SCOUT MINI (OMNI)

AgileX Robotics Team

User Manual V.2.0.0 2020.08

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. SCOUTMINI(OMNI) 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:

1.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.

2.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(OMNI), because SCOUT MINI(OMNI) is not equipped with any automatic obstacle avoidance sensor.
- Use SCOUT MINI(OMNI) always under 0°C~40°C ambient temperature.
- If SCOUT MINI(OMNI) is not configured with separate custom IP protection, its water and dust protection will be IP22 ONLY.

3.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.

4.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(OMNI) is 50KG. When in use, ensure that the payload does not exceed 50KG.
- When installing an external extension on SCOUT MINI(OMNI), 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(OMNI) has a defect, please immediately stop using it to avoid secondary damage.
- When SCOUT MINI(OMNI) has had a defect, please contact the relevant technical to deal with it, do not handle the defect by yourself.
- Always use SCOUT MINI(OMNI) in the environment with the protection level requires for the equipment.
- Do not push SCOUT MINI(OMNI) directly.
- When charging, make sure the ambient temperature is above 0°C.

5.Maintenance

- Tires are consumables, if the tire is severely worn, 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.

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1 SCOUT MINI (OMNI)Introduction

SCOUT MINI(OMNI) intelligent mobile chassis adopts four-wheel drive and has powerful off-road performance and small figure, realize that "smart like swallow, gallop like heart". SCOUT MINI (OMNI) adopts omnidirectional drive technology, and the unique operation mode of the Mecanum wheel can realize translation and rotation in place in any direction. While SCOUT MINI(OMNI) is half the size of SCOUT, it still has excellent off-road performance. At the same time, it achieves a breakthrough high-speed, precise, stable and controllable power control system of 10.8km/h. The SCOUT MINI(OMNI) development platform comes with a control core, supports standard CAN bus communication, can access standard CAN bus communication, and various external devices. On this basis, it supports secondary development such as ROS and access to more advanced and robot development systems. Equipped with standardremote control transmiter, 24V15Ah lithium battery power system, cruising range up to 10KM. Stereo camera, laser radar, GPS, IMU, manipulators and other equipment can be optionally added to SCOUT MINI(OMNI) as extended applications. SCOUT MINI(OMNI) can be applied to unmanned inspection, security, scientific research, exploration, logistics and other fields.

1.1 Component list

Name	Quantity
SCOUT MINI Robot body	x1
Battery charger(AC 220V)	x1
Aviation plug (male, 4-pin)	x1
USB to RS232 cable	x1
USB to CAN cable	x1
Remote control transmitter	x1

1.2 Tech specifications

Parameter Types	项目	指标
Mechanical specifications	L × W × H (mm)	625x585x222
	Wheelbase (mm)	475
	Front/rear wheel base (mm)	540
	Weight of vehicle body (kg)	20
	Battery type	Lithium battery 24V 15AH
	Motor	DC brushless 4 X 150W
	Drive type	Independent four-wheel drive
	Suspension	Independent suspension with rocker arm
	Steering	Four-wheel differential steering
	Safety equipment	Servo brake/anti-collision tube
Motion	No-load highest speed (km/h)	10.8
	Minimum turning radius	Be able to turn on a pivot
	Maximum climbing capacity	30°
	Minimum ground clearance (mm)	107
Control	Control mode	Remote control Command control mode
	RC transmitter	2.4G / extreme distance 1Km
	Communication interface	CAN

1.3 Development requirements

RC transmitter is provided (optional) in the factory setting of SCOUT MINI, which allows users to control the chassis of robot to move and turn; CAN interfaces on SCOUT MINI can be used for user' s customization.

2 The Basics

This section provides a brief introduction to the SCOUT MINI (OMNI) mobile robot platform, as shown in Figure 2.1 and Figure2.2.

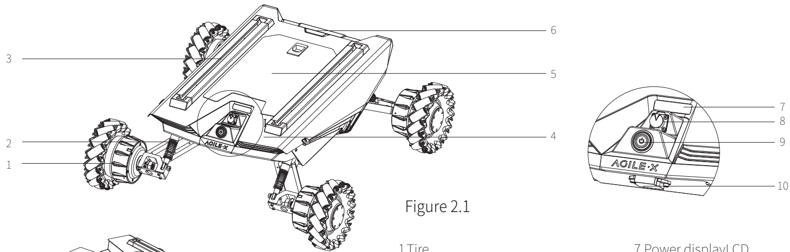


Figure 2.1

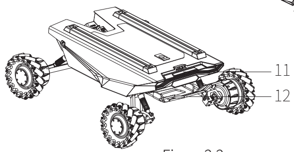


Figure2.2

1.Tire
2.Shock absorber spring
3.Expansion bracket
4.Control interface area
5.Electrical compartment panel
6.Tail light
7.Power displayLCD
8.CAN expansion interface
9.Power button
10.Charging interface
11.Front light
12 Front Collision Tube

The overall design of SCOUT MIN (OMNI) I adopts modular and intelligent design ideas. The composite design of filled solid tires and independent suspension on the power module, coupled with powerful wheel motors, make the SCOUT MINI(OMNI) robot chassis development platform have a strong through ability and ground adaptability. It can move flexibly on different grounds.The hub motor can save the design of complex transmission structure and make it possible to make the model smaller.

Anti-collision beam is mounted on the front of the vehicle to protect the front of the car body and reduce possible damages to the vehicle body during a collision. Light is mounted at front of the vehicle, of which the white light is designed for illumination in front.

Water-proof connectors for DC power and communication interfaces are provided at the rear of the robot, which not only allow flexible connection between the robot and external components but also ensures necessary protection to the internal of the robot even under severe operating conditions.

A standard aluminum profile expansion bracket is installed on the top of the car body, which is convenient for users to expand and use external equipment.

2.1 Robot status indication

Users can identify the status of vehicle body through the voltmeter, the beeper and lights mounted on SCOUT MINI (OMNI) .

- Rear power switch: When the power switch is pressed, its ring indicator will enter the constant mode;
- Power indication: the tail power display module displays current battery power information and voltage information;
- Front light: front indicator light, switchable by remote control and commands

2.2 Instructions on electrical interfaces

Simple design at the rear of SCOUT MINI(OMNI), all electrical interfaces are at the rear the body. Its interfaces includes voltage display interactive module, expansion interface, power button and charging interface. The position of each module at the rear is shown in the figure 2.3.

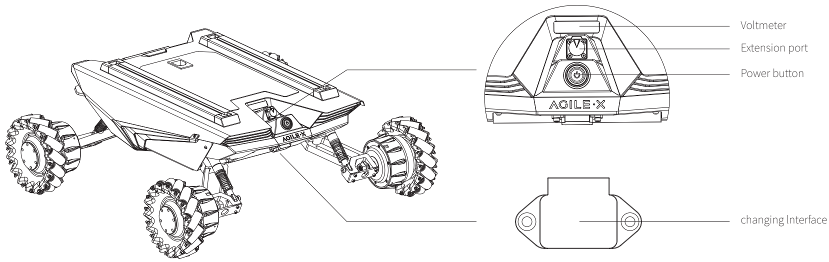
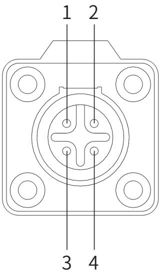


Figure 2.3 Schematic diagram of the rear electrical panel

SCOUT MINI (OMNI) configuration aviation extension interface is configured with a set of power supply and a set of CAN communication interface. 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 Instruction on the remote control

FS RC transmitter is an optional accessory of SCOUT MINI(OMNI) for manually the robot. Use the transmitter can easy control the SCOUT MINI(OMNI) robot chassis. The transmitter comes with a left-hand-throttle configuration. The definition and function shown in Figure 2.5.

The remote control has preset the key map, please do not change the key map casually. SWB for control mode selection, SWC for manual lighting control, SWD for control speed mode. The left stick controls forward and backward, and the right remote controls the car to rotate left and right. It is notable that the movement of the chassis on the internal control is mapped according to the percentage, so when the stick is in the same position, its speed is constant.

1.SWA
2.SWB
3.SWC
4.SWD
5.Left stick
6.Right stick
7.Power button 1
8.Power button 2
9.Phone/tablet fixed bracket interface
10.Ring interface
11.LCD panel

*When the customer gets the remote control, all the settings have been set don’ t need to set individually

Figure 2.5 Schematic Diagram of Buttons on FS RC transmitter

2.4 Instruction on remote control and command control

A reference coordinate system can be defined and fixed on the vehicle body as shown in Figure 2.6 in accordance with ISO 8855.

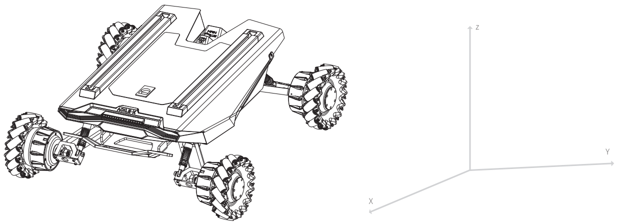
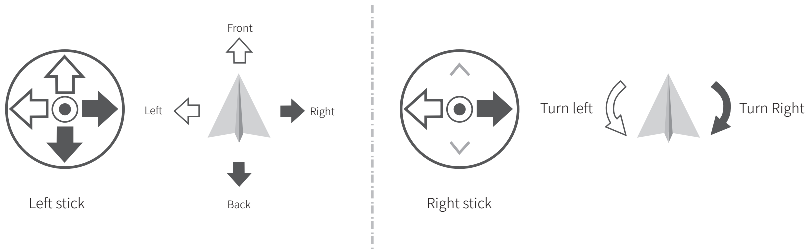


Figure 2.6 Schematic Diagram of Reference Coordinate System for Vehicle Body

As shown in Figure 3.0, the vehicle body of SCOUT MINI(OMNI) is in parallel with X axis of the established reference coordinate system. Following this convention, a positive linear velocity corresponds to the forward movement of the vehicle along positive x-axis direction and a positive angular velocity corresponds to positive right-hand rotation about the z-axis.When the left stick of the remote control is pushed to the maximum, the movement speed in the X direction is the largest, and when the left stick of the remote control is pushed to the minimum, the movement speed in the negative direction of the X direction is the larges. The right stick of the remote control controls the rotation of the car body. In the manual control mode with a RC transmitter, pushing the right stick forward will generate a positive linear velocity command and pushing left stick to the left will generate a positive angular velocity command.



2.5 Instructions on lighting control

Lights are mounted in front and at back of SCOUT MINI (OMNI), and the lighting control interface of SCOUT MINI (OMNI) is open to the users for convenience. Meanwhile, another lighting control interface is reserved on the RC transmitter for energy saving.

There are 3 kinds of lighting modes controlled with RC transmitter, which can be switched among each other by SWC toggling:

Note on mode control:

Toggling SWC lever respectively refers to NC mode, NO mode and BL mode in bottom, middle and top positions.

- NC mode: In NC mode, if the chassis is still, the front light will be turned off; if the chassis is in the traveling state at certain normal speed, the rear light will be turned on;
- NO mode: In NO mode, if the chassis is still, the front light will be normally on, and the rear light will enter the BL mode to indicate the still status; if in movement mode, the rear light is turned off but the front light is turned on;
- BL mode: Front and rear lights are both in breathing mode under all circumstances.

3 Getting Started

This section introduces the basic operation and development of the SCOUT MINI(OMNI) platform using the CAN bus interface.

3.1 Use and operation

The basic operating procedure of startup is shown as follows:

Check

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

Startup

- Press the SCOUT MINI (OMNI)power button and wait a few seconds;
- Toggling SWB to the middle, and the gear should be controlled in the location;
- You can toggle the light mode manually, make sure the mode selection is correct;
- Try to push the left stick forward slightly, just push a small part, it can be seen that the car moves forward slowly;
- Try to push the left stick back slightly, just push a small part, it can be seen that the car moves back slowly;
- Try to push the left stick to the left, just push a small part, it can be seen that the car slowly rotate to the left;
- Try to push the left stick to the right, just push a small part, it can be seen that the car slowly rotate to the right;
- Release the left stick, the car stop;
- Try to push the right stick to the left, just push a small part, it can be seen that the car slowly rotate to the left;
- Try to push the right stick to the right, just push a small part, it can be seen that the car slowly rotate to the right;
- Release the right stick, the car stop;
- You can try to control freely in a relatively empty area, and familiar with the speed of the vehicle.

Shut down

- Press the SCOUT MINI（OMNI）power button and release it;

Basic operating procedure of remote control:

- After the chassis of SCOUT MINI（OMNI）mobile robot is started correctly, turn on the RC transmitter and select the remote-control mode. Then, SCOUT MINI（OMNI）platform movement can be controlled by the RC transmitter.

3.2 Charging

SCOUT MINI（OMNI）is equipped with a 10A charger by default to meet customers' recharging demand.

The detailed operating procedure of charging is shown as follows:

- Make sure the electricity of SCOUT MINI（OMNI) chassis is powered off.
- Insert the plug of the charger into the rear charging port;
- Connect the charger to the power supply, turn on the switch of the charger, and enter the charging state.

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

3.3 Communication using CAN

SCOUT MINI（OMNI）provides CAN and RS232 interfaces for user customization. Users can use CAN command to control the vehicle.

3.3.1 CAN message protocol

SCOUT MINI（OMNI）adopts CAN2.0B communication standard which has a communication baud rate of 500K and Motorola message format. Via external CAN bus interface, the moving liner speed and the rotational angular speed of chassis can be controlled; SCOUT MINI（OMNI) will feedback on the current movement status information and its chassis status information in real time.

The protocol includes system status feedback frame, movement control feedback frame and control frame, the contents of which are shown as follows:

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

Table 3.1 Feedback Frame of SCOUT MINI Chassis System Status

Command Name	系统状态回馈指令			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x151	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Current status of vehicle body	unsigned int8	0x00 System in normal condition 0x01 Emergency stop mode 0x02 System exception	
byte [1]	Mode control	unsigned int8	0x00 Remote control mode 0x01 CAN command control mode[1] 0x02 Serial port control mode	
byte [2] byte [3]	Battery voltage higher 8 bits Battery voltage lower 8 bits	unsigned int16	Actual voltage X 10 (with an accuracy of 0.1V)	
byte [4] byte [5]	Failure Information higher 8 bits Failure Information lower 8 bits*	unsigned int16	See notes for details[Table 3.2]	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Table 3.2 Description of Failure Information

Failure Information Description		
字节	位	含义
byte [4]	bit [0]	Check error of CAN communication control command (0:No failure 1:Failure)
	bit [1]	Motor drive over-temperature alarm[1] (0:No alarm 1:Alarm) Temperature limited ti55°C
	bit [2]	Motor over-current alarm[1] (0:No alarm 1:Alarm) Current effective value 15A
	bit [3]	Battery under-voltage alarm (0:No alarm 1:Alarm) Alarm voltage 22.5V
	bit [4]	RC transmitter disconnection protection (0:Normal 1:RC transmitter disconnected)
	bit [5]	Reserved, default 0
	bit [6]	Reserved, default 0
	bit [7]	Reserved, default 0
byte [5]	bit [0]	Battery under-voltage Failure (0:No failure 1:Failure) Protective voltage 22V
	bit [1]	Battery over-voltage Failure (0:No failure 1:Failure)
	bit [2]	No.1 motor communication failure (0:No failure 1:Failure)
	bit [3]	No.2 motor communication failure (0:No failure 1:Failure)
	bit [4]	No.3 motor communication failure (0:No failure 1:Failure)
	bit [5]	No.4 motor communication failure (0:No failure 1:Failure)
	bit [6]	Motor drive over-temperature protection[2] (0:No protection 1:Protection) Temperature limited to 65°C
	bit [7]	Motor over-current protection[2] (0:No protection 1:Protection) Current effective value 20A

[1]: The subsequent versions of robot chassis firmware version after V1.2.8 are supported, but previous versions need to be updated before supported.

[2] The over-temperature alarm of motor drive and the motor over-current alarm will not be internally processed but just set in order to provide for the upper computer to complete certain pre-processing. If drive over-current occurs, it is suggested to reduce the vehicle speed; if over-temperature occurs, it is suggested to reduce the speed first and wait the temperature to decrease. This flag bit will be restored to normal condition as the temperature decreases, and the over-current alarm will be actively cleared once the current value is restored to normal condition;

[3]: The over-temperature protection of motor drive and the motor over-current protection will be internally processed. When the temperature of motor drive is higher than the protective temperature, the drive output will be limited, the vehicle will slowly stop, and the control value of movement control command will become invalid. This flag bit will not be actively cleared, which needs the upper computer to send the command of clearing failure protection. Once the command is cleared, the movement control command can only be executed normally.

The command of movement control feedback frame includes the feedback of current linear speed and angular speed of moving vehicle body. For the detailed content of protocol, please refer to Table 3.3.

Table 3.3 Movement control feedback frame

Command Name	Movement control feedback command			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x131	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Moving speed higher 8 bits	signed int16	Actual speed X 1000 (with an accuracy of 0.001m/s)	
byte [1]	Moving speed lower 8 bits			
byte [2]	Rotational speed higher 8 bits	signed int16	Actual speed X 1000 (with an accuracy of 0.001rad/s)	
byte [3]	Rotational speed lower 8 bits			
byte [4]	Reserved	signed int16	0x00	
byte [5]	Reserved		0x00	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

The control frame includes mode control, failure clearing command, control openness of linear speed, control openness of angular speed and checksum. For its detailed content of protocol, please refer to Table 3.4.

Table 3.4 Control Frame of Movement Control Command

Command Name	Control Command			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Decision-making control unit	Chassis node	0x130	20ms	500ms
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Control mode	unsigned int8	0x00 Remote control mode 0x01 CAN command control mode [1] 0x02 Serial port control mode	
byte [1]	Failure clearing command	unsigned int8	See notes for details2*	
byte [2]	Linear speed percentage	signed int8	Maximum speed 3m/s, value range (-100, 100)	
byte [3]	Angular speed percentage	signed int8	Maximum speed 2.5235rad/s,value range (-100, 100)	
byte [4]	Transverse linear velocity percentage	signed int8	Maximum speed 2.0m/s,value range (-100, 100)	
byte [5]	Reserved	—	0x00	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Note 1 - Control mode instructions

In case the RC transmitter is powered off, the control mode of SCOUT MINI(OMNI) is defaulted to command control mode, which means the chassis can be directly controlled via command. However, even though the chassis is in command control mode, the control mode in the command needs to be set to 0x01 for successfully executing the speed command. Once the RC transmitter is switched on again, it has the highest authority level to shield the command control and switch over the control mode.

Note 2 - Information about failure clearing command:

- 0x00 No failure clearing command
- 0x01 Clear battery under-voltage failure
- 0x02 Clear battery over-voltage failure
- 0x03 Clear No.1 motor communication failure
- 0x04 Clear No.2 motor communication failure
- 0x05 Clear No.3 motor communication failure
- 0x06 Clear No.4 motor communication failure
- 0x07 Clear motor drive over-temperature failure
- 0x08 Clear motor over-current failure

Note 3 - Example data: The following data is only used for testing

1, The vehicle moves forward at 0.15m/s.

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x01	0x00	0x0a	0x00	0x00	0x00	0x00	0x44

2. The vehicle rotates at 0.05235rad/s

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x01	0x00	0x00	0x0a	0x00	0x00	0x00	0x44

3. When the vehicle stays still, switch the control mode to command mode (test without RC transmitter switched on)

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x01	0x00	0x00	0x00	0x00	0x00	0x00	0x3a

The chassis status information will be fed back; what' s more, the information about motor current, encoder and temperature are also included. The following feedback frame contains the information about motor current, encoder and motor temperature:

The serial numbers of 4 motors in the chassis are shown in the figure below:

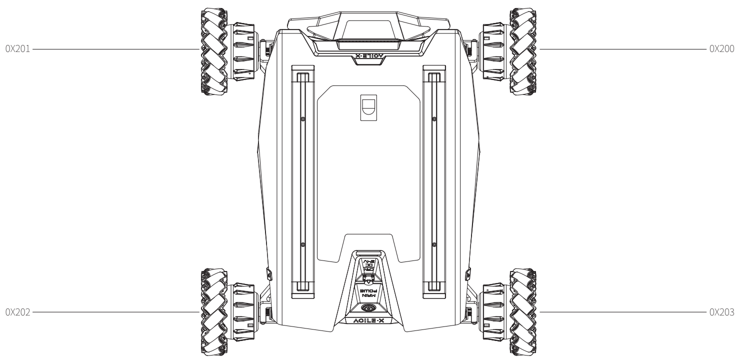


Figure 3.0 Schematic Diagram of Motor Feedback IDs

Table 3.5 No.1 Motor Information Feedback

Command Name	No.1 Motor Drive Information Feedback			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x200	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	No.1 drive current higher 8 bits	unsigned int16	Actual current X 10 (with an accuracy of 0.1A)	
byte [1]	No.1 drive current lower 8 bits			
byte [2]	No.1 drive rotational higher 8 bits	signed int16	Actual motor shaft velocity (RPM)	
byte [3]	No.1 drive rotational lower 8 bits			
byte [4]	No.1 drive temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [5]	No.1 motor temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Table 3.6 No.2 Motor Information Feedback

Command Name	No.2 Motor Drive Information Feedback			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x201	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	No.2 drive current higher 8 bits	unsigned int16	Actual current X 10 (with an accuracy of 0.1A)	
byte [1]	No.2 drive current lower 8 bits			
byte [2]	No.2 drive rotational higher 8 bits	signed int16	Actual motor shaft velocity (RPM)	
byte [3]	No.2 drive rotational lower 8 bits			
byte [4]	No.2drive temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [5]	No.2 motor temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Table 3.7 No.3 Motor Information Feedback

Command Name	No.3 Motor Drive Information Feedback			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x202	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	No.3drive current higher 8 bits	unsigned int16	Actual current X 10 (with an accuracy of 0.1A)	
byte [1]	No.3 drive current lower 8 bits			
byte [2]	No.3 drive rotational higher 8 bits	signed int16	Actual motor shaft velocity (RPM)	
byte [3]	No.3 drive rotational lower 8 bits			
byte [4]	No.3drive temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [5]	No.3 motor temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Table 3.8 No.4 Motor Information Feedback

Command Name	No.4 Motor Drive Information Feedback			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x203	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	No.4 drive current higher 8 bits	unsigned int16	Actual current X 10 (with an accuracy of 0.1A)	
byte [1]	No.4 drive current lower 8 bits			
byte [2]	No.4 drive rotational higher 8 bits	signed int16	Actual motor shaft velocity (RPM)	
byte [3]	No.4 drive rotational lower 8 bits			
byte [4]	No.4drive temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [5]	No.4 motor temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Table 3.9 Lighting Control Frame

Command Name	Lighting Control Frame			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Decision-making control unit	Steer-by-wire chassis	0x140	25ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Lighting control enable flag	unsigned int8	0x00 Control command invalid 0x01 Lighting control enable	
byte [1]	Front light mode	unsigned int8	0x00 NC 0x01 NO 0x02 BL mode 0x03 User-defined brightness	
byte [2]	Custom brightness of front light	unsigned int8	[0,100],where 0refers to no brightness, 100refers to maximum brightness[5]	
byte [3]	Reserved	--	0x00	
byte [4]	Reserved	--	0x00	
byte [5]	Reserved	--	0x00	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

Note [5]: The values are valid for custom mode.

Table 3.10 Lighting Control Feedback Frame

Command Name	Lighting Control Feedback Frame			
Sending code	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x141	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Current lighting control enable flag	unsigned int8	0x00 Control command invalid 0x01 Lighting control enable	
byte [1]	Current front light mode	unsigned int8	0x00 NC 0x01 NO 0x02 BL mode 0x03 User-defined brightness	
byte [2]	Current custom brightness of front light	unsigned int8	[0,100],where 0refers to no brightness, 100refers to maximum brightness	
byte [3]	Reserved	--	0x00	
byte [4]	Reserved	--	0x00	
byte [5]	Reserved	--	0x00	
byte [6]	Count paritybit (count)	unsigned int8	0~255counting loops, which will be added once every command sent	
byte [7]	Parity bit(checksum)	unsigned int8	Parity bit	

The data Parity bit is the last valid byte in the data segment of each frame of CAN message. Its checksum is calculated as follows: checksum =(ID_H + ID_L + data_length+ can_msg.data[0] + can_msg.data[1] + can_msg.data[2] + can_msg.data[3] +can_msg.data[4]+ …+ can_msg.data[n]) & 0xFF;

- ID_H and ID_L are respectively higher 8 bits of a frame ID. For example, if ID is 0x540, the corresponding ID_H is 0x05 and ID_L is 0x40;
- Data_length refer to the valid data length of a data segment in one frame of CAN message, which includes the checksum byte;
- Can_msg.data[n] is the specific content of each byte in the valid data segment; the count parity bit needs to participate in the calculation of checksum, but the checksum itself does not participate in the calculation.

```
/**
 * @brief  CAN message checksum example code
 * @param[in]  id : can id
 * @param[in]  *data : can message data struct pointer
 * @param[in]  len : can message data length
 * @return  the checksum result
 */
static uint8 Agilex_CANMsgChecksum(uint16 id, uint8 *data, uint8 len)
{
  uint8 checksum = 0x00;
  checksum = (uint8)(id & 0x00ff) + (uint8)(id >> 8) + len;
  for(uint8 i = 0 ; i < (len-1); i++)
  {
     checksum += data[i];
  }
  return checksum;
}
```

Figure 3.1 CAN Message Check Algorithm

3.3.2 CAN cable connection

2 aviation male plugs are supplied along with SCOUT MINI（OMNI) as shown in Figure 3.2.The line is defined as CANH for yellow and CANL for blue.

Note: In the current SCOUT MINI(OMNI) version, only the top interface is open to rear extension. The maximum achievable output current is typically around 5A.

Red:VCC(battery positive)
Black:GND(battery negative)
Blue:CAN_L
Yellow:CAN_H

Figure 3.2 Schematic Diagram of Aviation Male Plug

3.3.3 Implementation of CAN command control

Correctly start the chassis of SCOUT MINI（OMNI) mobile robot, and turn on DJI RC transmitter. Then, switch to the command control mode, i.e. toggling SWB of DJI RC transmitter to the top. At this point, SCOUT MINI（OMNI) chassis will accept the command from CAN interface, and the host can also parse the current state of chassis with the real-time data fed back from CAN bus. For the detailed content of protocol, please refer to CAN communication protocol.

3.4 Firmware upgrade

The RS232 port on SCOUT MINI（OMNI）can be used by users to upgrade the firmware for the main controller in order to get bugfixes and feature enhancements. A PC client application with graphical user interface is provided to help make the upgrading process fast and smooth. A screenshot of this application is shown in Figure 3.3.

Upgrade preparation

- Serial cable X 1
- USB-to-serial port X 1
- SCOUT MINI（OMNI) chassis X 1
- Computer (Windows operating system) X 1

Upgrade procedure:

- Before connection,ensure the robot chassis is powered off；
- Connect the serial cable onto the serial port at rear end of SCOUT MINI（OMNI) chassis；
- Connect the serial cable to the computer；
- Open the client software；
- Select the port number；
- Power on SCOUT MINI（OMNI）chassis, and immediately click to start connection(SCOUT MINI（OMNI) chassis will wait for 6s before power-on; if the waiting time is more than 6s, it will enter the application); if the connection succeeds,"connected successfully" will be prompted in the
- text box;
- Load Bin file;

  Click the Upgrade button, and wait for the prompt of
- upgrade completion;

  Disconnect the serial cable, power off the chassis, and then turn the power off and on again。

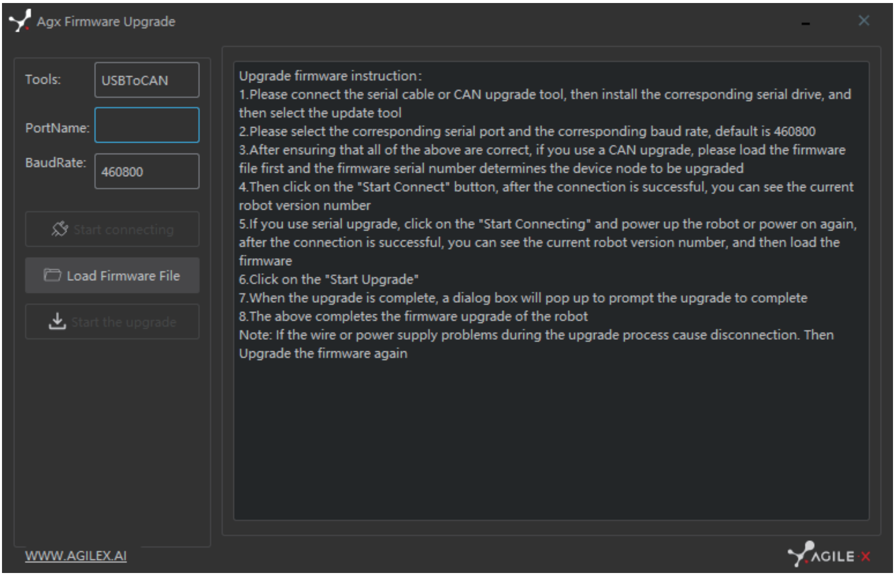


Figure 3.3 Client Interface of Firmware Upgrade

4 Attention

This section includes some precautions that should be paid attention to for SCOUT MINI (OMNI) use and development.

4.1 Battery

- The battery supplied with SCOUT MINI is not fully charged in the factory setting, but its specific power capacity can be displayed on the voltmeter at rear end of SCOUT MINI chassis or read via CAN bus communication interface. The battery recharging can be stopped when the green LED on the charger turns green. Note that if you keep the charger connected after the green LED gets on, the charger will continue to charge the battery with about 0.1A current for about 30 minutes more to get the battery fully charged.
- Please do not charge the battery after its power has been depleted, and please charge the battery in time when low battery level alarm is on;
- Static storage conditions: The best temperature for battery storage is -20°C to 60°C; 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; lithium-ion batteries cannot be charged below 0°C (32°F) and modifying or replacing the original batteries are strictly prohibited.

4.2 Operational environment

- The operating temperature of SCOUT MINI（OMNI）outdoors is -10°C to 45°C; please do not use it below -10°C and above 45°C outdoors;
- The operating temperature of SCOUT MINI（OMNI）indoors is 0 °C to 42°C; please do not use it below 0°C and above 42°C indoors;
- The requirements for relative humidity in the use environment of SCOUT MINI（OMNI）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（OMNI）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 recommended use environment should not exceed 25°C;

4.3 Electrical/extension cords

- For the power supply at rear end, the current should not exceed 5A and the total power should not exceed 120W;
- 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.

4.4 Additional safety advices

- 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 safety problem;
- Without technical support and permission, please do not personally modify the internal equipment structure.

5 Q&A

Q：SCOUT MINI（OMNI）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（OMNI）remote control is in normal condition, and the information about chassis status and movement can be received 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（OMNI）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 in command control mode. You can check the status of error flag from the error bit in the chassis status feedback frame.

Q: SCOUT MINI（OMNI）gives a "beep-beep-beep..." sound in operation, how to deal with this problem?

A: If SCOUT MINI（OMNI）gives 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 occur, there may be internal errors. You can check related error codes via CAN bus or communicate with related technical personnel.

Q: Is the tire wear of SCOUT MINI（OMNI）is normally seen in operation?

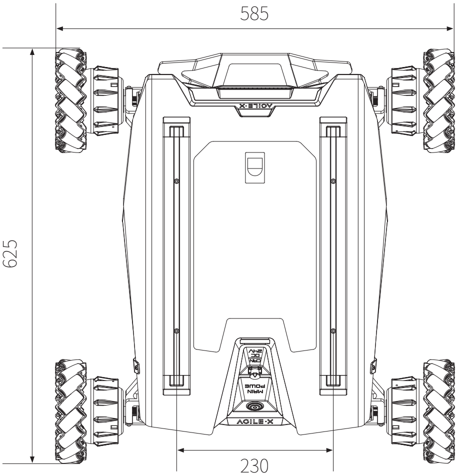
A: The tire wear of SCOUT MINI（OMNI）is normally seen when it is running. As SCOUT MINI（OMNI）is based on the fourwheel differential steering design, sliding friction and rolling friction both occur when the vehicle body rotates. If the floor is not smooth but rough, tire surfaces will be worn out. In order to reduce or slow down the wear, small-angle turning can be conducted for less turning on a pivot.

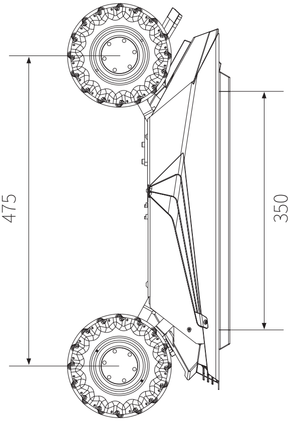
Q:When communication is implemented via CAN bus, the chassis feedback command is issued correctly, but why does not the vehicle respond to the control command?

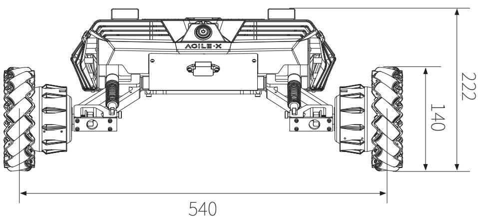
A: There is a communication protection mechanism inside SCOUT MINI（OMNI）, which means the chassis is provided with timeout protection when processing external CAN control commands. Suppose the vehicle receives one frame of communication protocol, but it does no receive the next frame of control command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

6 Product Dimensions

6.1 Illustration diagram of product external dimensions







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