SCOUT MINI USER MANUAL

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Document version

Safety Information

Attention

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SCOUT MINI USER MANUAL





SCOUT MINI

AgileX Robotics Team

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Document version

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This chapter contains important safety information, before the robot is powered on for the first time, any individual or organization must read and understand this information before using the device. If you have any questions about use, please contact us at support@agilex.ai. Please

follow and implement all assembly instructions and guidelines in the chapters of this manual, which is very important. Particular attention should be paid to the text related to the warning signs.

Safety Information

The information in this manual does not include the design, installation and operation of a complete robot application, nor does it include all peripheral equipment that may affect the safety of the complete system. The design and use of the complete system need to comply with the safety requirements established in the standards and regulations of the country where the robot is installed.

SCOUT MINI integrators and end customers have the responsibility to ensure compliance with the applicable laws and regulations of relevant countries, and to ensure that there are no major dangers in the complete robot application. This includes but is not limited to the following:

Effectiveness and responsibility

- Make a risk assessment of the complete robot system.
- Connect the additional safety equipment of other machinery defined by the risk assessment together.
- Confirm that the design and installation of the entire robot system's peripheral equipment, including software and hardware systems, are correct.
- This robot does not have a complete autonomous mobile robot, including but not limited to automatic anti-collision, anti-falling, biological approach warning and other related safety functions. Related functions require integrators and end customers to follow relevant regulations and feasible laws and regulations for safety assessment. To ensure that the developed robot does not have any major hazards and safety hazards in actual applications.
- Collect all the documents in the technical file: including risk assessment and this manual.
- Know the possible safety risks before operating and using the equipment.

Environmental Considerations

- For the first use,please read this manual carefully to understand the basic operating content and operating specification.

- For remote control operation, select a relatively open area to use SCOUT MINI, because SCOUT MINI is not equipped with any automatic obstacle avoidance sensor.
- Use SCOUT MINI always under -10℃~45℃ ambient temperature.
- If SCOUT MINI is not configured with separate custom IP protection, its water and dust protection will be IP22 ONLY.

Pre-work Checklist

- Make sure each device has sufficient power.
- Make sure Bunker does not have any obvious defects.
- Check if the remote controller battery has sufficient power.

Operation

- In remote control operation, make sure the area around is relatively spacious.
- Carry out remote control within the range of visibility.
- The maximum load of SCOUT MINI is 10KG. When in use, ensure that the payload does not exceed 10KG.
- When installing an external extension on SCOUT MINI, confirm the position of the center of mass of the extension and make sure it is at the center of rotation.
- Please charge in tine when the device is low battery alarm. When SCOUT MINI has a defect, please immediately stop using it to avoid secondary damage.
- When SCOUT MINI has had a defect, please contact the relevant technical to deal with it, do not handle the defect by yourself.
- Always use SCOUT MINI in the environment with the protection level requires for the equipment.
- Do not push SCOUT MINI directly.
- When charging, make sure the ambient temperature is above 0℃.

Maintenance

- If the tire is severely worn or burst, please replace it in time.
- If the battery do not use for a long time, it need to charge the battery periodically in 2 to 3 months.

Attention

This Section includes some precautions that should be paid attention to for SCOUT MINI use and development.

Battery precautions

- The battery supplied with SCOUT MINI is not always fully charged in the factory setting, but its specific power capacity can be displayed on the voltmeter at tail end of SCOUT MINI chassis or read via CAN bus communication interface. Once the green indicator light of charger is switched on, it means the battery recharging is completed, but after this indicator light is on, the battery will still be charged slowly with 0.1A current for possibility about 30 minutes;
- Please do not charge the battery after its power has been depleted, and please charge the battery in time when low battery level alarm on SCOUT MINI is on;
- Static storage conditions: The best temperature for battery storage is -10℃ to 45℃; in case of storage for no use, the battery must be recharged and discharged once about every 2 months, and then stored in full voltage state. Please do not put the battery in fire or heat up the battery, and please do not store the battery in high-temperature environment;
- Charging: The battery must be charged with a dedicated lithium battery charger; please do not charge the battery below 0℃ and do no use non-originally standard batteries, power supplies and chargers.

Application environment precautions

- The operating temperature of SCOUT MINI is -10℃ to 45℃; please do not use it below -10℃ and above 45℃ ;
- The requirements for relative humidity in the use environment of SCOUT MINI are: maximum 80%, minimum 30%;
- Please do not use it in the environment with corrosive and flammable gases or closed to combustible substances;
- Do not place it near heaters or heating elements such as large coiled resistors, etc.; Except for specially customized version (IP protection class customized), SCOUT MINI is not water-proof, thus please do not use it in rainy, snowy or water-accumulated environment;
- The elevation of recommended use environment should not exceed 1,000m;
- The temperature difference between day and night of recommend-ed use environment should not exceed 25℃;

Precautions for electrical external extension

- For the extended power supply, the current should not exceed 5 A and the total power should not exceed 120 W;
- When the system detects that the battery voltage is lower than the safe voltage class, external power supply extensions will be actively switched to. Therefore, users are

suggested to notice if external extensions involve the storage of important data and have no power-off protection.

Safety precautions

- In case of any doubts during use, please follow related instruction manual or consult related technical personnel;
- Before use, pay attention to field condition, and avoid mis-operation that will cause personnel
- Without technical support and permission, please do not personally modify the internal equipment structure.

Other notes

- SCOUT MINI has plastic parts in front and rear, please do not directly hit those parts with excessive force to avoid possible damages;
- When handling and setting up, please do not fall off or place the vehicle upside down;
- For non-professionals, please do not disassemble the vehicle without permission.

Contents

1 Introduction to SCOUT MINI

SCOUT MINI intelligent mobile chassis, with 4WD, strong off-road performance and compact body shape, truly achieves "dexterous and flexible". SCOUTMINI inherits the advantages of SCOUT four-wheel differential chassis family, i.e. four-wheel drive, independent suspension, in-situ rotation and so on, and has made innovation in the design of hub motor. The minimum turning radius of the chassis is 0 m, and the climbing angle is close to 30 degrees. SCOUT MINI is still capable of excellent off-road performance although it is only half of SCOUT in size. In addition, it has a breakthrough high-speed, accurate, stable and controllable dynamic control system up to 20 km/h. SCOUTMINI development platform with its own control core, supports standard CAN bus communication, and can access to standard CAN bus communication, as well as all kinds of external equipment. On such basis, it supports secondary development such as ROS and more advanced access and the access of robot development system. Equipped with standard RC transmitter, 24V 15Ah lithium battery power system, its endurance mileage is up to 10 km. Additional components such as stereo camera, laser radar, GPS, IMU, manipulator, etc. can be optionally installed on SCOUT MINI for expanded applications. SCOUT MINI is

frequently used for unattended inspection, security, scientific research, prospecting, logistics, etc.

1.1 Product list

Name	Quantity
SCOUT MINI robot body	x1
Battery charger (AC 220V)	x1
Aviation male plug (4-Pin)	x1
USB to CAN	x1
RC transmitter	x1

1.2 Performance parameters

Type	Items	Parameters

Mechanical	Dimensions (mm)	612x580x245
	Axle Track (mm)	451
	Front/rear track (mm)	490
	Kerb weight (Kg)	23
	Battery type	Lithium battery
	Battery parameters	24V 15Ah
	Power drive motor	DC brushless 4 X 250W (Mecanum wheel 150W)
	Drive type	Independent four-wheel drive
	Steering drive motor	-
	Parking type	Servo brake/anti-collision tube
	Steering type	Four-wheel differential steering
	Suspension	Independent suspension with rocker arm
	Steering motor reduction ratio	-
	Steering motor encoder	-
	Drive motor reduction ratio	1：4.3
	Drive motor sensor	Hall
Performation	IP grade	IP22
	Maximum speed（m/s）	1.5
	Minimum turning radius (mm)	0
	Maximum gradeability (°)	15°
	Ground clearance (mm)	115
	Maximum endurance (h)	3
	Maximum travel (km)	35KM
	Charging time (h)	2H
	Working temperature (℃)	-10C°~40C°

Control	Control mode	Remote control mode Command control mode
	Remote controller	2.4G/limit distance 100M
	Communication Interface	CAN

1.3 Requirement for development

FS RC transmitter is provided optionally in the factory settings of SCOUT MINI and it allows users to control the mobile chassis to move and turn; the CAN provided on SCOUT MINI can be used for secondary development via the CAN interface.

2 The Basics

This Section will basically introduce the basic knowledge about SCOUT MINI mobile robot chassis to users and developers. The overview of an entire mobile robot chassis is shown in Figure 2.1 and Figure 2.2 below.

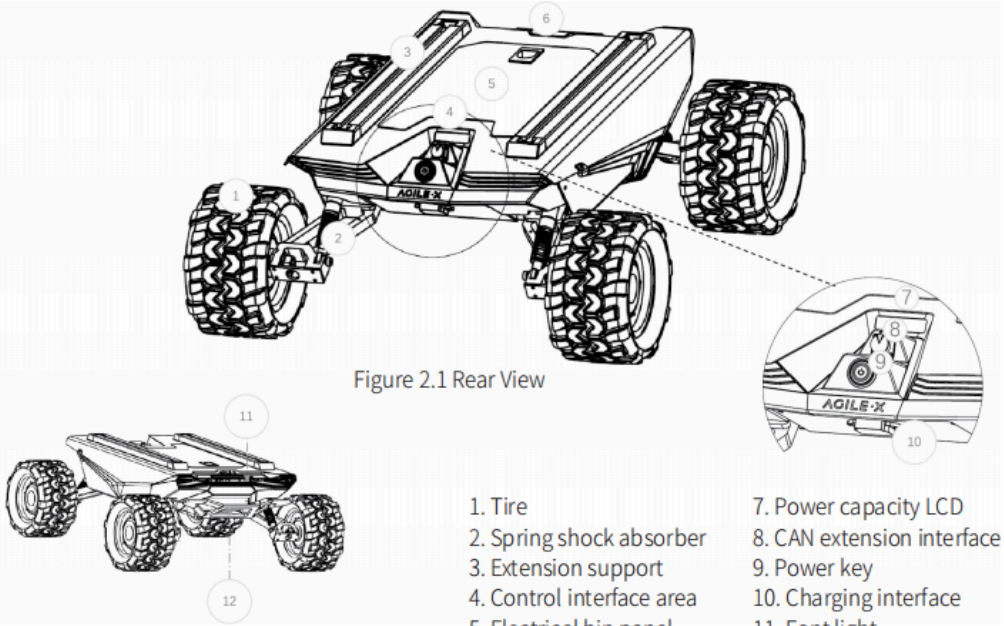


Figure 2.1 Rear View

Figure 2.1 Front View

Based on the concept of modular and intelligent design as a whole, SCOUT MINI combines filled solid tires with independent suspension as its power module, which, along with powerful

hub motor, enables the development platform of SCOUT MINI robot chassis to flexibly move on different ground surfaces with high passing ability and ground adaptability. The hub motor saves the complex transmission structure design and makes it possible for the model to become more compact.

Anti-collision fence is mounted in the front of the vehicle to protect the front and reduce possible damages to the vehicle body during a collision. The front of the vehicle is equipped with white lights, which can be illuminated.

Electrical interfaces for DC power and communication interfaces are provided at the rear of the robot to facilitate secondary development. The electrical interfaces adopt waterproof plug-in components, not only allowing flexible connection between the robot and external components for customers but also allowing the use of the robot even under severe operating conditions.

A standard aluminum extension support is installed at the top of the vehicle to facilitate the use of external equipment extension.

2.1 Status indication

Users can identify the status of vehicle body through the voltmeter, the power supply and lights mounted on SCOUT MINI.

- Tail power switch: When the power switch is pressed, the ring indicator light will enter constant mode.
- Power indication: the tail power display module showing the information of the power capacity and voltage of the current battery.
- Front light: Front width light, can be switched by RC transmitter and command.

2.2 Instructions on electrical interfaces

In the SCOUT MINI tail minimalist design, all electrical interfaces are in the tail. The interfaces include voltage display interactive module, extension interface, power switch and charging interface. The position of each module at the tail is as shown in the figure.2.3.

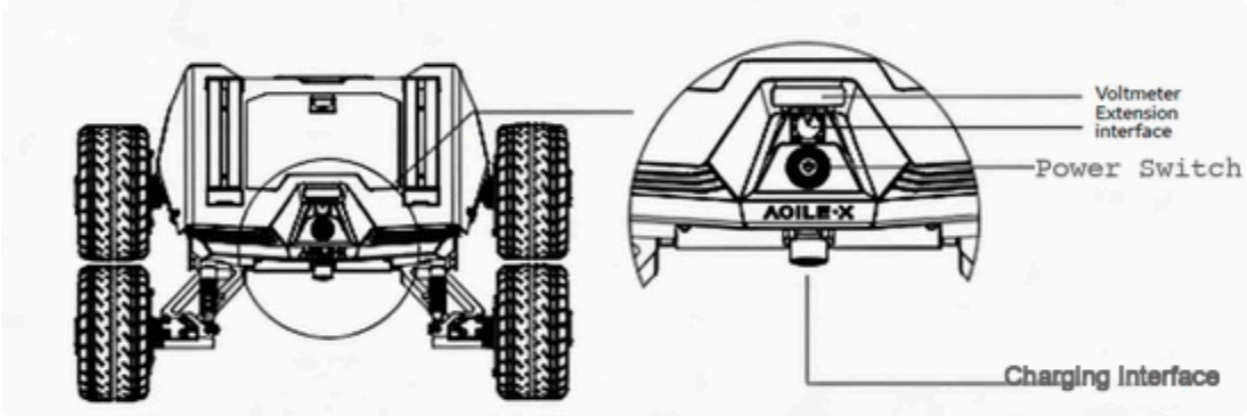
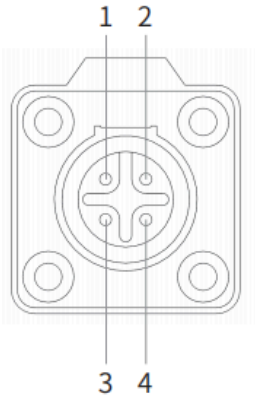


Figure 2.3 Rear Electrical Panel

SCOUT MINI aviation extension interface is configured with both a set of power supplies and a set of CAN communication interfaces. These interfaces can be used to supply power to extended devices and establish communication. The specific definitions of pins are shown in Figure 2.4.



Pin No.	Pin Type	Function and Definition	Remarks
1	Power	VCC	Power positive, voltage range 23 - 29.2V, MAX. current 5A
2	Power	GND	Power negative
3	CAN	CAN_H	CAN bus high
4	CAN	CAN_L	CAN bus low

Figure 2.4 Pin definition figure

2.3 Remote control instructions

FS RC transmitter is an optional feature of SCOUT MINI for users to choose as actually required. With this RC transmitter designed on the left throttle in this product, users can easily control SCOUT MINI universal robot chassis. Its definitions and functions are shown in Figure 2.5 for reference.

The RC transmitter is preset the mapping of keys at factory. Do not arbitrarily change the key mapping, otherwise normal control will be unavailable. The lever SWB switches control mode; the SWC controls speed mode, SWD manual light control switch; the left rocker controls forward and backward movement; the right rocker controls the vehicle for left rotation and right rotation. It is worth noting that the mobile chassis on the internal control is mapped by percentage, so the speed will be constant when the lever is in the same position.

Key1 is used to clear the robot errors on the remote controller. Key2 is to enter setting menu.



Figure 2.5 Schematic diagram of FS controller buttons

Remote control interface description:

Scout : model

Vol: battery voltage

Car: chassis status

Batt: Chassis power percentage

P:Park

Remoter: remote control battery level

Fault Code: Error information (refer to the fault information description table)

2.4 Description of movement by remote control and control by command

A reference coordinate system shown in Figure 3.0 is established in accordance with ISO 8855 standard for moving vehicles on ground.

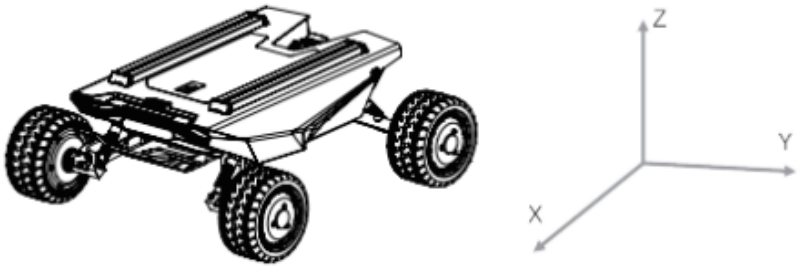
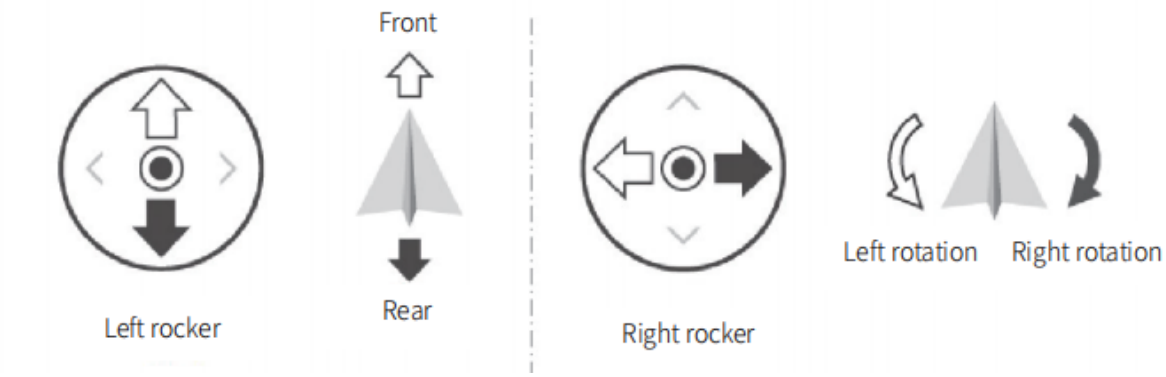


Figure 3.0 Schematic Diagram of Reference Coordinate System for Vehicle Body

As shown in Figure 3.0, the vehicle body of SCOUT MINI is in parallel with X axis of the established reference coordinate system.In the controller mode with RC transmitter, pushing the left rocker of the RC transmitter forward and backward respectively refers to the movement on the positive and negative directions of axis X; when the left rocker of the RC transmitter is pushed to the maximum position, the speed of movement towards the position direction of axis X reaches the maximum; when the left rocker of the RC transmitter is pushed to the minimum position, the speed of movement towards the negative direction of axis X reaches the maximum; the right rocker of the RC transmitter controls the rotational movement of vehicle body to left and right; pushing the right rocker of the RC transmitter to left and right respectively refers to the rotational movement of vehicle body from the positive direction of axis X to the positive direction of axis Y and from the positive direction of axis X to the negative direction of axis Y; when the right rocker of the RC transmitter is pushed to the maximum position on the left, the rotational linear speed on anticlockwise direction reaches the maximum; when the right rocker of the RC transmitter is pushed to the maximum position on the right, the rotational linear speed on clockwise direction reaches the maximum.

In the control command mode, the positive value of linear speed refers to movement towards the positive direction of axis X, and the negative value of linear speed refers to movement towards the negative direction of axis X; the positive value of angular speed refers to the rotational movement of vehicle body from the positive direction of axis X to the positive direction of axis Y, and the negative value of angular speed refers to the rotational movement of vehicle body from the positive direction of axis X to the negative direction of axis Y.



2.5 Instructions on lighting control

The front and back of SCOUT MINI are equipped with lights. For the convenience of users, SCOUT MINI opens the light control interface to the outside world. At the same time, in order to save energy, a lighting control interface is reserved on the remote control. At present, there are 2 light modes of the remote control, and the mode switching can be switched through the SWD lever:

Mode control instructions: The SWD lever is turned to the bottom for the normally closed mode, and the top is for the breathing light mode.

Normally closed mode: In the normally closed mode, if the chassis is stationary, the lights will turn off; if the chassis is traveling at normal speed, the lights will turn on;

Normally on mode: In the normally on mode, if the chassis is stationary, the lights are always on; if in sports mode, the lights are on;

Breathing light mode: The light is in breathing light mode.

2.6 Speed mode description

For the convenience of users, SCOUT MINI has set 2 speed modes, which are low speed and medium speed which can be switched by the SWC lever on the remote control.

Mode control instructions: the SWC lever is turned to the top for medium speed mode, the middle is for low speed mode.

Low speed mode: maximum speed is 0.5 m/s.

Medium speed mode: maximum speed is 1.5 m/s.

3 Getting Started

This Section mainly introduces the basic operation and use of the SCOUT MINI platform and also introduces how to conduct secondary development of the vehicle body via the external CAN ports and CAN bus protocol.

3.1 Use and operation

The basic operating procedure of startup is shown as follows:

Check

Check the condition of the vehicle body. Check whether there are significant anomalies; if so, please contact the after-sale service personnel for support.

Startup

Press the SCOUT MINI power button and wait for a few seconds; Move SWB to the middle and choose the position to be controlled;

You can try to manually switch the light mode and make sure that the mode selection is correct;

Try to gently push the left rocker a little forward, then you can see the vehicle moves forward slowly;

Try to gently push the left rocker a little backward, then you can see the vehicle moves backward slowly;

Release the left rocker, then the vehicle will stop;

Try to gently push the right rocker a little leftward, then you can see the vehicle rotates leftward slowly;

Try to gently push the right rocker a little rightward, then you can see the vehicle rotates rightward slowly;

Release the right rocker, then the vehicle will stop;

Try to control freely in the relatively open area, and get familiarized with the vehicle moving speed.

Shutdown

Press the SCOUT MINI power button to release.

Basic operating procedure of remote control

After SCOUT MINI mobile chassis is started correctly, turn on the RC transmitter and select the remote-control mode. Then, the SCOUT MINI platform motion can be controlled by the RC transmitter.

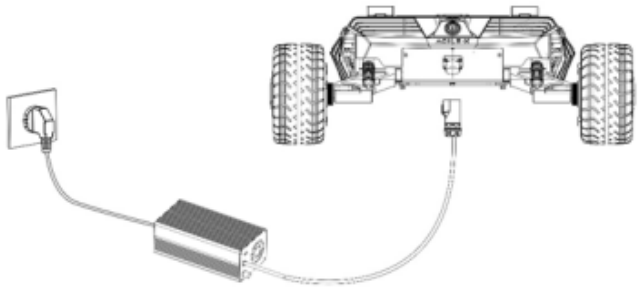
3.2 Charging

SCOUT MINI is equipped with a 10 A charger by default to meet customers' charging demand. The detailed operating procedure of charging is shown as follows:

- Make sure SCOUT MINI chassis is in power-off state.

- Insert the charger plug into the charging interface on the rear of the vehicle;
- Connect the charger to power supply and turn on the switch in the charger. Then, the robot enters the charging state.

Note: For now, the battery needs about 1.5 hours to be fully recharged from 22 V, and the voltage of fully-recharged battery is about 29.2 V; the recharging duration is calculated as 15 AH ÷ 10A = 1.5h.



3.3 Development

SCOUT MINI provides CAN interfaces for customization and development. Users can send command to control the chassis through the CAN interface.

3.3.1 CAN cable connection

SCOUT MINI provides a aviation plug as shown in Picture 3.2, the definitions of the wire are Yellow to CANH and Blue to CANL

Note: There is only the rear external extension interface available for the current SCOUT MINI version and it is able to provide up to 5A current.



Figure 3.2 Schematic diagram of aviation plug male connector

3.3.2 Implementation of CAN command control

Power on SCOUT MINI and turn on the remote control, put the SWB switch to the top position to enable command control mode, so that SCOUT MINI would receive the data from the CAN interface, the host computer is able to receive the current status of the chassis with the can interface, please refer to the CAN protocol as below for detail.

3.3.3 CAN protocol

SCOUT MINI adopts CAN2.0B communication standard which has a communication baud rate of 500K and Motorola message format. Via external CAN bus interface, the moving linear speed and the rotational angular speed of chassis can be controlled; SCOUT MINI will feedback the current motion status information, SCOUT MINI chassis status information, etc. The protocol includes system status feedback frame, movement control feedback frame and control frame, the contents are shown as follows:

The system status feedback command includes the feedback information about current status of chassis, control mode status, battery voltage and system failure. The description is given in Table 3.1.

Table 3.1 SCOUT MINI Chassis Status Feedback Frame

Command Name		System Status Feedback Command		
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x211	200ms	None

Data length	0x08		
Location	Function	Data type	Description
byte [0]	Current status of Chassis	unsigned int8	0x00 Normal condition 0x02 System error
byte [1]	Control mode	unsigned int8	0x00 Stand by 0x01 CAN command control 0x03 Remote control
byte [2] byte [3]	Battery voltage upper 8 bits Battery voltage lower 8 bits	unsigned int16	Actual voltage × 10(Accuracy 0.1V)
byte [4]	Reserve	-	0x00
byte [5]	Failure Information	unsigned int8	Refer to Table3.2 Failure Information Description
byte [6]	Reserve	-	0x00
byte [7]	Count Parity bit (Count)	unsigned int8	0~255 Loops counting. Count is incremented once while single command sent each time

Table 3.2 Description of Failure Information

Failure Information Description		
Byte	Bit	Description

byte [5]	bit [0]	Low-voltage failure(0: Normal 1: Failure) Protection Voltage is 20.5V
	bit [1]	Low-voltage warning[2](0: Normal 1: Warning) Warning voltage is 22.5V
	bit [2]	Remote control signal lost protection(0: Normal 1: Lost signal)
	bit [3]	Drive NO.1 communication failure(0: Normal 1: Failure)
	bit [4]	Drive NO.2 communication failure(0: Normal 1: Failure)
	bit [5]	Drive NO.3 communication failure(0: Normal 1: Failure)
	bit [6	Drive NO.4 communication failure(0: Normal 1: Failure)
	bit [7	Reserved, default value 0

[1]:It is available for V1.2.8 version or later, firmware upgrade is necessary for previous version.

[2]:The buzzer will sound when the battery low-voltage warning , but the chassis is still controllable, and the power supply would be cut off when it comes to Low-voltage failure.

The motion control feedback frame includes the feedback of moving and rotation speed of chassis. Please refer to Table 3.3 for detail.

Table 3.3 Motion Control Feedback Frame

Command Name	Motion Control Feedback Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x221	20ms	None
Data length	0x08			
Position	Function	Data type	Description	

byte [0] byte [1]	Moving speed upper 8 bits Moving speed lower 8 bits	signed int16	Actual speed X 1000 (Accuracy 0.001 m/s)
byte [2] byte [3]	Rotation speed upper 8 bits Rotation speed lower 8 bits	signed int16	Actual speed X 1000 (Accuracy 0.001rad/s)
byte [4] byte [5]	Lateral speed higher 8 bits Lateral speed lower 8 bits	signed int16 signed int16	Actual speed X 1000 (Accuracy 0.001 m/s)(Only available in Mecanum mode)
byte [6]	Reserve	-	0x00
byte [7]	Reserve	-	0x00

The motion control frame includes the controlling of linear speed and angular speed . Please refer to Table 3.4 for detail.

Table 3.4 Motion Command Control Frame

Command Name	Motion Command Control Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Key Unit	Chassis node	0x111	20ms	500ms
Data length	0x08			
Position	Function	Data type	Description	
byte [0] byte [1]	Linear velocity higher 8 bits Linear velocity lower 8 bits	signed int16	Linear moving speed mm/s(unit) Range[-1500,1500]	
byte [2] byte [3]	Angular velocity higher 8 bits Angular velocity lower 8 bits	signed int16	Rotation angular speed 0.001rad/s(unit) Range [-2523,2523]	

byte [4] byte [5]	Lateral velocity higher 8 bits Lateral velocity lower 8 bits	signed int16	Linear moving speed mm/s(unit) Range[-3000,3000](Only available in Mecanum mode)
byte [6]	Reserve	—	0x00
byte [7]	Reserve	—	0x00

The control mode setting frame is used to set the terminal interface. Please refer to Table 3.5 for detail.

Table 3.5 Control Mode Setting Frame

Command Name	Control mode Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Key Unit	Chassis node	0x421	None	None
Data length	0x01			
Location	Function	Data type	Description	
byte [0]	CAN Command Mode	unsigned int8	0x00 Stand by 0x01 CAN Command mode	

Description for control mode

If SCOUT MINI is power on without the connection with remote control, the default control mode is stand by, the chassis would receive the control command only and not respond to the speed command, enable the CAN control mode before using the CAN control. If you power on the remote control, then the remote control has the highest priority, the chassis would switch the control mode based on remote control only.

The status clear frame is used to clear the system failures, please refer to table 3.6 for detail.

Table 3.6 Status Clear Frame

Command Name	Control mode Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Key Unit	Chassis node	0x441	None	None
Data length	0x01			

Location	Function	Data type	Description
byte [0]	Failures clear command	unsigned int8	0x00 Clear all failures 0x01 Clear motor1 failures 0x02 Clear motor2 failures 0x03 Clear motor3 failures 0x04 Clear motor4 failures

[Note] Sample data, the following data is only for testing

1.The chassis moves forward at 0.15m/s.

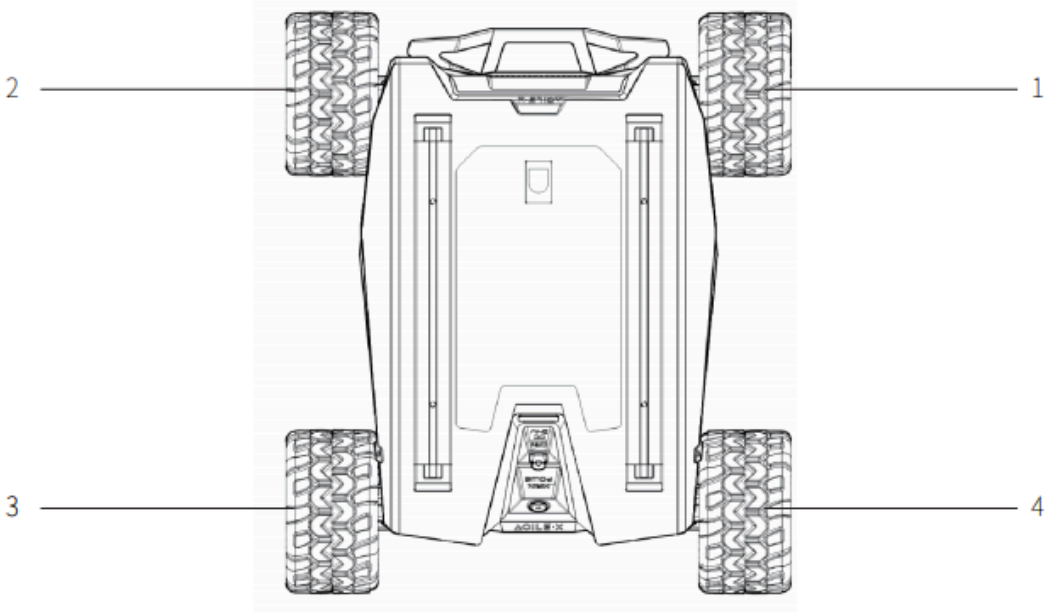
byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x96	0x00	0x00	0x00	0x00	0x00	0x00

2.The chassis steering 0.2rad

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x00	0x00	0x00	0x00	0x00	0x00	0xC8

In addition to the feedback of chassis status, there are also feedback data of the motor current information、encoder data and temperature. Please refer to the table below for the frame detail.

The number of the motor is shown in the picture below:



Picture3.0 Motor ID Feedback

Table 3.7 Motor Rotational Speed and Current Feedback Frame

Command Name	Motor driver high-speed information feedback frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Key Unit	Chassis node	0x251~0x254	20ms	None
Data length	0x08			
Location	Function	Data type	Description	
byte [0] byte [1]	Motor rotational speed upper 8bits Motor rotational speed lower 8bits	signed int16	Motor rotational speed(RPM)	
byte [2] byte [3]	Motor current upper 8bits Motor current lower 8bits	signed int16	Motor current (0.1A)	
byte [4] byte [5] byte [6] byte [7]	Reserved Reserved Reserved Reserved	-	0x00	

Table 3.8 Motor Drive Status Feedback Frame

Command Name	Motor driver low-speed information feedback frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x261~0x264	100ms	None
Data length	0x08			
Location	Function	Data type	Description	

byte [0] byte [1]	Drive voltage upper 8 bit Drive voltage lower 8 bit	unsigned int16	Drive voltage (0.1V)
byte [2] byte [3]	Drive temperature upper 8 bit Drive temperature lower 8 bit	signed int16	Unit: 1℃
byte [4]	Motor temperature	signed int8	Unit: 1℃
byte [5]	Drive status	unsigned int8	Refer to Table 3.9 for detail
byte [6]	Reserved	-	0x00
byte [7]	Reserved	-	0x00

Table 3.9 Drive Status

Byte	Bit	Description
byte[5]	bit[0]	Power supply voltage (0: Normal 1: Low)
	bit[1]	Motor over- temperature (0: Normal 1: Over-temperature)
	bit[2]	Motor over-current(0: Normal 1: Over-current)
	bit[3]	Drive over-temperature(0: Normal 1: Over-temperature)
	bit[4]	Reserved
	bit[5]	Reserved
	bit[6]	Reserved
	bit[7]	Reserved

The front and the external light are also controlled by command, please refer to the Table3.10 below for detail.

Table3.10 Light Control Frame

Command Name	Light control Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x121	100ms	500ms
Data length	0x08			
Location	Function	Data type	Description	
byte [0]	Light control enable sign	unsigned int8	0x00 command invalid 0x01 Light control enable	
byte [1]	Front light	unsigned int8	0x00 Turn on 0x01 Turn off 0x02 Breathing 0x03 Customize brightness	
byte [2]	Front light brightness customization	unsigned int8	Range[0,100] 100 is the brightest[5]	
byte [3]	Reserved	-	0x00	
byte [4]	Reserved	-	0x00	
byte [5]	Reserved	-	0x00	
byte [6]	Reserved	-	0x00	
byte [7]	Count Parity bit (Count)	unsigned int8	0once while single command sent each time~255 Loops counting. Count is incremented	

Note[5] This value is only valid with customization mode

Table 3.11 Light Control Feedback Frame

Command Name	Light control feedback Frame

Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x231	500ms	None
Data length	0x08			
Location	Function	Data type	Description	
byte [0]	Light control enable sign	unsigned int8	0x00 command invalid 0x01 Light control enable	
byte [1]	Front light	unsigned int8	0x00 Turn on 0x01 Turn off 0x02 Breathing 0x03 Customize brightness	
byte [2]	Front light brightness customization	unsigned int8	Range[0,100] 100 is the brightest	
byte [3]	Reserved	-	0x00	
byte [4]	Reserved	-	0x00	
byte [5]	Reserved	-	0x00	
byte [6]	Reserved	-	0x00	
byte [7]	Count Parity bit (Count)	unsigned int8	0once while single command sent each time~255 Loops counting. Count is incremented	

Table 3.12 System Version Enquiry Frame

Command Name	System Version Enquiry Command			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Key Unit	Chassis node	0x411	None	None
Data length	0x01			
Location	Function	Data type	Description	

byte [0]	System version enquiry	unsigned int8	0x01 Fixed value

Table 3.13 System Version feedback Frame

Command Name	System version information feedback frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x41A	None	None
Data length	0x08			
Location	Function	Data type	Description	
byte [0] byte [1]	Main board hardware version upper 8 bit Main board hardware version lower 8 bit	unsigned int16	Upper 8 bit is main version Lower 8 bit is second version	
byte [2] byte [3]	Drive hardware version upper 8 bit Drive hardware version lower 8 bit	unsigned int16	Upper 8 bit is main version Lower 8 bit is second version	
byte [4] byte [5]	Main board software version upper 8 bit Main board software version lower 8 bit	unsigned int16	Upper 8 bit is main version Lower 8 bit is second version	

byte [6] byte [7]	Drive software version upper 8 bit Drive software version lower 8 bit	unsigned int16	Upper 8 bit is main version Lower 8 bit is second version

Table 3.14 Odometer Feedback Frame

Command Name	Odometer Feedback Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x311	20ms	None
Data length	0x08			
Location	Function	Data type	Description	
byte [0] byte [1] byte [2] byte [3]	Left wheel odometer highest bit Left wheel odometer second highest bit Left wheel odometer second lowest bit Left wheel odometer lowest bit	signed int32	Left wheel odometer feedback (Unit: mm)	

byte [4] byte [5] byte [6] byte [7]	Right wheel odometer highest bit Right wheel odometer second highest bit Right wheel odometer second lowest bit Right wheel odometer lowest bit	signed int32	Right wheel odometer feedback (Unit: mm)

Table 3.15 Remote Control Feedback Frame

Command Name	Remote Control Feedback Frame			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Key unit	0x241	20ms	None
Data length	0x08			
Location	Function	Data type	Description	
byte[0]	SW feedback	unsigned int8	bit[0-1]: SWA： 2- Up 3-Down bit[2-3]: SWB : 2-Up 1-Middle 3-Down bit[4-5]: SWC : 2-Up 1-Middle 3-Down bit[6-7]: SWD： 2-Up 3-Down	
byte[1]	Right joystick left and right	signed int8	Range[-100,100]	
byte[2]	Right joystick up and down	signed int8	Range[-100,100]	
byte[3]	Left joystick up and down	signed int8	Range[-100,100]	

byte[4]	Left joystick left and right	signed int8	Range[-100,100]
byte[5]	Left knob VRA	signed int8	Range[-100,100]
byte[6]	Reserved	--	0x00
byte [7]	Count Parity bit	Unsigned int8	0~255 Loops counting

3.4 Firmware upgrade

To facilitate the customer's upgrading of the firmware version used by SCOUT MINI and bring the customer a better experience, SCOUT MINI provides a hardware interface for the firmware upgrading, and the corresponding client software as well.

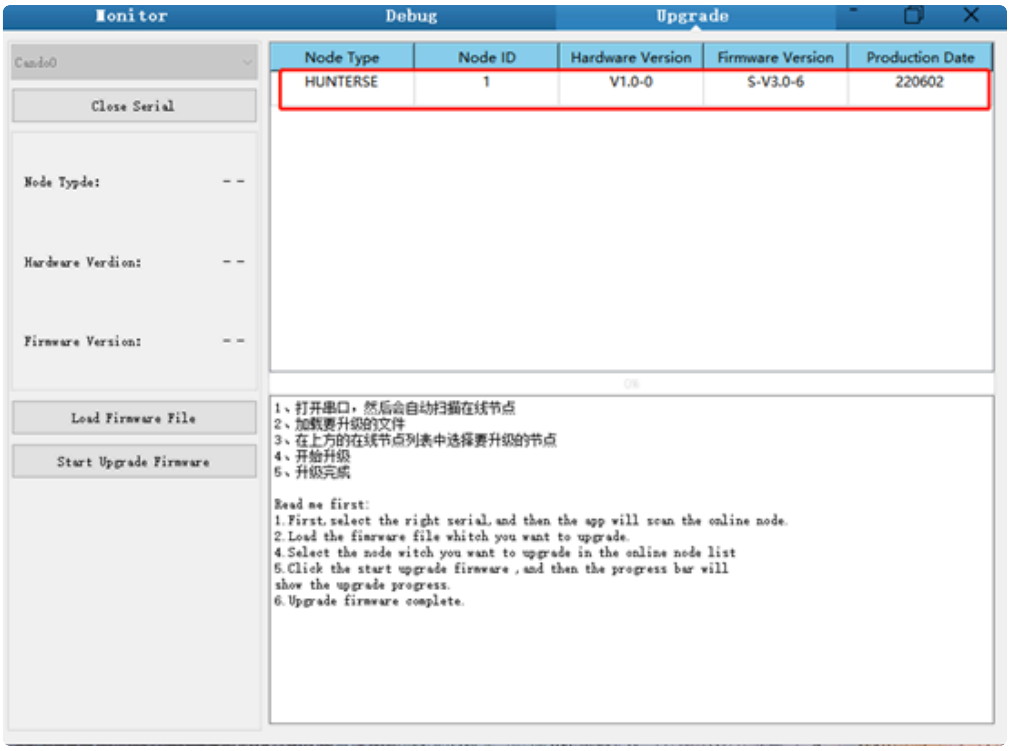
Upgrade Preparation

- Agilex CAN debugging module X 1
- Micro USB cable X 1
- SCOUT MINI chassis X 1
- A computer (WINDOWS OS (Operating System)) X 1

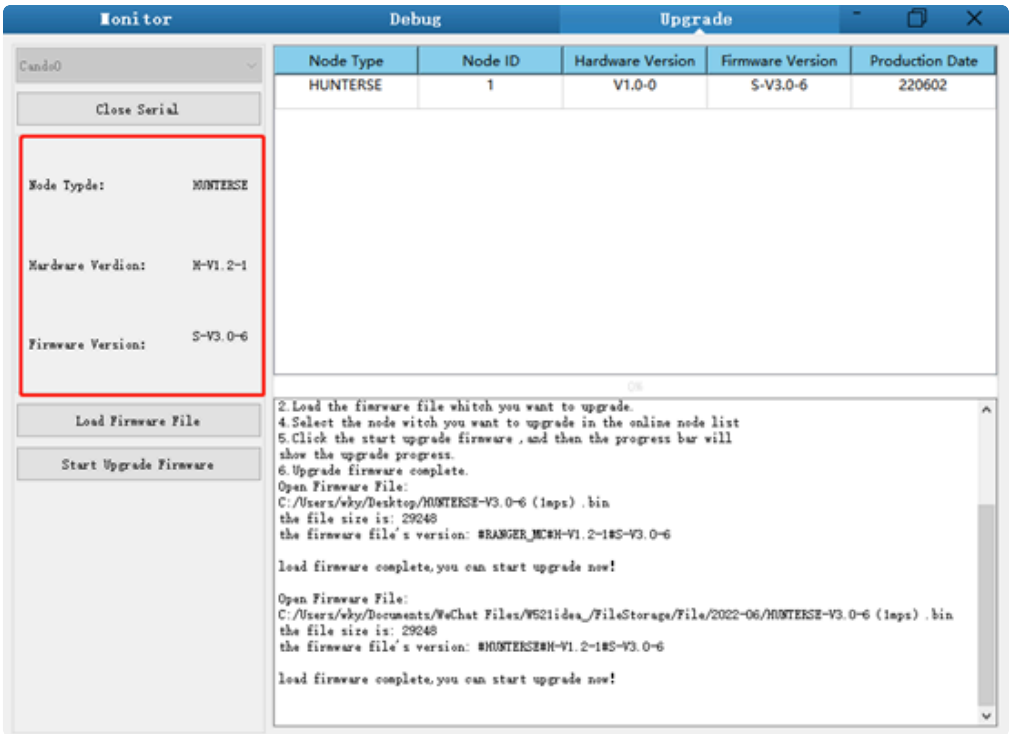
Upgrade Process

1.Plug in the USBTOCAN module on the computer, and then open the AgxCandoUpgradeToolV1.3_boxed.exe software (the sequence cannot be wrong, first open the software and then plug in the module, the device will not be recognized).

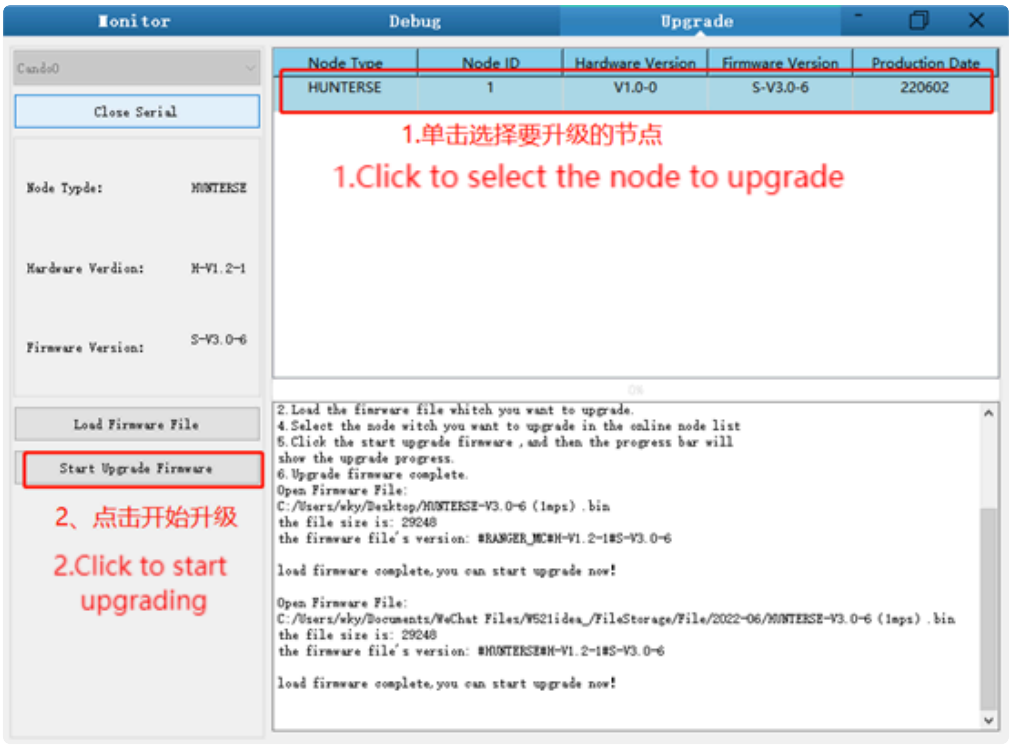
2.Click the Open Serial button, and then press the power button on the car body. If the connection is successful, the version information of the main control will be recognized, as shown in the figure.

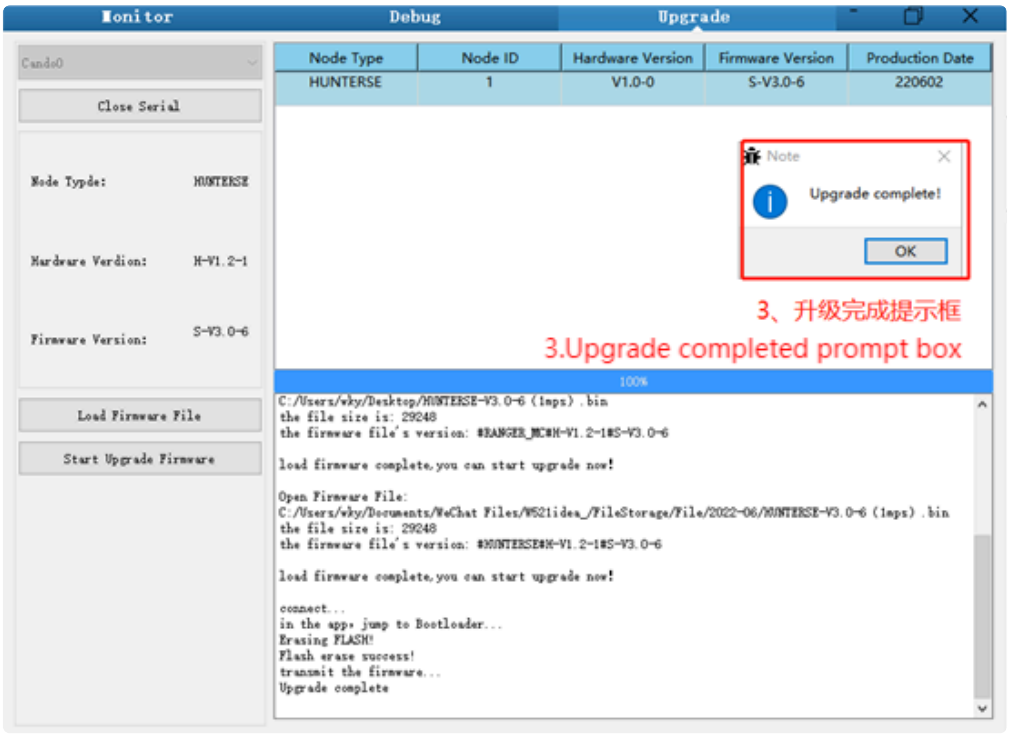


3.Click the Load Firmware File button to load the firmware to be upgraded. If the loading is successful, the firmware information will be obtained, as shown in the figure



4.Click the node to be upgraded in the node list box, and then click Start Upgrade Firmware to start upgrading the firmware. After the upgrade is successful, a pop-up box will prompt.





3.5 SCOUT MINI ROS Package

ROS provide some standard operating system services, such as hardware abstraction, low-level device control, implementation of common function, interprocess message and data packet management. ROS is based on a graph architecture, so that process of different nodes can receive, and aggregate various information (such as sensing, control, status, planning, etc.) Currently ROS mainly support UBUNTU.

Development Preparation

Hardware preparation

- CANlight can communication module ×1
- Thinkpad E470 notebook ×1
- SCOUT MINI mobile robot chassis ×1
- SCOUT MINI remote control FS-i6s ×1
- SCOUT MINI top aviation power socket ×1

Use example environment description

- Ubuntu 16.04 LTS (This is a test version, tasted on Ubuntu 18.04 LTS)
- ROS Kinetic (Subsequent versions are also tested)
- Git

Hardware connection and preparation

- Lead out the CAN wire of the SCOUT MINI top aviation plug or the tail plug, and connect CAN_H and CAN_L in the CAN wire to the CAN_TO_USB adapter respectively;
- Turn on the knob switch on the SCOUT MINI mobile robot chassis, and check whether the emergency stop switches on both sides are released;
- Connect the CAN_TO_USB to the USB hub of the laptop. The connection diagram is shown in Figure 3.4.

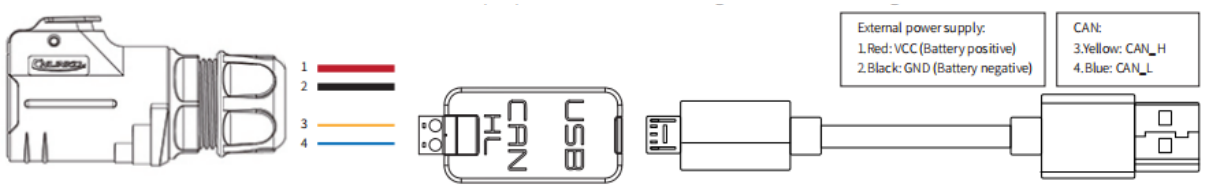


Figure 3.4 CAN Connection Diagram

ROS installation and environment setting

For installation details, please refer to

http://wiki.ros.org/kinetic/Installation/Ubuntu

Test CANABLE hardware and CAN communication

Setting CAN-TO-USB adaptor

- Enable gs_usb kernel module

```
$ sudo modprobe gs_usb
```

- Setting 500k Baud rate and enable can-to-usb adaptor

$ sudo ip link set can0 up type can bitrate 500000

- If no error occurred in the previous steps, you should be able to use the command to view the can device immediately

$ ifconfifig -a

- Install and use can-utils to test hardware

$ sudo apt install can-utils

- If the can-to-usb has been connected to the SCOUT MINI robot this time, and the car has been turned on, use the following commands to monitor the data from the SCOUT MINI chassis

$ candump can0

Please refer to:

[1]https://github.com/agilexrobotics/agx_sdk

[2]https://wi-ki.rdu.im/_pages/Notes/Embedded-System/Linux/-can-bus-in-linux.html

AGILEX SCOUT MINI ROS PACKAGE download and compile

- Download ros package

$ sudo apt install -y libasio-dev
$ sudo apt install -y ros-$ROS_DISTRO-teleop-twist-keyboard

- Clone compile SCOUT MINI code

$ cd ~/catkin_ws/src
$ git clone https://github.com/agilexrobotics/ugv_sdk.git
$ git clone https://github.com/agilexrobotics/scout_ros.git
$ cd ..
$ catkin_make

Please refer to: https://github.com/agilexrobot-ics/scout_mini_ros

Start the ROS node

- Start the based node

$ roslaunch scout_bringup scout_mini_robot_base.launch

- Start the keyboard remote operation node

$ roslaunch scout_bringup scout_teleop_keyboard.launch

Github ROS development package directory and usage instructions

*_base:: The core node for the chassis to send and receive hierarchical CAN messages. Based on the communication mechanism of ros, it can control the movement of the chassis and read the status of the bunker through the topic.

*_msgs: Define the specific message format of the chassis status feedback topic.

*_bringup: startup files for chassis nodes and keyboard control nodes, and scripts to enable the usb_to_can module.

4 Q&A

Q: SCOUT MINI is started up correctly, but why cannot the RC transmitter control the vehicle body to move?

A: First, check whether the drive power supply is in normal condition, whether the drive power switch is pressed down and whether E-stop switches are released; then, check whether the control mode selected with the top left mode selection switch on the RC transmitter is correct.

Q: SCOUT MINI RC transmitter is in normal condition, and the information about chassis status and movement is all fed back correctly, but when the control frame protocol is issued, why cannot the vehicle body control mode be switched and the chassis respond to the control frame protocol?

A: Normally, if SCOUT MINI can be controlled by a RC transmitter, it means the chassis movement is under proper control; if the chassis feedback frame can be accepted, it means CAN extension link is in normal condition. Please check the CAN control frame sent to see whether the data check is correct and whether the control mode is command control mode. You can check the status of error flag from the error bit in the chassis status feedback frame.

Q: SCOUT MINI gives "beep-beep-beep..." sound when running, how to deal with this problem?

A: If SCOUT MINI give this "beep-beep-beep" sound continuously, it means the battery is in the alarm voltage state. Please charge the battery in time. Once other related sound occurs, there may be internal errors. You can check related error codes via the CAN bus or communicate with related technical personnel.

Q: Is the tire wear of SCOUT MINI is normally seen when it is running?

A: The tire wear of SCOUT MINI is normally seen when it is running. As SCOUT MINI is based on the four-wheel differential steering design, sliding friction and rolling friction both occur

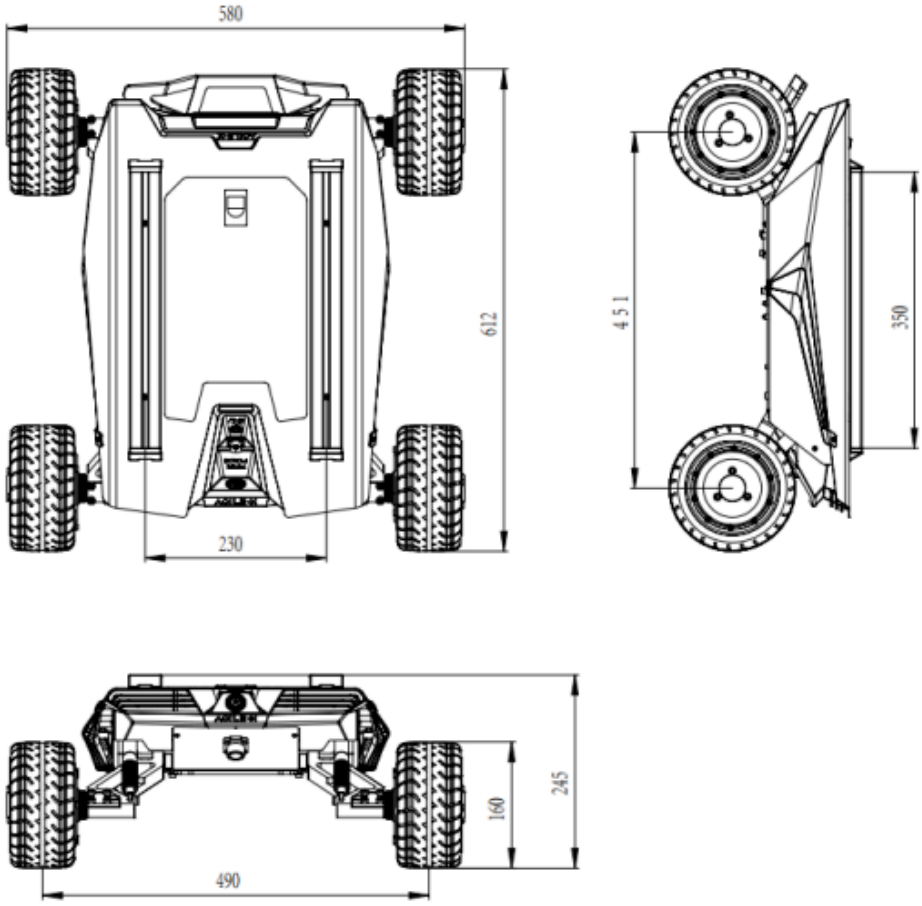
when the vehicle body rotates. If the floor is not smooth but rough, tire surfaces will be worn out. In order to reduce or slow down the wear, small-angle turning can be conducted for less turning on a pivot.

Q: When communication is implemented via CAN bus, the chassis feedback command is issued correctly, but why does not the vehicle respond to the control command?

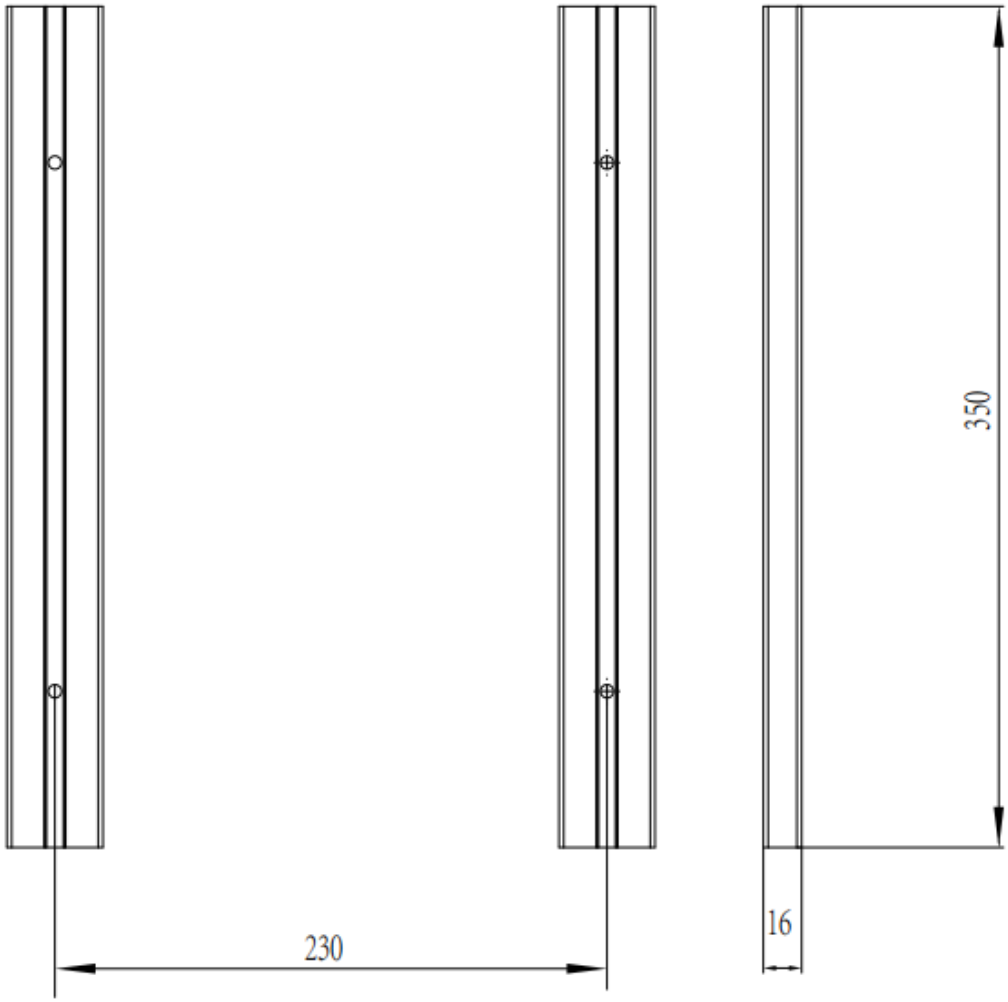
A: There is a communication protection mechanism inside SCOUT MINI, which means the chassis is provided with timeout protection when processing external CAN control commands. Suppose the vehicle receives one frame of communication protocol, but it does no receive the next frame of control command after 500 ms. In this case, it will enter communication protection mode and set the speed to 0. Therefore, commands from upper computer must be issued periodically.

5 Product Dimensions

5.1 Illustration diagram of product external dimensions



5.2 Illustration diagram of top extended support dimensions


350
230
16