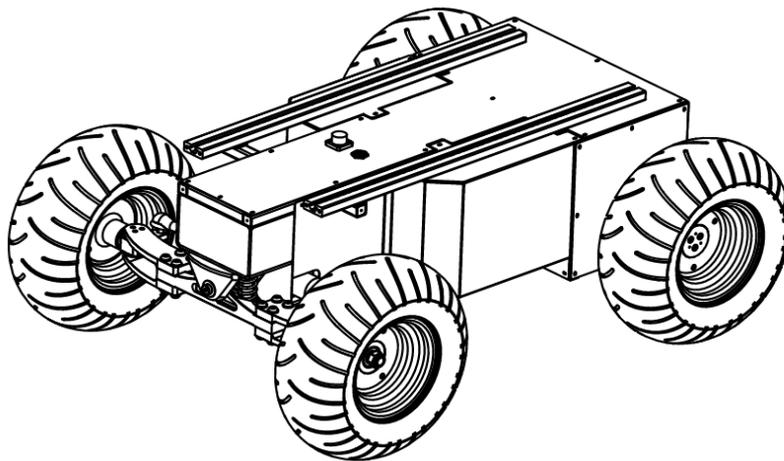




# AgileX Product HUNTER User Manual

**AgileX Robotics Team**

Version 1.2 Release



## Revision History

Version	Content of Changes	Person in Charge	Date
v1.2.6	1. [New addition] Added the Revision History 2. [New addition] Added motor feedback information 3. [Modification] Modified supported maximum current on top	Xie Zhiqiang	2019/9/2
v1.2.7	1. [Modification] Modified known errors	Xie Zhiqiang	2019/9/25

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## 1. Introduction

HUNTER is designed as a programmable UGV upon Ackermann model, of which the chassis is based on Ackermann steering. Therefore, it has similar characteristics to cars but has more significant advantages on Portland cement and asphalt roads over them. Compared to the four-wheel differential chassis, HUNTER chassis has a higher load carrying capacity and can reach higher movement speed with less wear of structure and tires for long-term operation. Although HUNTER is not designed as suitable for all kinds of terrains, it is equipped with a rocker arm suspension which can pass common obstacles such as speed bumps, etc. Additional components such as stereo camera, laser radar, GPS, IMU and robotic manipulator can be optionally installed on HUNTER for advanced navigation and computer vision applications. HUNTER is frequently used for autonomous driving education and research, indoor and outdoor security patrolling, environment sensing, general logistics and transportation, to name here only.

### 1.1 Component list

Name	Quantity
Robot body	X 1
Key lock	X 1
Battery charger (AC 220V)	X 1
Aviation plug (male, 4-pin)	X 2
DJI remote control transmitter(optional)	X 1

### 1.2 Tech specifications

Parameter Types	Items	Values
Mechanical specifications	L × W × H (mm)	980 X 718 X 330
	Wheelbase (mm)	650
	Front/rear wheel base (mm)	578
	Weight of vehicle body (kg)	45~50
	Battery type	Lithium battery 24V 20aH
	Power drive motor	DC brushless 2 X 200W
	Steering drive motor	DC brushless 200W
	Reduction gearbox	1:30
	Drive type	Rear wheel drive
	Steering	Front wheel Ackermann
	Maximum steering angle	30°
	Steering accuracy	0.5°
Motion	No-load highest speed (m/s)	1.5
	Minimum turning radius (mm)	1700
	Maximum climbing capacity	20°
	Minimum ground clearance (mm)	105
Control	Control mode	Remote control Control command mode
	RC transmitter	2.4G/extreme distance 1km
	Communication interface	CAN / RS232

DJI/FS RC transmitter is provided (optional) in the factory setting of HUNTER, which allows users to control the chassis of robot to move and turn; CAN and RS232 interfaces on HUNTER can be used for user's customization.

## 2. The Basics

This section provides a brief introduction to the HUNTER mobile robot platform, as shown in Figure 2.1 and Figure 2.2.

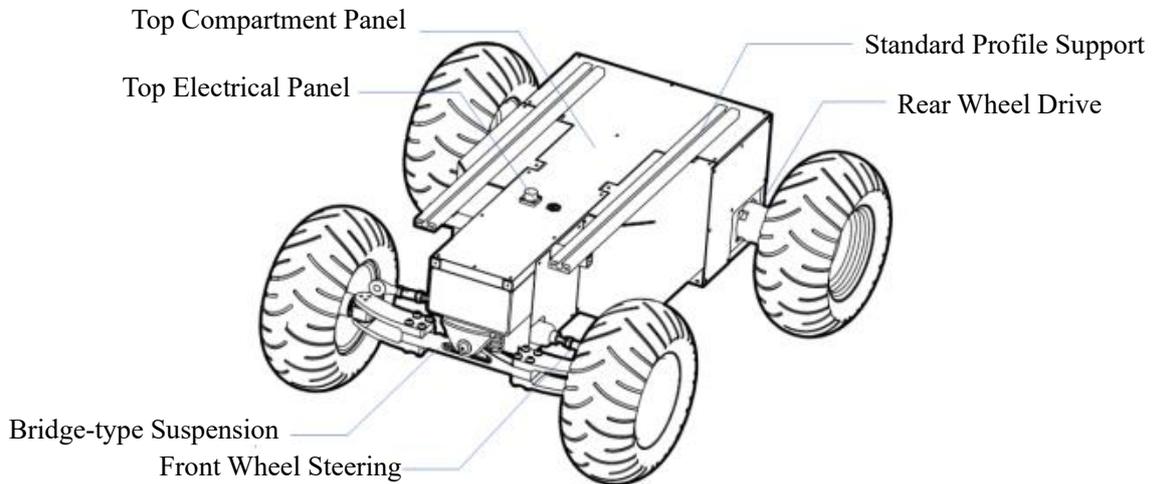


Figure 2.1 Front View

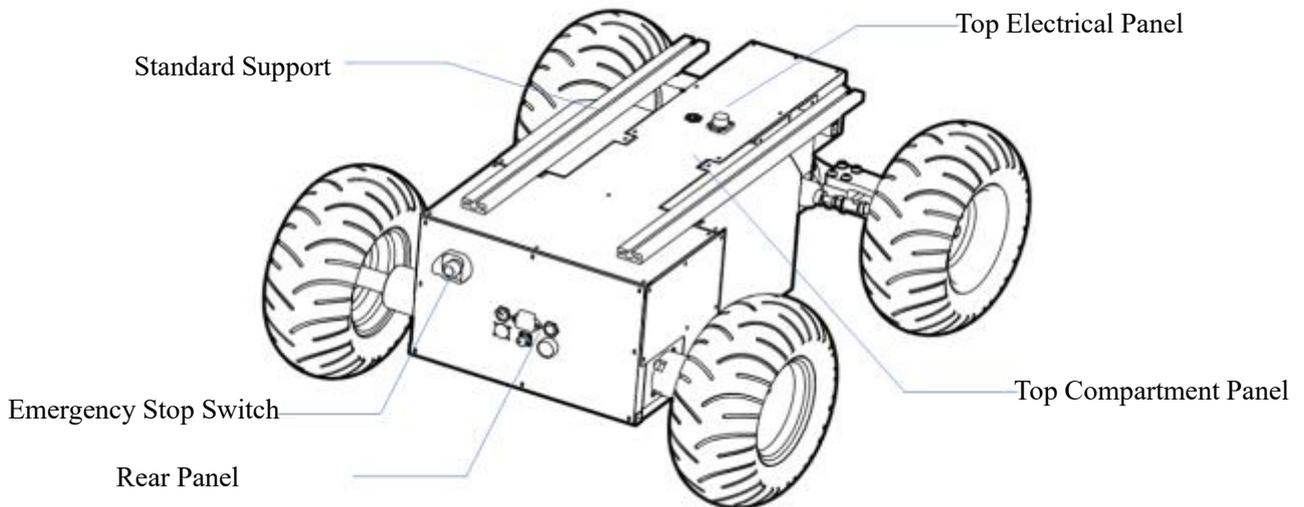


Figure 2.2 Rear View

Designed as a complete intelligent module, HUNTER combines inflatable rubber wheels with independent suspension as its power module, which, along with powerful DC brushless servo motor, enables the chassis of HUNTER robot to flexibly move on different ground surfaces with high passing ability and ground adaptability.

An emergency stop switch is mounted at the rear end of vehicle body, which can shut down power of the robot immediately when the robot behaves abnormally.

Water-proof connectors for DC power and communication interfaces are provided both on top and 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.

## 2.1 Status indication

Users can identify the status of vehicle body through the voltmeter, the beeper and lights mounted on HUNTER. For details, please refer to Table 2.1.

Table 2.1 Descriptions of Vehicle Status

Status	Description
Voltage	The current battery voltage can be read from the voltmeter on the rear electrical interface and with an accuracy of 1V.
Replace battery	When the battery voltage is lower than 22V, the vehicle body will give a beep-beep-beep sound as a warning. <b>When the battery voltage is detected as lower than 21.5V, HUNTER will actively cut off the power supply to external extensions and drive to prevent the battery from being damaged. In this case, the chassis will not enable movement control and accept external command control.</b>
Robot powered on	Front and rear lights are switched on.

## 2.2 Instructions on electrical interfaces

### 2.2.1 Top electrical interface

HUNTER provides two 4-pin aviation connectors and one DB9 (RS232) connector. **(The current version can be used for upgrade of firmware but do not support for command).**

The position of the top aviation connector is shown in Figure 2.3.

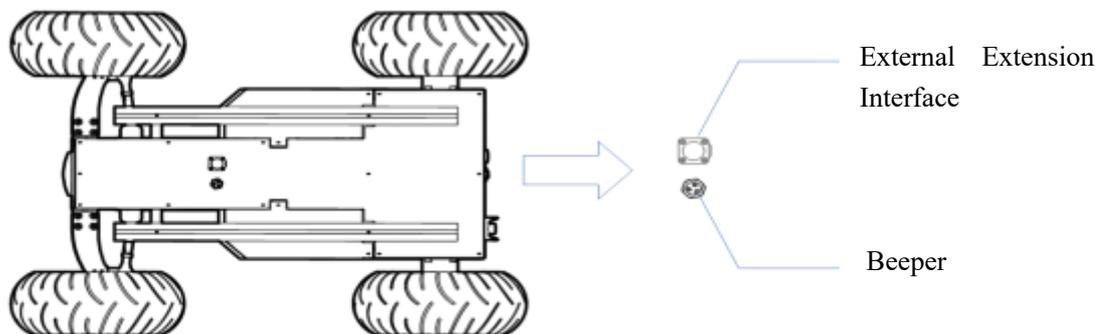


Figure 2.3 Schematic Diagram of HUNTER Electrical Interface on Top

HUNTER has each aviation extension interface respectively on top and at rear end which 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.

It should be noted that, the extended power supply here is internally controlled, which means the power supply will be actively cut off once the battery voltage drops below the pre-specified threshold voltage. Therefore, users need to notice that HUNTER platform will send a low voltage alarm before the threshold voltage is reached and also pay attention to battery recharging during use.

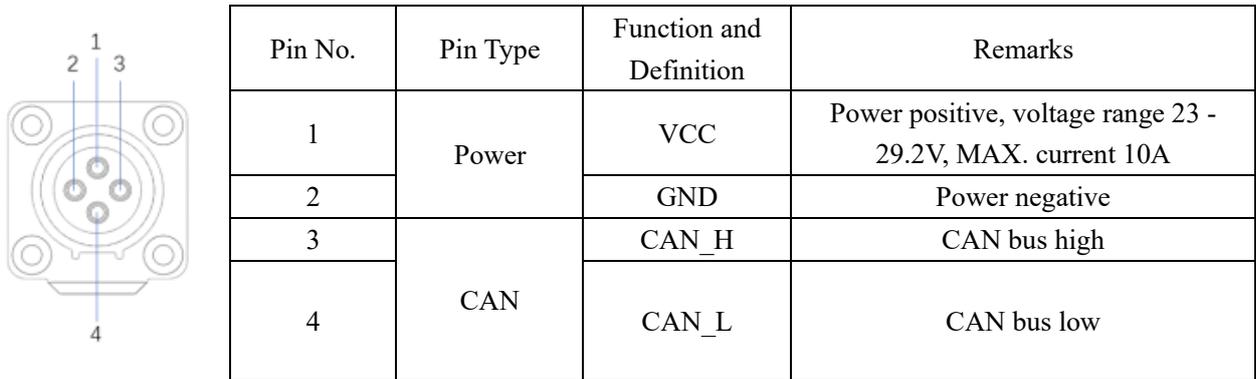


Figure 2.4 Definitions for Pins of Top Aviation Extension Interface

### 2.2.2 Rear electrical interface

The extension interface at rear end is shown in Figure 2.4, where Q1 is the key switch as the main electrical switch; Q2 is the recharging interface; Q3 is the power supply switch of drive system; Q4 is DB9 serial port (The current version can be used for upgrade of firmware but do not support for command); Q5 is the extension interface for CAN and 24V power supply; Q6 is the display interaction of battery voltage.

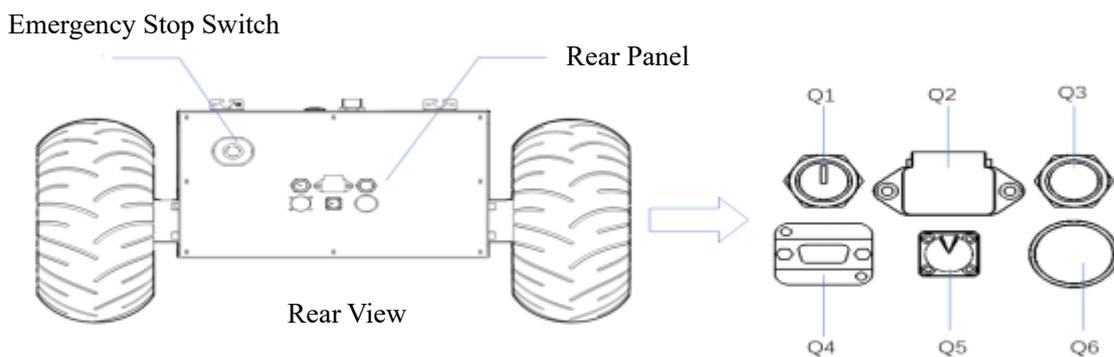


Figure 2.4 Rear View

Specific definitions for pins of Q4 are shown in Figure 2.5.

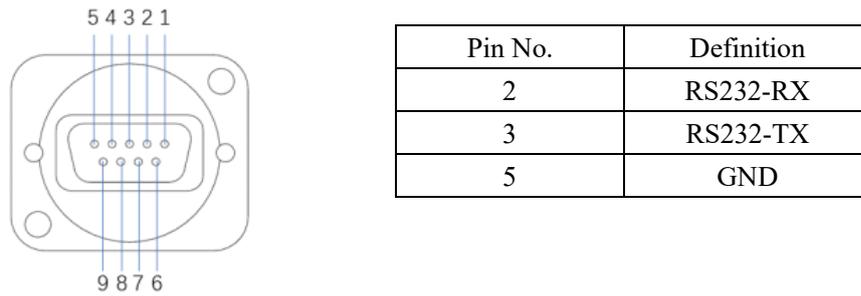


Figure 2.5 Illustration Diagram of Q4 Pins

The rear panel provides the same CAN communication interface and 24V power interface with the top one (two of them are internally inter-connected). The pin definitions are given in Figure 2.6.

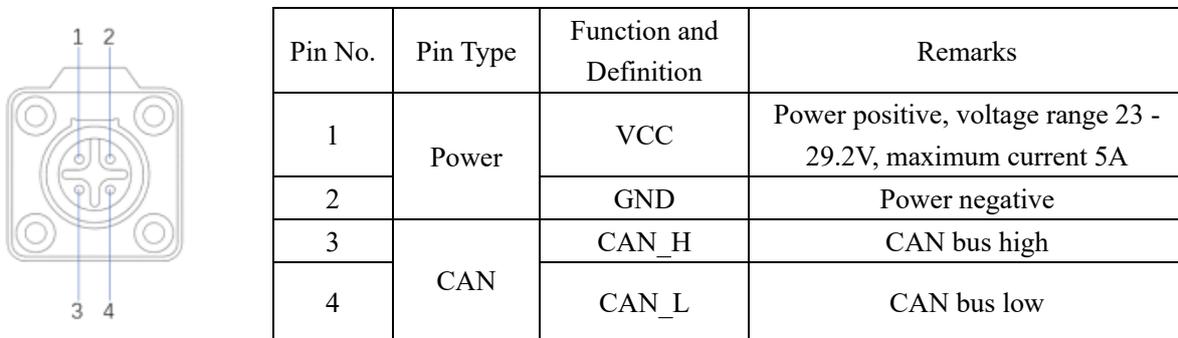


Figure 2.6 Description of Rear Aviation Interface Pins

### 2.3 DJI Remote control instructions

#### FS\_i6\_S remote control instructions

FS RC transmitter is an optional accessory of HUNTER for manually controlling the robot. The transmitter comes with a left-hand-throttle configuration. In addition to the two sticks S1 and S2 used for sending linear and angular velocity commands, two switches are enabled by default: SWB for control mode selection (top position for command control mode and the middle position for remote control mode), SWC for lighting control. The two POWER buttons need to be pressed and held together to turn on or turn off the transmitter.



Figure 2.9 Schematic Diagram of Buttons on FS RC transmitter

### 2.3 Instructions on control demands and movements

A reference coordinate system can be defined and fixed on the vehicle body as shown in Figure 2.8 in accordance with ISO 8855.

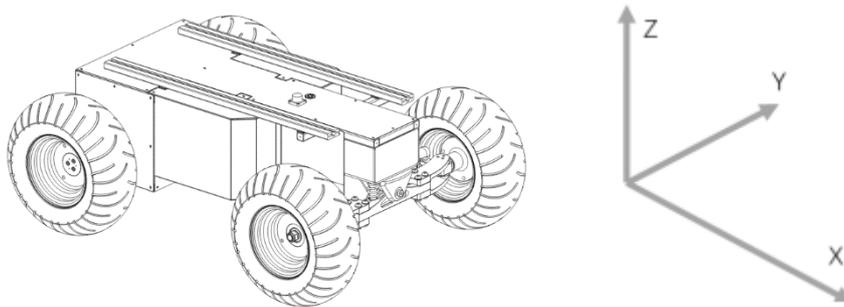


Figure 2.8 Schematic Diagram of Reference Coordinate System for Vehicle Body

As shown in Figure 2.8, the vehicle body of HUNTER 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. In the manual control mode with a RC transmitter, pushing the C1 stick (DJI model) or the S1 stick (FS model) forward will generate a positive linear velocity command and pushing C2 (DJI model) and S2 (FS model) to the left will generate a positive angular velocity command.

## 3. Getting Started

This section introduces the basic operation and development of the HUNTER 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 vehicle body. Check whether there are significant anomalies; if so, please contact the after-sale service personnel for support;
  - Check the state of emergency-stop switches. Make sure both emergency stop buttons are released;
  - Take off the cover of rear panel and you will see it;
  - For first-time use, check whether Q3 (drive power supply switch) on the rear panel has been pressed down; if so, please release it, and then the drive will be powered off;
- **Startup**
  - Rotate the key switch (Q1 on the electrical panel), and normally, the voltmeter will display correct battery voltage and front and rear lights will be both switched on;
  - Check the battery voltage. If there is no continuous "beep-beep-beep..." sound from beeper, it means the battery voltage is correct; if the battery power level is low, please charge the battery;
  - Press Q3 (drive power switch button);
- **Shutdown**
  - Rotate the key switch to cut off the power supply;
- **Emergency stop**
  - Press down emergency push buttons both on the left and the right of HUNTER vehicle body;

Basic operating procedure of remote control

After the chassis of HUNTER mobile robot is started correctly, turn on the RC transmitter and select the remote control mode. Then, HUNTER platform movement can be controlled by the RC transmitter.

### 3.2 Charging

HUNTER 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 HUNTER chassis is powered off. Before charging, please make sure Q1 (key switch) in the rear control console is turned off;

- Insert the charger plug into Q2 charging interface on the rear control panel;
- 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 3 to 5 hours to be fully recharged from 22V, and the voltage of fully-recharged battery is about 29.2V; the recharging duration is calculated as  $30\text{aH} \div 10\text{A} = 3\text{h}$

### 3.3 Communication using CAN

HUNTER provides CAN and RS232 (**not open to current version**) interfaces for user customization. Users can select one of these interfaces to conduct command control over the vehicle body.

#### 3.3.1 CAN message protocol

HUNTER 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; HUNTER 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 HUNTER Chassis System Status

Command Name	System Status Feedback Command			
Sending node	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 (not enabled) 0x01 System exception	
byte [1]	Mode control	signed int8	0x00 Remote control mode 0x01 Command control mode	
byte [2]	Battery voltage higher 8 bits	unsigned int16	Actual voltage X 10 (with an accuracy of 0.1V)	
byte [3]	Battery voltage lower 8 bits			
byte [4]	<b>Failure information higher 8 bits</b>	unsigned int16	See notes for details <b>【**】</b>	
byte [5]	<b>Failure information lower 8 bits</b>			
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent	
byte [7]	Parity bit (checksum)	unsigned int8	Parity bit	

Description of Failure Information		
Byte	Bit	Meaning
byte [4]	bit [0]	Check error of CAN communication control command (0: No failure 1: Failure)
	bit [1]	Abnormal condition of front wheel steering encoder (0: No failure 1: Failure)
	bit [2]	RC transmitter disconnection protection (0: No failure 1: Failure) <sup>[1]</sup>
	bit [3]	Reserved, default 0
	bit [4]	Reserved, default 0
	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)
	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 failure (0: No failure 1: Failure)
	bit [7]	Motor over-current failure (0: No failure 1: Failure)

**Note [1]: The RC transmitter disconnection protection only supports FS RC transmitter; DJI RC transmitter is not supported and only available in manual mode.**

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 3.2.

Table 3.2 Movement Control Feedback Frame

Command Name	Movement Control Feedback Command			
Sending node	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]	Internal steering angle higher 8 bits	signed int16	Actual speed X 1000 (with an accuracy of 0.001rad)	
byte [3]	Internal steering angle higher 8 bits			
byte [4]	Reserved	-	0x00	
byte [5]	Reserved	-	0x00	
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent	
byte [7]	Parity bit (checksum)	unsigned int8	<b>Parity bit</b>	

The control frame includes mode control, failure clearing command, control openness of linear speed, control openness of internal steering angle and checksum. For its detailed content of protocol, please refer to Table 3.3.

Table 3.3 Control Frame of Movement Control Command

Command Name	Control Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Decision-making control unit	Chassis node	0x130	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Control mode	unsigned int8	0x00 Remote control mode 0x01 Command control mode <sup>[1]</sup>	
0x01 Command control mode [1]				
byte [1]	<b>Failure clearing command</b>	unsigned int8	See Note 2 for details*	
byte [2]	Linear speed	signed int8	Maximum speed 1.50m/s, value range (-	

	percentage		100, 100)
byte [3]	Internal steering angle percentage	signed int8	Maximum internal steering angle (-43°, 43°), value range (-100, 100)
byte [4]	Reserved	-	0x00
byte [5]	Reserved	-	0x00
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent
byte [7]	Parity bit (checksum)	unsigned int8	<b>Parity bit</b>

**Note 1 - Control mode instructions**

In case the RC transmitter is powered off, the control mode of HUNTER 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**

Command Name	Function Setting Command			
	Sending node	Receiving node	ID	Cycle (ms)
Decision-making control unit	Chassis node	<b>0x210</b>	None	<b>None</b>
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Set the current position to zero	unsigned int8	0x00 Invalid	0xAA Set the current position to zero
byte [1]	Reserved	-	0x00	

byte [2]	Reserved	-	0x00
byte [3]	Reserved	-	0x00
byte [4]	Reserved	-	0x00
byte [5]	Reserved	-	0x00
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent
byte [7]	Parity bit (checksum)	unsigned int8	<b>Parity bit</b>

Command name	Function Setting Feedback Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Decision-making control unit	Chassis node	<b>0x211</b>	None	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Feedback of zero status setting	unsigned int8	0x00 Invalid 0xAA Set the current position to zero successfully	
byte [1]	Reserved	-	0x00	
byte [2]	Reserved	-	0x00	
byte [3]	Reserved	-	0x00	
byte [4]	Reserved	-	0x00	
byte [5]	Reserved	-	0x00	
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent	
byte [7]	Parity bit (checksum)	unsigned int8	Parity bit	

**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 front wheels of vehicle steer by 4.3°**

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 transmitterswitchedon)**

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, and 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:

Table 3.3.5 Feedback of Steering Motor Information

Command Name	No.1 Motor Drive Information Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	<b>0x201</b>	20ms	<b>None</b>
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 speed higher 8 bits	signed int16	Actual motor shaft velocity (RPM)	
byte [3]	No. 1 drive rotational speed lower 8 bits			
byte [4]	No. 1 hard disk drive (HDD) temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [5]	Reserved	--	0x00	
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent	
byte [7]	Parity bit (checksum)	unsigned int8	<b>Parity bit</b>	

Command Name	Left Rear Motor Drive Information Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	<b>0x202</b>	20ms	<b>None</b>
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 speed higher 8 bits	signed int16	Actual motor shaft velocity (RPM)
byte [3]	No. 2 drive rotational speed lower 8 bits		
byte [4]	No. 2 hard disk drive (HDD) temperature	signed int8	Actual temperature (with an accuracy of 1°C)
byte [5]	Reserved	--	0x00
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent
byte [7]	Parity bit (checksum)	unsigned int8	<b>Parity bit</b>

Command Name	Right Rear Motor Drive Information Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout (ms)
Steer-by-wire chassis	Decision-making control unit	<b>0x203</b>	20ms	<b>None</b>
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	No. 3 drive 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 speed higher 8 bits	signed int16	Actual motor shaft velocity (RPM)	
byte [3]	No. 3 drive rotational speed lower 8 bits			
byte [4]	No. 3 hard disk drive (HDD) temperature	signed int8	Actual temperature (with an accuracy of 1°C)	
byte [5]	Reserved	--	0x00	
byte [6]	Count parity bit (count)	unsigned int8	0 - 255 counting loops, which will be added once every command sent	
byte [7]	Parity bit (checksum)	unsigned int8	<b>Parity bit</b>	

**Note 4: 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:  $\text{checksum} = (\text{ID\_H} + \text{ID\_L} + \text{data\_length} + \text{can\_msg.data}[0] + \text{can\_msg.data}[1] + \text{can\_msg.data}[2] + \text{can\_msg.data}[3] + \text{can\_msg.data}[4] + \dots + \text{can\_msg.data}[n]) \& 0\text{xFF}$ :

- **ID\_H** and **ID\_L** are respectively higher 8 bits and lower 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** refers to the valid data length of a data segment in one frame of CAN message, which includes the checksum byte;

```

/**
 * @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

- **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.

### 3.3.2 CAN cable connection

2 aviation male plugs are supplied along with HUNTER as shown in Figure 3.2. Users need to lead wires out by welding on their own. For wire definitions, please refer to Table 2.2.



Figure 3.2 Schematic Diagram of Aviation Male Plug

*Note: In the current HUNTER version, only the top interface is open to external extension. The maximum achievable output current is typically around 5 A.*

### 3.3.3 Implementation of CAN command control

Correctly start the chassis of HUNTER mobile robot, and turn on DJI RC transmitter. Then, switch to the command control mode, i.e. toggling S1 mode of DJI RC transmitter to the top. At this point, HUNTER 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 upgrades

The RS232 port on HUNTER 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
- HUNTER 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 HUNTER chassis;
- Connect the serial cable to the computer;

- Open the client software;
- Select the port number;
- Power on HUNTER chassis, and immediately click to start connection (HUNTER 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 turn the power off and on again.

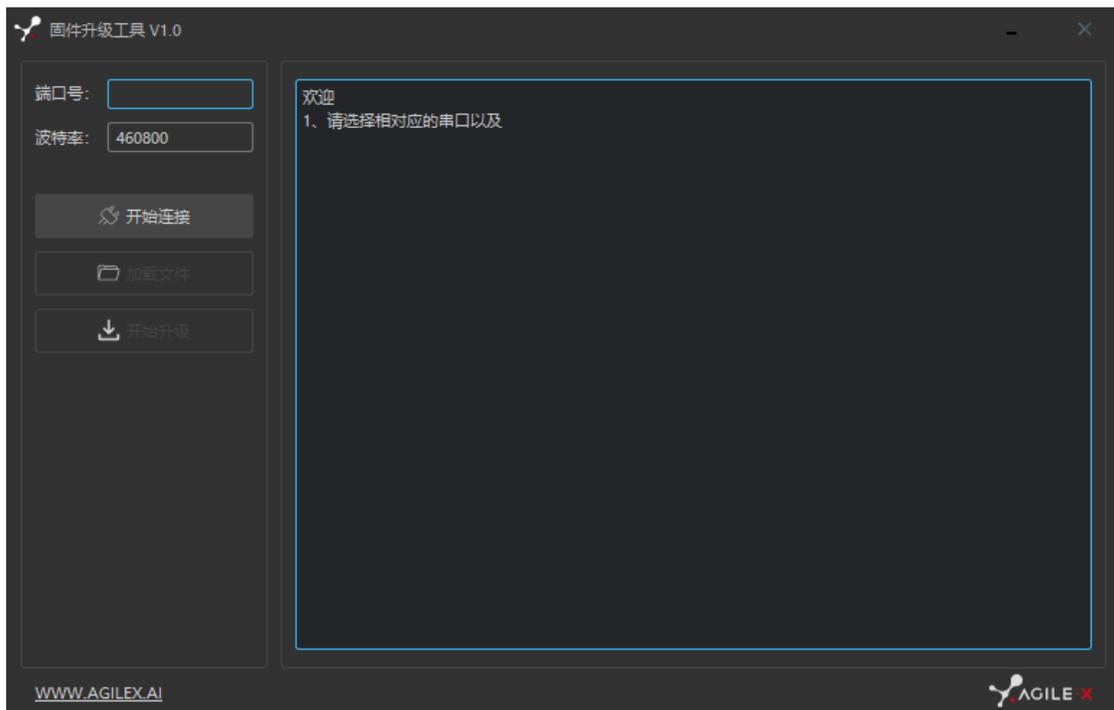


Figure 3.3 Client Interface of Firmware Upgrade

## 4. Precautions

This section includes some precautions that should be paid attention to for HUNTER use and development.

### 4.1 Battery

- The battery supplied with HUNTER is not fully charged in the factory setting, but its specific power capacity can be displayed on the voltmeter at real end of HUNTER 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  $-20^{\circ}\text{C}$  to  $60^{\circ}\text{C}$ ; 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  $0^{\circ}\text{C}$  ( $32^{\circ}\text{F}$ ) and modifying or replacing the original batteries are strictly prohibited.

### 4.2 Operational environment

- The operating temperature of HUNTER outdoors is  $-10^{\circ}\text{C}$  to  $45^{\circ}\text{C}$ ; please do not use it below  $-10^{\circ}\text{C}$  and above  $45^{\circ}\text{C}$  outdoors;
- The operating temperature of HUNTER indoors is  $0^{\circ}\text{C}$  to  $42^{\circ}\text{C}$ ; please do not use it below  $0^{\circ}\text{C}$  and above  $42^{\circ}\text{C}$  indoors;
- The requirements for relative humidity in the use environment of HUNTER 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), HUNTER 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  $25^{\circ}\text{C}$ ;

### 4.3 Electrical/extension cords

- For the extended power supply on top, the current should not exceed 10A and the total power should not exceed 240W;

- For the extended 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 Mechanical load**

#### **4.5 Other notes**

- HUNTER 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.

## 5. Q&A

**Q: HUNTER 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: HUNTER 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 HUNTER 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: HUNTER gives a "beep-beep-beep..." sound in operation, how to deal with this problem?**

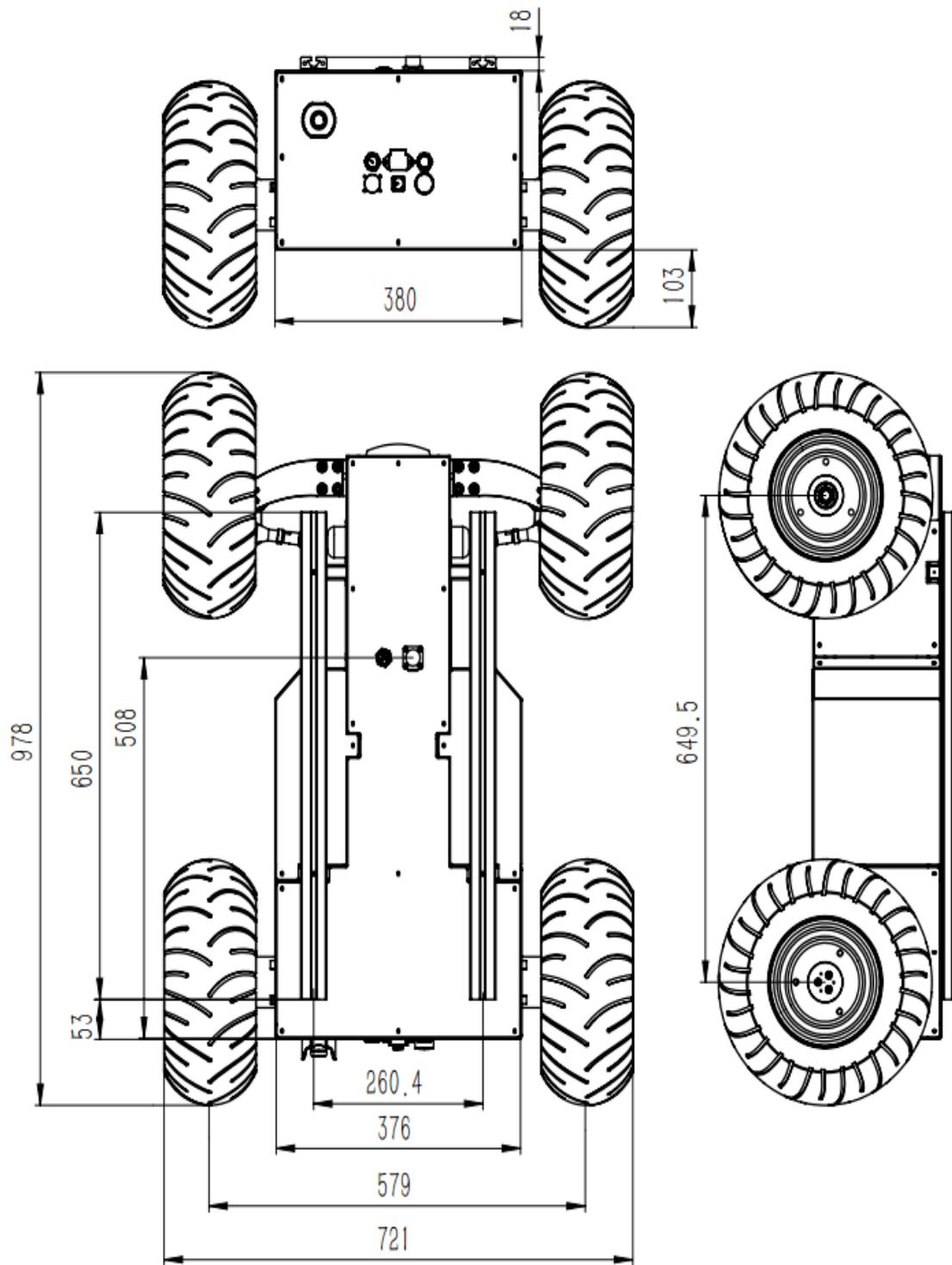
**A:** If HUNTER gives this "beep-beep-beep" sound continuously, it means the battery is in the alarm voltage state. Please charge the battery in time.

**Q: Is the tire wear of HUNTER is normally seen in operation?**

**A:** The tire wear of HUNTER is normally seen when it is running. As HUNTER 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.

## 6. Product Dimensions

### 6.1 Illustration diagram of product external dimensions



## **6.2 Illustration diagram of top extended support dimensions**