byte [4] byte [5]	7 号转向转角高八位 High order byte of steering angle of No. 7 motor 7 号转向转角低八位 Low order byte of steering angle of No. 7 motor	signed int16	当前转角 单位 0.01° The Current steering angle, whose unit is 0.01 °
byte [6] byte [7]	8 号转向转角高八位 High order byte of steering angle of No. 8 motor 8 号转向转角低八位 Low order byte of steering angle of No. 8 motor	signed int16	当前转角 单位 0.01° The Current steering angle, whose unit is 0.01 °

四轮转速反馈 Rotational speed feedback of four wheels

指令名称 Command		四轮转速信息反馈帧 Information feedback frame of four wheels' rotational speed		
发送节点	接 收 节 点	ID	周期（ms）	接收超时(ms)

Node for sending	Node for receiving		Period	Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit		20ms	无 None
数据长度 Data length	0x08	0x281		
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0] byte [1]	1 号轮转速高八位 High order byte of rotational speed of No. 1 motor 1 号轮转速低八位 Low order byte of rotational speed of No. 1 motor	signed int16	当前转速 单位 mm/s The current rotational speed, whose unit is mm/s	
byte [2] byte [3]	2 号轮转速高八位 High order byte of rotational speed of No. 2 motor 2 号轮转速低八位 Low order byte of rotational speed of No. 2 motor	signed int16	当前转速 单位 mm/s The current rotational speed, whose unit is mm/s	
byte [4] byte [5]	3 号轮转速高八位 High order byte of rotational speed of No. 3 motor 3 号轮转速低八位 Low order byte of rotational speed of No. 3 motor	signed int16	当前转速 单位 mm/s The current rotational speed, whose unit is mm/s	
byte [6] byte [7]	4 号轮转速高八位 High order byte of rotational speed of	signed int16	当前转速 单位 mm/s The current rotational speed, whose unit is mm/s	

	No. 4 motor 4 号轮转速低八位 Low order byte of rotational speed of No. 4 motor		

运动模型切换指令用于切换底盘运动模型，其具体协议内容如下

The motion mode switching command is used to change motion model of the chassis, and the details of the protocol are as follows

指令名称 Command Current motion mode feedback command			当前运动模式回馈指令	
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms）Period	接收超时(ms) Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x291	20ms	无
数据长度 Data length	0x02			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	当前底盘运动模式 Current motion mode	unsigned int8	0x00 前后阿克曼模式 front and rear Ackerman mode 0x01 斜移模式 oblique motion mode 0x02 自旋模式 spin mode	
byte [1]	是否处于运动模型切换过程 Whether the chassis is in the process of switching the motion model	unsigned int8	0x00 切换完成 switching is completed. 0x01 运动模型切换中 in the process of switching motion mode 模型切换过程不响应速度控制指令 The chassis does not respond to speed control commands in the process of switching motion mode.	

运动模型切换指令用于切换底盘运动模型，其具体协议内容如下

The motion mode switching command is used to change motion model of the chassis, and the details of the protocol are as follows

指令名称 Command			控制指令 Control command	
发送节点 Node for sending	接收节点 Node for receiving	ID	周期（ms）Period	接收超时(ms) Receive timeout
决策控制单元 Decision-making and control unit	底盘节点 Node for the chassis	0x141	无 None	无 None
数据长度 Data length	0x01			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	运动模式	unsigned int8	0x00 前后阿克曼模式(上电默认）front and rear Ackerman mode (default) 0x01 斜移模式 oblique motion mode 0x02 自旋模式 spin mode	

超声波反馈指令 Ultrasonic Feedback Command

指令名称 Command	超声波回馈指令 Ultrasonic Feedback Command			
发送节点 Node for sending	接收节点 Node for receiving	ID	周期 Period	接收超时 Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	342	50ms	无 None
数据长度 Data length	0×08			
位置 Byte	描述 Meaning	数据类型 Data type	说明 Note	
byte【0】	1 号探头距离高八位 High order byte of the distance measured by No. 1 ultrasonic sensor	int16	距离单位：nm The distance unit is nm. 正数：有效数据 Positive value: valid data -1：传感器离线 -1: the sensor is offline. -2：传感器数据校验失败	
byte【1】	1 号探头距离低八位 Low order byte of the distance measured by No.			

	1 ultrasonic sensor		-2: sensor data validation failed -3：传感器数据异常 -3: abnormal sensor data -4：系统异常 -4: system exception
byte【2】	2 号探头距离高八位 High order byte of the distance measured by No. 2 ultrasonic sensor	int16	
byte【3】	2 号探头距离低八位 Low order byte of the distance measured by No. 2 ultrasonic sensor		
byte【4】	3 号探头距离高八位 High order byte of the distance measured by No. 3 ultrasonic sensor	int16	
byte【5】	3 号探头距离低八位 Low order byte of the distance measured by No. 3 ultrasonic sensor		
byte【6】	4 号探头距离高八位 High order byte of the distance measured by No. 4 ultrasonic sensor	int16	
byte【7】	4 号探头距离低八位 Low order byte of the distance measured by No. 4 ultrasonic sensor		

指令名称 Command	超声波回馈指令 Ultrasonic Feedback Command			
发送节点 Node for sending	接收节点 Node for receiving	ID	周期 period	接收超时 Receive timeout
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	343	50ms	无 None

数据长度 Data length	0×08			
位置 Byte	描述 Meaning	数据类型 Data type	说明 Note	
byte【0】	5 号探头距离高八位 High order byte of the distance measured by No. 5 ultrasonic sensor	int16	距离单位：nm The distance unit is nm. 正数：有效数据 Positive value: valid data -1：传感器离线 -1: the sensor is offline. -2：传感器数据校验失败 -2: sensor data validation failed -3：传感器数据异常 -3: abnormal sensor data -4：系统异常 -4: system exception	
byte【1】	5 号探头距离低八位 Low order byte of the distance measured by No. 5 ultrasonic sensor			
byte【2】	6 号探头距离高八位 High order byte of the	int16		

	distance measured by No. 6 ultrasonic sensor		
byte【3】	6 号探头距离低八位 Low order byte of the distance measured by No. 6 ultrasonic sensor		
byte【4】	7 号探头距离高八位 High order byte of the distance measured by No. 7 ultrasonic sensor	int16	
byte【5】	7 号探头距离低八位 Low order byte of		

	the distance measured by No. 7 ultrasonic sensor		
byte【6】	8 号探头距离高八位 High order byte of the distance measured by No. 8 ultrasonic sensor	int16	
byte【7】	8 号探头距离低八位 Low order byte of the distance measured by No. 8 ultrasonic sensor		

超声波避障设定指令 Ultrasonic obstacle avoidance setting command

指令名称 Command	**超声波避障设定指令** Ultrasonic obstacle avoidance setting command			
发送节点 Node for sending	接收节点 Node for receiving	ID	周期 Period	接收超时 Receive timeout
决策控制单元	底盘节点	0×451	无 None	无 None

Decision-making and control unit	Node for the chassis			
数据长度 Data length	0×01			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte[0]	设置超声波避障使能状态 Set the ultrasonic obstacle avoidance	unsigned int8	0×00 关闭超声波避障功能 Disable ultrasonic obstacle avoidance 0×01 打开超声波避障功能 Enable ultrasonic obstacle avoidance	

超声波避障设定反馈指令 Feedback command of ultrasonic obstacle avoidance setting

指令名称 Command	**超声波避障设定反馈指令 Feedback command of ultrasonic obstacle avoidance setting**			
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period	接收超时 Receive timeout
底盘节点 Node for the chassis	决策控制单元 Decision-making and control unit	0×45A	无 None	无 None
数据长度 Data length	0×01			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte[0]	当前超声波避障使能状态 Current status of ultrasonic obstacle avoidance	unsigned int8	0×00 关闭超声波避障功能 Ultrasonic obstacle avoidance is disabled. 0×01 打开超声波避障功能 Ultrasonic obstacle avoidance is enabled.	

总电池 BMS 数据反馈，其具体协议内容如下

The feedback data of BMS for all batteries, and the details of the protocol are as follows

指令名称 Command feedback data of BMS		BMS 数据反馈 The		
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘	决策控制单元	0x361	500ms	无 None

Drive-by-wire chassis	Decision-making and control unit			
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	电池 SOC Battery SOC （State of Charge）	unsigned int8	范围 0~100 Range 0~100	
byte [1]	电池 SOH Battery SOH (State of Health)	unsigned int8	范围 0~100 Range 0~100	
byte [2] byte [3]	电池电压值高八位 High order byte of battery voltage 电池电压值低八位 Low order byte of battery voltage	unsigned int16	单位：0.01V Unit: 0.01 V	
byte [4] byte [5]	电池电流值高八位 High order byte of battery current 电池电流值低八位 Low order byte of battery current	signed int16	单位：0.1A Unit: 0.1 A	
byte [6] byte [7]	电池温度高八位 High order byte of battery temperature 电池温度低八位 Low order byte of battery temperature	signed int16	单位：0.1℃ Unit: 0.1 ℃	

指令名称 Command feedback data of BMS			BMS 数据反馈 The	
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)

线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x362	500ms	无 None
数据长度 Data length	0x04			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	Alarm Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent	
byte [1]	Alarm Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent	
byte [2]	Warning Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent	
byte [3]	Warning Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent	

第一块电池 BMS 数据反馈 The feedback data of BMS for No. 1 battery

指令名称 Command			BMS 数据反馈 The feedback data of BMS	
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x363	500ms	无 None
数据长度 Data length	0x08			

位置 Byte	功能 Meaning	数据类型 Data type	说明 Note
byte [0]	电池 SOC Battery SOC	unsigned int8	范围 0~100 Range 0~100
byte [1]	电池 SOH Battery SOH	unsigned int8	范围 0~100 Range 0~100
byte [2] byte [3]	电池电压值高八位 High order byte of battery voltage 电池电压值低八位 Low order byte of battery voltage	unsigned int16	单位：0.01V Unit: 0.01 V
byte [4] byte [5]	电池电流值高八位 High order byte of battery current 电池电流值低八位 Low order byte of battery current	signed int16	单位：0.1A Unit: 0.1 A
byte [6] byte [7]	电池温度高八位 High order byte of battery temperature 电池温度低八位 Low order byte of battery temperature	signed int16	单位：0.1℃ Unit: 0.1 ℃

指令名称 Command		BMS 数据反馈 The feedback data of BMS		
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x364	500ms	无 None
数据长度 Data	0x04			

length				
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	Alarm Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent	
byte [1]	Alarm Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent	
byte [2]	Warning Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent	
byte [3]	Warning Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent	

第二块电池 BMS 数据反馈 The feedback data of BMS for No. 2 battery

指令名称 Command feedback data of BMS		BMS 数据反馈 The		
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x365	500ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	电池 SOC Battery SOC	unsigned int8	范围 0~100 Range 0~100	
byte [1]	电池 SOH Battery SOH	unsigned int8	范围 0~100 Range	

			0~100
byte [2] byte [3]	电池电压值高八位 High order byte of battery voltage 电池电压值低八位 Low order byte of battery voltage	unsigned int16	单位：0.01V Unit: 0.01 V
byte [4] byte [5]	电池电流值高八位 High order byte of battery current 电池电流值低八位 Low order byte of battery current	signed int16	单位：0.1A Unit: 0.1 A
byte [6] byte [7]	电池温度高八位 High order byte of battery temperature 电池温度低八位 Low order byte of battery temperature	signed int16	单位：0.1℃ Unit: 0.1 ℃

指令名称 Command	BMS 数据反馈 The feedback data of BMS

发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x366	500ms	无 None
数据长度 Data length	0x04			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	Alarm Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流	

			BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent
byte [1]	Alarm Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent
byte [2]	Warning Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent
byte [3]	Warning Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent

第三块电池 BMS 数据反馈 The feedback data of BMS for No. 3 battery

指令名称 Command			BMS 数据反馈 The feedback data of BMS	
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x367	500ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	电池 SOC Battery SOC	unsigned int8	范围 0~100 Range 0~100	
byte [1]	电池 SOH Battery SOH	unsigned int8	范围 0~100 Range 0~100	
byte [2] byte [3]	电池电压值高八位 High order byte of battery voltage 电池电压值低八位 Low order byte of	unsigned int16	单位：0.01V Unit: 0.01 V	

	battery voltage			
byte [4] byte [5]	电池电流值高八位 High order byte of battery current 电池电流值低八位 Low order byte of battery current	signed int16	单位：0.1A Unit: 0.1 A	
byte [6] byte [7]	电池温度高八位 High order byte of battery temperature 电池温度低八位 Low order byte of battery temperature	signed int16	单位：0.1℃ Unit: 0.1 ℃	
指令名称 Command			BMS 数据反馈 The feedback data of BMS	
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x368	500ms	无 None
数据长度 Data length	0x04			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	Alarm Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent	

byte [1]	Alarm Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent
byte [2]	Warning Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent
byte [3]	Warning Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent

第四块电池 BMS 数据反馈 The feedback data of BMS for No. 4 battery

指令名称 Command feedback data of BMS			BMS 数据反馈 The	
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x369	500ms	无 None
数据长度 Data length	0x08			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	电池 SOC Battery SOC	unsigned int8	范围 0~100 Range 0~100	
byte [1]	电池 SOH Battery SOH	unsigned int8	范围 0~100 Range 0~100	
byte [2] byte [3]	电池电压值高八位 High order byte of battery voltage 电池电压值低八位 Low order byte of battery voltage	unsigned int16	单位：0.01V Unit: 0.01 V	
byte [4] byte [5]	电池电流值高八位 High order byte of	signed int16	单位：0.1A Unit: 0.1 A	

	battery current 电池电流值低八位 Low order byte of battery current		
byte [6] byte [7]	电池温度高八位 High order byte of battery temperature 电池温度低八位 Low order byte of battery temperature	signed int16	单位：0.1℃ Unit: 0.1 ℃

指令名称 Command	BMS 数据反馈 The feedback data of BMS			
发送节点 node for sending	接收节点 Node for receiving	ID	周期 period (ms)	接收超时 Receive timeout(ms)
线控底盘 Drive-by-wire chassis	决策控制单元 Decision-making and control unit	0x36A	500ms	无 None
数据长度 Data length	0x04			
位置 Byte	功能 Meaning	数据类型 Data type	说明 Note	
byte [0]	Alarm Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent	
byte [1]	Alarm Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent	

byte [2]	Warning Status 1	unsigned int8	BIT1：过压 BIT2：欠压 BIT3：高温 BIT4：低温 BIT7：放电过流 BIT1: Overvoltage; BIT2: Undervoltage; BIT3: High temperature; BIT4: Low temperature; BIT7: Discharge overcurrent
byte [3]	Warning Status 2	unsigned int8	BIT0：充电过流 BIT0: Charging overcurrent

3.3 固件升级 Firmware Upgrade

为了方便用户对四轮四转底盘所使用的固件版本进行升级，给客户带来更加完善的体验，四轮四转底盘提供了固件升级的硬件接口以及与之对应的客户端软件。其客户端界面如下图所示。
To facilitate users to upgrade the firmware of the 4WD chassis and bring customers a better experience, the 4WD chassis provides a hardware interface and a software for upgrading firmware. The GUI (Graphical User Interface) of the software is shown in the figure below.

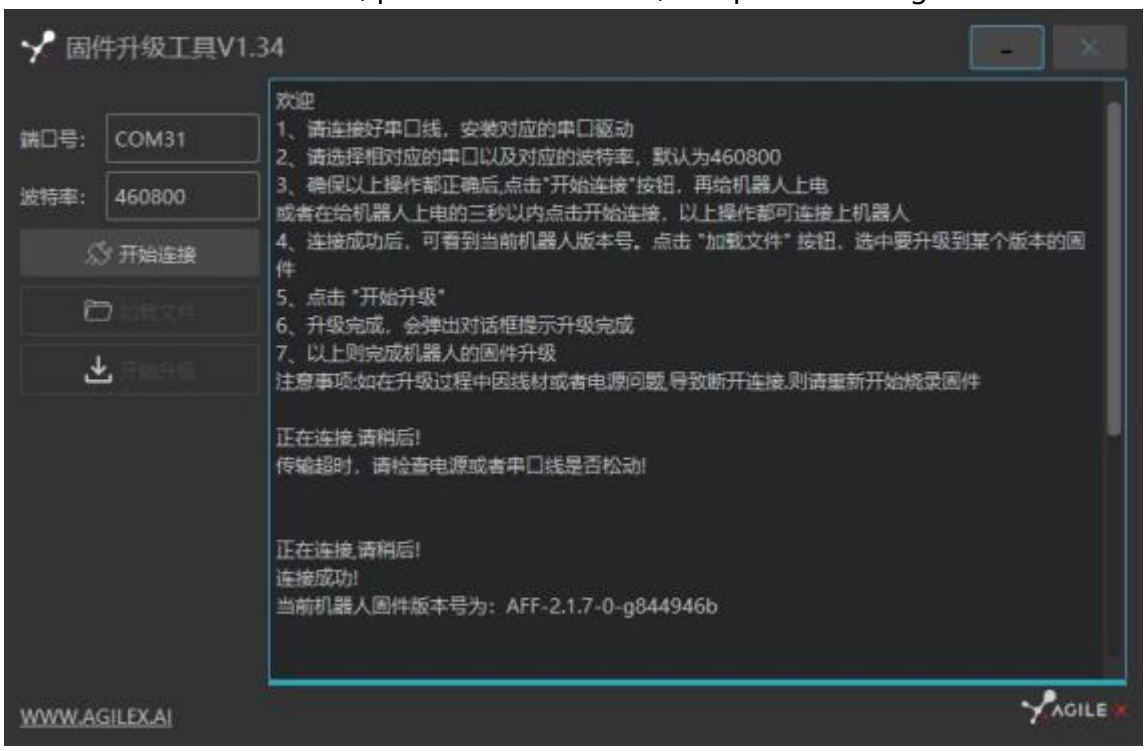
升级准备 Upgrade Preparation

松灵 CAN 调试模块 Songling CAN debugging module X 1
micro USB 线 micro USB cable X 1
四轮四转底盘 the 4WD chassis X 1
电脑(WINDOWS 操作系统) a computer (WINDOWS OS (Operating System)) X 1

升级过程 Upgrade Process

连接前保证机器人底盘电源处于断开状态； Make sure that the power supply of the chassis is disconnected before upgrading
使松灵 can 调试模块连接至底盘的航空插； Connect the Songling CAN debugging module to the circular connector of the chassis
串口线连接至电脑；Connect the serial cable to the computer
打开客户端软件；Open the software
选择端口号； Select the port number
四轮四转底盘上电，立即点击开始连接（四轮四转底盘会在上电前 3S 等待，如果时间超过 3S 则会断开进入应用程序)；若连接成功，会在文本框提示“连接成功”；加载 BIN 文件；
Power on the 4WD chassis, and click the button "Start Connection" immediately (after the 4WD chassis is powered on, it will wait for 3 S to connect to the firmware upgrade software, and it will enter the normal program after 3 S); if the connection is successful, it will show "Connection Succeeded" in the text box ; load the BIN file;
点击升级，等待升级完成的提示即可；

Click the "Upgrade" button and wait for the message box that the upgrade is successful;
断开串口线，底盘断电，再次通电即可。
Disconnect the serial cable, power off the chassis, and power on it again.



3.4 RANGER ROS 使用说明 RANGER use manual for ROS

ROS 提供一些标准操作系统服务，例如硬件抽象，底层设备控制，常用功能实现，进程间消息以及数据包管理。ROS 是基于一 种图状架构，从而不同节点的进程能接受，发布，聚合各种信息（例如传感，控制，状态，规划等等）。目前 ROS 主要支持 UBUNTU。
ROS (Robot Operating System) provides some standard operating system services, such as hardware abstraction, low-level device control, implementation of commonly used functionality, message-passing between processes, and package management. ROS is based on a graph architecture, where processing takes place in nodes that may receive, post, and multiplex various information (such as sensor data, control, state, planning, and other messages). Currently ROS mainly supports UBUNTU OS.

开发准备 Development Preparation

硬件准备 Hardware Equipment

- CANlight can 通 讯 模 块 CANlight CAN communication module X1
- 笔 记 本 电 脑 Laptop X1
- AGILEX Ranger 移动机器人底盘 AGILEX Ranger mobile robot chassis X1
- AGILEX Ranger 配套遥控器 FS-i6s Paired remote control FS-i6s for the AGILEX Ranger X1
- AGILEX Ranger 尾部部航空插座 Circular connector on the rear of the AGILEX Ranger X1

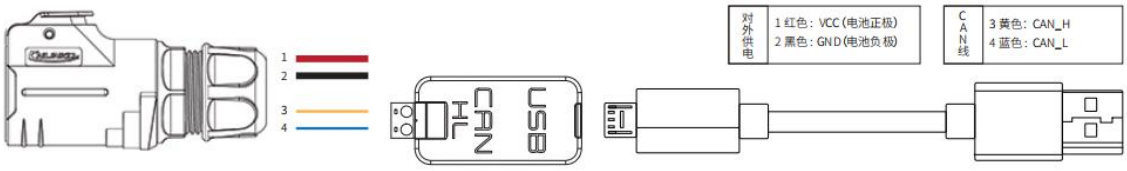
使用示例环境说明 Tested Development Environment

- Ubuntu 16.04 LTS（此为测试版本，在 Ubuntu 18.04 LTS 测试过 This is the tested version, and it also is tested on Ubuntu 18.04 LTS）
- ROS Kinetic（后续版本亦测试过 also been tested on the later versions）
- Git

硬件连接与准备 Hardware Connection and Preparation

将 Ranger 尾部航空插头 can 线引出，将 can 线中 can_H 和 can_L 分别与 CAN_TO_USB 适配器相连； 打开 Ranger 移动机器人底盘电源开关；将 CAN_TO_USB 连接至笔记本的 usb 口。连接示意如图所示。

Pull out the CAN wires of the circular connector on the rear of RANGER, and connect can_H and can_L wires of the CAN to the CAN_TO_USB adapter; power on the RANGER; connect the CAN_TO_USB adapter to the USB port of the laptop. The wiring diagram is shown in the figure below.



CAN 线连接示意图 The CAN wiring diagram

ROS 安装和环境设置 ROS Installation and Environment Setup

安装具体可以参考 http://wiki.ros.org/kinetic/Installa- tion/Ubuntu

Please refer to http://wiki.ros.org/kinetic/Installation/Ubuntu for details

测试 CANABLE 硬件与 CAN 通讯 Test the Communication between CANABLE hardware and CAN

设置 CAN-TO-USB 适配器 Set the CAN-TO-USB adapter

- 使能 gs_usb 内核模块 Enable the gs_usb kernel module

```
$ sudo modprobe gs_usb
```

- 设置 500k 波特率和使能 can-to-usb 适配器 Set baud rate to 500k and enable the CAN-TO-USB adapter

```
$ sudo ip link set can0 up type can bitrate 500000
```

- 如果在前面的步骤中没有发生错误，您应该可以使用 命令立即查看 can 设备 If there is no error in the previous steps, you can check the CAN devices with the command below

```
$ ifconfig -a
```

- 安装并使用 can-utils 来测试硬件 Install and use can-utils to test hardware

```
$ sudo apt install can-utils
```

- 若此次 can-to-usb 已经和 Ranger 相连，且小车已经开启的情况下，使用下列指令可以监听来自 Ranger 底盘的数据了 If the CAN-TO-USB adapter has been connected to the

RANGER and the RANGER has been powered on, the command below can be used to monitor the data from the RANGER.

```
$ candump can0
```

3.5 Github ROS 开发包目录与使用说明 The Github ROS development kit and user manual

ranger_base:：ranger 收发层次 can 消息的核心节点，基于 ros 的通信机制，可通过 topic 控制 ranger 运动和读取 ranger 的状态。 an important ROS node for sending and receiving CAN messages, using topics to control the movement of the RANGER, and read its status, which is based on the ROS communication architecture.

ranger_msgs：定义 ranger 状态反馈 topic 的具体消息格式 define the message format of the topic for RANGER status feedback

ranger_bringup：ranger 节点和键盘控制节点的启动文件，以及使能 usb_to_can 模块的脚本 the startup file of the RANGER node and the keyboard_control node, and the script to enable the USB_TO_CAN module

通过键盘发送指令控制 ranger：Send commands to control the RANGER through the keyboard:

1. 启动底盘节点 Run the RANGER node

```
roslaunch ranger_bringup ranger_minimal.launch
```

注意启动之前需要先使能松灵配备的 usb_to_can 模块，使能指令如下：rosrun ranger_bringup bringup_can2usb.bash。该指令只需要每次给上电的 usb_to_can 模块执行一次。

Note that the Songling USB_TO_CAN module needs to be enabled before running the RANGER node. The command is as follows: rosrun ranger_bringup bringup_can2usb.bash. This command only needs to be executed once after the USB_TO_CAN module is powered on.

2. 启动键盘节点 Run the keyboard_control node

```
roslaunch ranger_bringup ranger_teleop_keyboard.launch
```

注意查看终端打印，用指定的按键控制 ranger 运动 Please pay attention to check the output of the terminal, and use the specific keys to control the movement of RANGER

3.6 车体坐标系说明 The vehicle body coordinate system

以车体中心为坐标原点，朝前为 x 轴正方向，朝左为 y 轴正方向，朝上为 z 轴正方向

The vehicle body coordinate system is defined as follows: the center of the vehicle is the origin, the positive direction of the X-axis points to the front of the vehicle, the positive direction of the Y-axis points to the left side of the vehicle, and the positive direction of the Z-axis points upwards.

4 维护说明 Maintenance Instructions

4.1 保养方法 Maintenance method

车辆保养 The vehicle maintenance

轮胎磨损严重，请及时更换。When the tires are severely worn, please replace them in time.

电池保养 Battery maintenance

如果长时间不使用，需要按照 2 到 3 个月对电池进行周期性充电。 If the battery is not used for a long time, please don't forget to charge it every 2 to 3 months.

5、产品尺寸 Product Size