BUNKER

AgileX Robotics Team

User Manual V.2.1.0 2020.03

This chapter contains important safety information, before the robot is powered on for he 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. BUNKER 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 Bunker, because Bunker is not equipped with any automatic obstacle avoidance sensor.
- Use Bunker always under -20°C~60°C ambient temperature.
- If Bunker is not configured with separate custom IP protection, its water and dust protection will be IP44 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.
- When using, make sure the emergency stop switch has been released.

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 BUNKER is 70KG. When in use, ensure that the payload does not exceed 70KG.
- When installing an external extension on BUNKER, confirm the position of the center of mass of the extension and make sure it is at the center of rotation.
- Please charge in time when the device voltage is lower than 48V.
- When BUNKER has a defect, please immediately stop using it to avoid secondary damage.
- When BUNKER has had a defect, please contact the relevant technical to deal with it, do not handle the defect by yourself.
- Always use BUNKER in the environment with the protection level requires for the equipment.
- Do not push BUNKER directly.
- When charging, make sure the ambient temperature is above 0°C.

5.Maintenance

- Regularly check the tension of the hanging crawler, and tighten the crawler every 150~200h.
- After every 500 hours of operation, the bolts and nuts of each part of the car body should be inspected. If they are loose, they must be tightened immediately.
- In order to ensure the storage capacity of the battery, the battery should be stored under electricity, and it should be charged regularly when not used for a long time.

CONTENTS

1 BUNKER Introduction

BUNKER is designed as a multi-purpose tracked chassis with different application scenarios considered: simple and sensitive operation, large development space, adapt to various fields of development and application, independent suspension system, high payload and suspension, strong climbing ability, can climb stairs. It can be used for the development of special robots such as inspection and exploration, rescue and detonation, special shooting, special transportation, etc., to solve the robot mobile solution.

1.1 Component list

Name	Quantity
BUNKER Robot Body	x1
Battery Charger(AC 220V)	x1
Aviation plug (4Pin)	x2
FS remote control transmitter(Optional)	x1
USB to RS232	x1
USB to CAN communication module	x1

1.2 Tech specifications

Parameter Types	Items	Values
Dimensions	Dimensions	1023*778*400mm
	Inner dimensions	600*300*230mm
	Chassis height	90mm
	Track width	150mm
	Length	520mm
Weight	Weight	About 130kg
	Load	80kg
Battery	Type	Lithium battery
	Capacity	30AH
	Voltage	48V
Motion	Maximum climbing capacity	36°
	Speed	0~1.5m/s
	Minimum turning radius	Be able to turn on a pivot
	Maximum obstacle	170mm
Control	Control mode	Remote control
	RC transmitter	2.4G/extreme distance 1KM
	Communication interface	CAN

1.3 Required for development

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

2 The Basics

This section provides a brief introduction to the BUNKER mobile robot platform. It is convenient for users and developers to have a basic understanding of BUNKER chassis.

2.1 Description of electrical interface

The interface at rear end is shown in Figure 2-1, where Q1 is CAN and 48V power supply aviation interface; Q2 is the power switch; Q3 is the recharging interface; Q4 is the aerial; Q5 is the drive test interface; Q6 is the emergency stop switch; Q7 is the display of battery voltage.

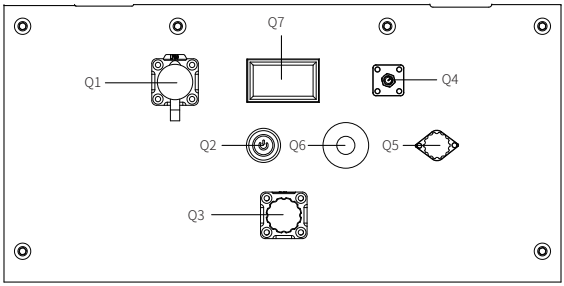
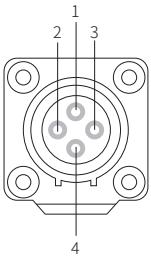


Figure 2.1 Tail electrical interface

The definitions of Q1 communication and power interface as shown in Figure 2-2.



Pin No.	Pin Type	Function and Defition	Remarks
1	Power	VCC	Power positive, voltage range 46 - 54V, maximum current 10A
2	Power	GND	Power negative
3	CAN	CAN_H	CAN bus high
4	CAN	CAN_L	CAN bus low

Figure 2.2 Pin definition figure of tail aviation expansion interface

2.2Instructions on remote control

FS RC transmitter is an optional accessory of BUNKER for manually controlling the robot. The transmitter comes with a left-hand-throttle configuration. The functions of the buttons are defined as: SWA, SWC, SWD are enabled by default. SWB for control mode selection, top position for command control mode and the middle position for remote control mode. When configuring the autowalker navigation system, the bottom is the navigation control mode. S1 is the throttle button to control the forward and backward of BUNKER; S2 controls the rotation, POWER is the power button, and it can be turned on at the same time. It should be noted that when the remote controller is turned on, SWA, SWB, SWC, SWD all need to be at the top.

Figure 2.3 Schematic Diagram of Buttons on FS RC transmitter

2.3Instructions on control demands and movements

A reference coordinate system can be defined and fixed on the vehicle body as shown in Figure 2.4 in accordance with ISO 8855.

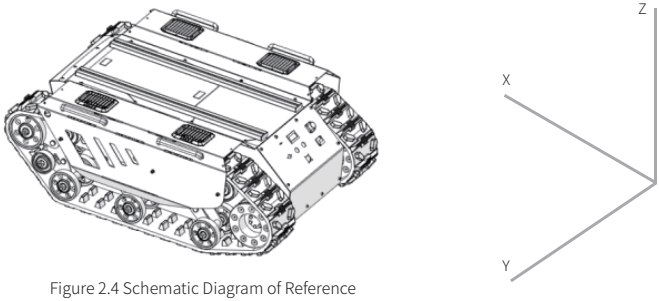


Figure 2.4 Schematic Diagram of Reference Coordinate System for Vehicle Body

As shown in Figure 2.4, the vehicle body of BUNKER is in parallel with X axis of the established reference coordinate system.
In RC control mode, push the remote control stick S1 forward to move in the positive X direction, push stick S1 backward to move in the negative X direction. When S1 is pushed to the maximum value, the movement speed in the positive X direction is the maximum, when S1 is pushed to the minimum value, the movement speed is the maximum in the negative direction of the X direction.The remote control stick S2 controls the rotation of the car body left and right. The remote control joystick S2 controls the rotation of the car body left and right. When S2 pushes the car body to the left, it rotates from the positive direction of the X axis to the positive direction of the Y axis. When S2 pushes the car body to the right, it rotates from the positive direction of the X axis to the negative direction of the Y axis. S2 When pushing to the left to the maximum value, the counterclockwise rotation speed is the maximum. When S2 is pushed to the right to the maximum value, the clockwise rotation speed is the maximum.
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.

3 Getting Started

This section introduces the basic operation and development of the BUNKER platform using the CAN bus interface.

3.1 Use and operation

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 Q6 emergency stop button at the rear is released;
- 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

- Press the key switch (Q2 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 the voltage is higher than 48V, it means the battery voltage is correct; if the battery power level is low, please charge the battery;

Shutdown

- Press the key switch to cut off the power supply;

Emergency stop

- Press down emergency push button at the rear of BUNKER vehicle body;

Basic operating procedure of remote control

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

3.2 Charging

BUNKER is equipped with a standard charger by default to meet customers' recharging demand.

The detailed operating procedure of charging is shown as follows:

- Make sure the electricity of BUNKER chassis is powered off. Before charging, please make sure Q2 (key switch) in the rear control console is turned off;
- Insert the charger plug into Q3 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.

3.3 Communication using CAN

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

BUNKER uses CAN2.0B communication standard with 500K baud rate and Motorola message format. The moving linear speed and the rotational angular speed of chassis can be controlled by CAN bus interface. The feedback of current motion status and chassis status would be provided from BUNKER simultaneously.

The protocol includes system status feedback frame, motion control feedback frame and control frame, please refer to the content as below for detail:

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

Table 3.1 Bunker Chassis Status Feedback Frame

Command Name	System Status Feedback Command			
Sending node	Receiving node	ID	Cycle(ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x211	200ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Current status of vehicle body	unsigned int8	0x00 Normal condition 0x01 Emergency stop 0x02 System Error	
byte [1]	Mode control	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(with an accuracy of 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 every time	

Table 3.2 Description of Failure Information

Description of Failure Information		
Byte	Bit	Meaning
byte [5]	bit [0]	Low-voltage failure
	bit [1]	Low-voltage warning
	bit [2]	Remote control signal lost protection(0: Normal 1: Lost signal)
	bit [3]	Drive 1 communication failure(0: Normal 1: Failure)
	bit [4]	Drive 2 communication failure(0: Normal 1: Failure)
	bit [5]	Reserve, default value 0
	bit [6]	Reserve, default value 0
	bit [7]	Reserve, default value 0

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

Table 3.3 Motion Control Feedback Frame

Command Name	Movement Control Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x221	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Moving speed upper 8 bits	signed int16	Actual speed X 1000 (with an accuracy of 0.001m/s)	
byte [1]	Moving speed lower 8 bits			
byte [2]	Rotation speed upper 8 bits	signed int16	Actual speed X 1000 (with an accuracy of 0.001rad/s)	
byte [3]	Rotation speed lower 8 bits			
byte [4]	Reserved	-	0x00	
byte [5]	Reserved	-	0x00	
byte [6]	Reserved	-	0x00	
byte [7]	Reserved	-	0x00	

The motion control frame includes linear speed, angular speed and checksum. 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)
Decision-making control unit	Chassis node	0x111	20ms	500ms
Data length	0x08			
Position	Function	Data type	Description	
byte [0]	Linear velocity upper 8 byte	Signed int16	Linear moving speed mm/s(unit) Range[-1500,1500]	
byte [1]	Linear velocitylower 8 byte			
byte [2]	Linear speed percentage	Signed int16	Rotation angular speed 0.001rad/s(unit) Range [-1000,1000]	
byte [3]	Angular speed percentage			
byte [4]	Reserved	—	0x00	
byte [5]	Reserved	—	0x00	
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	Control mode Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Decision-making control unit	Chassis node	0x421	20ms	500m/s
Data length	0x01			
Location	Function	Data type	Description	
byte [0]	CAN Command Mode	Unsigned int8	0x00 Stand by 0x01 CAN Command mode	

Note[1] Description for control mode

When the remote control is power off, the control mode of BUNKER is can command control by default , that means chassis can be controlled by commands directly. Please note that the control mode in command still need to set 0x01 if the speed command need to be executed successfully. 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	Status Clear Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Key Unit	Chassis node		None	None
Data length	0x01	0x441		
Location	Function	Data type	Description	
byte [0]	Failures clear command	Unsigned int8	0x00 Clear all failures 0x01 Clear motor1 failures 0x02 Clear motor2 failures	

Note[2]Testing data : The following data is used for testing only.

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]
0x01	0x96	0x00	0x00	0x00	0x00	0x00	0x00

2.The chassis rotates at 0.2rad/s.

byte [0]	byte [1]	byte [2]	byte [3]	byte [4]	byte [5]	byte [6]	byte [7]
0x00	0x00	0x00	0xc8	0x00	0x00	0x00	0x44

In addition to the feedback of chassis status, there are also feedback data from the motors and sensors.

Table 3.7 Motor Rotational Speed Feedback Frame

Command Name	Motor Rotational Speed Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Decision-making control unit	Chassis node	0x251~0x254	20ms	None
Data length	0x08			
Position	Function	Data type	Description	
byte [0] byte[1]	Motor rotational speed upper 8bits Motor rotational speed lower 8bits	signed int8	Motor rotational speed(RPM)	
byte[2] -byte[7]	Reserve	--	0x00	

Table 3.8 Motor Temperature, Voltage and Status Feedback Frame

Command Name	Motor Rotational Speed Feedback Frame			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x261-0x264	None	None
Data length	0x08			
Location	Function	Data type	Description	
byte [0]	Reserved	-	0x00	
byte [1]	Reserved	-	0x00	
byte [2] byte [3]	Drive temperature upper 8 bits Drive temperature lower 8 bits	Signed int 16	Unit: 1°C	
byte [4]	Reserved	-	0x00	
byte [5]	Drive status	Unsigned int 8	Refer to Table 3.9 for detail	
byte [6]	Reserved	-	0x00	
byte [7]	Reserved	-	0x00	

Table 3.9 Drive Status Byte

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

Table 3.10 Odometer Feedback Frame

Command Name	System Status Feedback Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x311	20ms	None
Data length	0x08			
Location	Function	Data type	Description	
byte [0]	Left wheel odometer highest bit	Signed int 32	Left wheel odometer feedback (Unit: mm)	
byte [1]	Left wheel odometer second highest bit			
byte [2]	Left wheel odometer second lowest bit			
byte [3]	Left wheel odometer lowest bit			
byte [4]	Right wheel odometer highest bit	Signed int 32	Right wheel odometer feedback (Unit: mm)	
byte [5]	Right wheel odometer second highest bit			
byte [6]	Right wheel odometer second lowest bit			
byte [7]	Right wheel odometer lowest bit			

Table 3.11 Remote Control Feedback Frame

Command Name	System Status Feedback Command			
Sending node	Receiving node	ID	Cycle (ms)	Receive-timeout(ms)
Steer-by-wire chassis	Decision-making control unit	0x311	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	Singed int8	Range[-100,100]	
byte [6]	Reserved	--	0x00	
byte [7]	Count Parity bit	Unsigned int8	0~255 Loops counting	

3.3.2 CAN Cable Connection

An aviation male plugs are supplied along with BUNKER as shown in Figure 3.2. The definition of the line is yellow for CANH, blue for CANL, red for positive power supply, and black for negative power supply. The external expansion interface of the current BUNKER version is only open to the top interface. In this version, the power supply can provide a maximum current of 10A.

Figure 3.2 Schematic diagram of aviation plug male connector

3.3.3Implementation of CAN

Correctly start the chassis of BUNKER mobile robot, and turn on FS RC transmitter. Then, switch to the command control mode, i.e. toggling SWB mode of FS RC transmitter to the top. At this point, BUNKER 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 BUNKER can be used by users to upgrade the firmware for the main controller in order to get bug fixes 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
- BUNKER chassis X 1
- Computer(Windows operating system)X1

Firmware update software

- https://github.com/agilexrobotics/agilex_firmware

Upgrade preparation

- Before connection, ensure the robot chassis is powered off;
- Connect the serial cable onto the upgrade serial port of BUNKER chassis(need to disassemble the rear electrical plate);
- Connect the serial cable to the computer;
- Open the client software;
- Select the port number;
- Power on BUNKER chassis, and immediately click to start connection (BUNKER 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

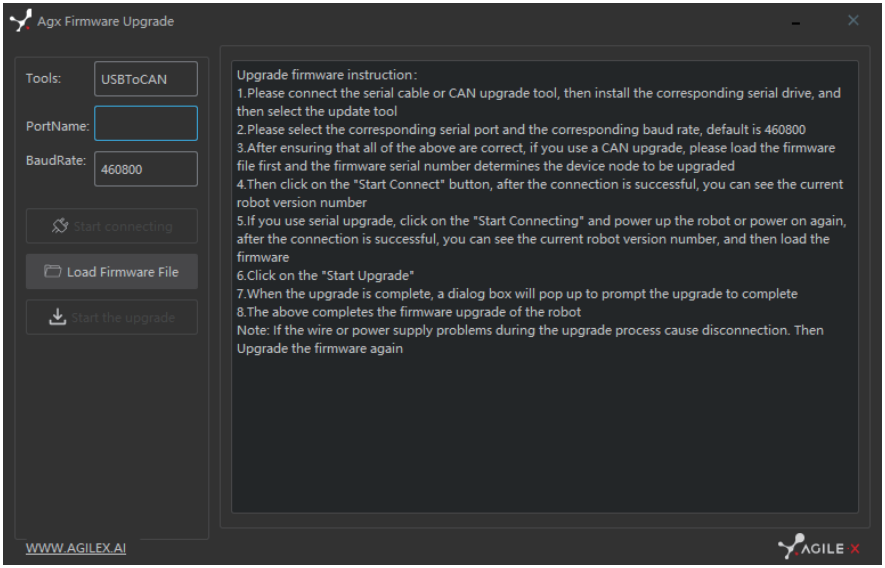


Figure 3.3 Client Interface of Firmware Upgrade

3.5 BUNKER ROS Package Use Example

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.

Preparation

Hardware preparation

- CANlight can communication module ×1
- Thinkpad E470 notebook ×1
- AGILEX BUNKER mobile robot chassis ×1
- AGILEX BUNKER remote control FS-i6s ×1
- AGILEX BUNKER 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 BUNKER 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 BUNKER mobile robot chassis, and check whether the emergency stop switches on both sides are released;
- Connect the CAN_TO_USB to the usb point of the notebook. The connection diagram is shown in Figure 3.4.

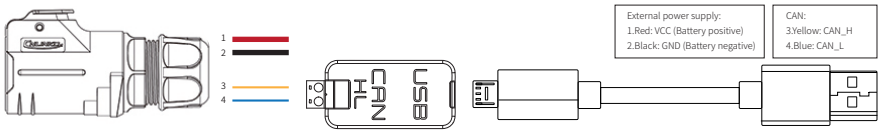


Figure 3.4 CAN connection diagram

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 BUNKER robot this time, and the car has been turned on, use the following commands to monitor the data from the BUNKER chassis
  $ candump can0
- Please refer to:
  [1]https://github.com/agilexrobotics/agx_sdk [2]https://wiki.rdu.im/_pages/Notes/Embedded-System/Linux/-can-bus-in-linux.html

AGILEX BUNKER ROS PACKAGE download and compile

- Download ros package
  $ sudo apt install ros-$ROS_DISTRO-teleop-twist-keyboard
  $ sudo apt install ros-$ROS_DISTRO-joint-state-publisher-gui
  $ sudo apt install ros-$ROS_DISTRO-ros-controllers
  $ sudo apt install ros-$ROS_DISTRO-webots-ros
  $ sudo apt install libasio-dev
- Clone compile bunker_ros code
  $ cd ~/catkin_ws/src
  $ git clone https://github.com/agilexrobotics/bunker_ros.git
  $ git clone https://github.com/agilexrobotics/agx_sdk.git
  $ cd ~/catkin_ws
  $ catkin_make
  Please refer to: https://github.com/agilexrobotics/bunker_ros

Start the ROS node

- Start the based node
  $ roslaunch bunker_bringup bunker_robot_base.launch
- Start the keyboard remote operation node
  $ roslaunch bunker_bringup bunker_teleop_keyboard.launch

4 Attention

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

4.1 Battery

- The battery supplied with BUNKER is not fully charged in the factory setting, but its specific power capacity can be displayed on the voltmeter at rear end of BUNKER chassis or read via CAN bus communication interface.
- Please do not charge the battery after its power has been depleted, and please charge the battery in time when the low voltage at the rear of BUNKER shows below 48V.
- 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 1 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 BUNKER outdoors is -10°C to 45°C; please do not use it below -10°C and above 45°C outdoors;
- The operating temperature of BUNKER 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 BUNKER 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), BUNKER 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;
  Regularly check and maintenance the track tension wheel.

4.3 Electrical/extension cords

- For the extended power supply at rear end, the current should not exceed 6.25A and the total power should not exceed 300W;

4.5 Other notes

- 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.

4.4 Additional safety advice

- 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;
- In case of emergencies, press down the emergency stop button and power off the equipment;
- Without technical support and permission, please do not personally modify the internal equipment structure.

5 Q&A

Q：BUNKER 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:BUNKER 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?

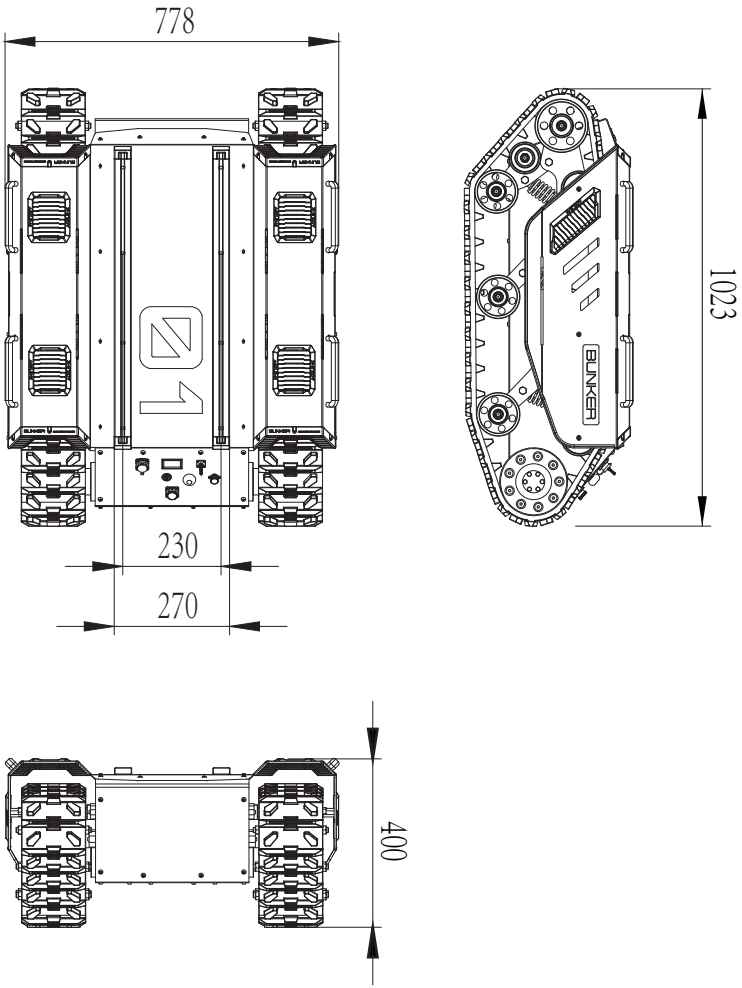
A:Normally, if BUNKER can be controlled by a RC transmitter, it means the chassis movement is under proper control; if the chassis feedback frame can be accepted, it means CAN extension link is in normal condition. Please check the CAN control frame sent to see whether the data check is correct and whether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

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?

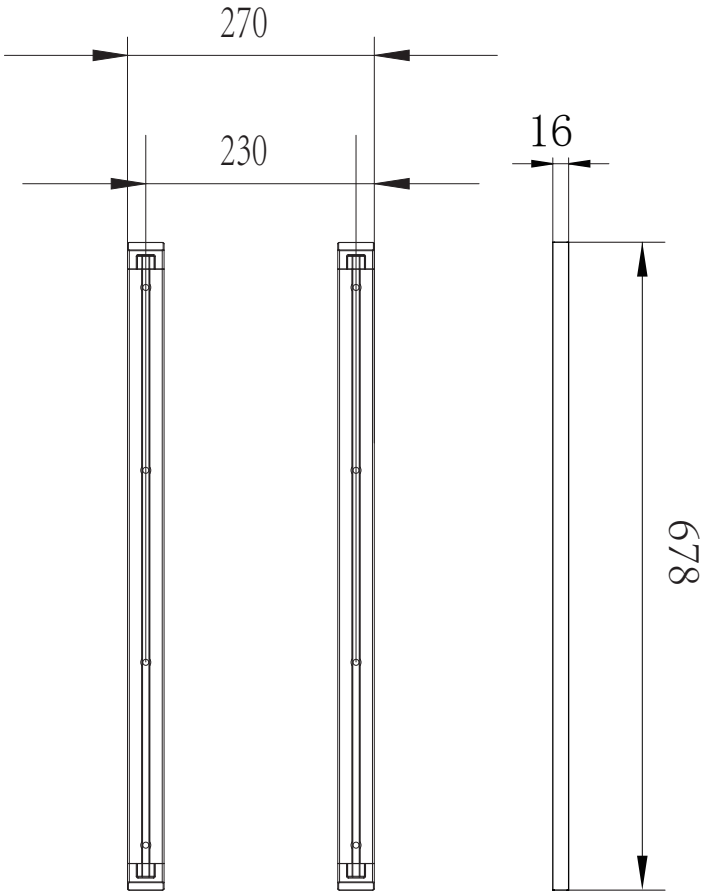
A:There is a communication protection mechanism inside BUNKER, which means the chassis is provided with timeout protection when processing external CAN control commands. Suppose the vehicle receives one frame of communication protocol, but it does no receive the next frame of control command after 500ms. 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 Product outline dimension illustration



6.2 Top expansion stent size description diagram



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