Ackerman Chassis

Xspirebot-MK-mid

User manual V3.0.0

Table of Contents

1. Foreword

(1) Thank you for purchasing our products. This user manual is applicable to Xspirebot MK-mid Ackerman robot chassis (hereinafter referred to as " MK-mid ").

(2) Please be sure to read this manual and precautions carefully before use, and strictly follow these instructions.

(3) Our company will not be held responsible for any losses caused by the use of this product in violation of these instructions.

(4) Please keep this manual in a safe place so that you can refer to it at any time during operation.

(5) Professionals should be invited to debug, connect and install the robot chassis to avoid irreparable losses.

(6) Do not install, remove, replace equipment lines or replace corresponding modules while the power is on. If you need to debug this product while the power is on, please use a special debugging tool with good insulation performance and perform the corresponding operation under the guidance of professionals.

(7) Please use this product under the conditions permitted by laws and regulations, and will not affect public property and life safety.

(8) Our company will update this product from time to time, and the updated content will be added to the new version of the manual without further notice.

(9) This manual may contain technical inaccuracies or inconsistencies with product operations. If you encounter problems that cannot be solved when using this manual, please contact our customer service or technical support department.

(10) We strive to ensure that the contents of this manual are correct. If you find any inappropriateness or errors, please contact us for confirmation. Thank you!

2. Safety Information

This manual does not cover the design, installation, and operation of a complete robot, nor does it cover all peripheral equipment that may affect the safety of this complete system. The design and use of this complete system must comply with the standards and regulations of the location where the robot is installed. Integrators and end customers of MK-mid are responsible for complying with the laws and regulations of the relevant countries to ensure that there are no significant hazards in the application of the robot. This includes, but is not limited to, the following:

Validity and responsibility:

- Make a risk assessment of the complete robot system. Connect the additional safety equipment of other machines defined in the risk assessment. Confirm that the design and installation of the peripheral equipment of the entire robot system, including software and hardware systems, are accurate.
- This robot does not have the relevant safety functions of a complete autonomous mobile robot, such as automatic collision avoidance, fall prevention, and biological proximity warning, but it is not limited to the above description. The relevant functions require integrators and customers to follow laws and regulations for safety assessment to ensure that the developed robot does not pose any major dangers or safety hazards in actual application.
- Collect all documents in the technical files, including risk assessment and this manual. Be aware of possible safety risks before operating and using the equipment.

Environment:

- First, please read this manual carefully to understand the basic operation content and specifications.
- For remote control operation, choose a relatively open area or suspend the driving wheel for the corresponding operation test. The chassis itself does not have any automatic obstacle avoidance sensors.
- Use in an ambient temperature of -20℃~50℃.
- In the case of a robot chassis with a non-customized IP protection level, the chassis's dust and waterproof level is IP42.

Examine:

- Make sure all devices are fully charged.
- Make sure there are no obvious abnormalities on the robot chassis.
- Check if the remote control batteries are sufficiently charged.

Operate:

- Make sure the remote control is turned on during debugging to ensure the chassis can receive the remote control command.
- Make sure the surrounding area is relatively open during operation and control the remote control within the line of sight.
- MK-mid has a maximum speed of 9.7Km/h (customized) and a maximum load of 80Kg; to ensure the normal operation of the robot chassis, the maximum load of the chassis does not exceed the corresponding load value during use.
- Please charge in time when the device alarms for low battery (when the battery is less than 10%, the whole robot chassis will alarm with a first-level fault, and the alarm indicator will flash to give a corresponding low battery prompt).
- When the device is abnormal, please stop using it immediately to avoid secondary equipment damage.
- When the device is abnormal, please contact the relevant technicians and do not handle it without authorization.
- Please use it in an environment that meets the protection level requirements according to the IP protection level.
- Do not push the robot chassis directly when the power is off.
- When charging, ensure that the ambient temperature is greater than 0℃.

Maintainance:

- If the tire is severely worn, please replace it in time.
- If the robot is not used for a long time, please ensure that the battery is fully charged and recharge the battery at least once a month.

3. Introduction

MK-mid is an all-around modular robot mobile platform. It adopts a front Ackerman steering structure and rear-wheel differential drive. Compared with the chassis with differential structure, MK-mid has faster walking ability and stronger load capacity on ordinary roads, and less wear on tires. MK-mid is equipped with double wishbone independent suspension at the front and rear. The chassis has strong stability and excellent shock absorption. It can easily pass through complex ground environments and common obstacles such as speed bumps, and is more suitable for long-term outdoor operation. The chassis is an underlying control system built based on VCU robot chassis control, which adopts CAN bus management and has the characteristics of high response, high precision and modularity. It is equipped with a navigation system, gimbal, logistics cabinet, robotic arm, scientific research equipment and other modules, it is widely used in autonomous driving, unmanned inspection, logistics, transportation and distribution, scientific research and various new application explorations that require mobile chassis.

3.1 Product List

After the goods arrive, please carefully confirm the product list:

Robot Chassis ×1

Remote Control x 1

Charger（48V） ×1

User Manual×1

3.2 Parameters

Parameter Type	Performance	Parameter
Structural	Design Size	920*740*350mm
	Chassis Weight	71 kg
	Structural Form	Front Ackerman steering, rear dual motor differential drive
	Suspension	Front and rear double wishbone independent suspension
	Chassis Material	Q235/AL6061
	Ground Clearance	150 mm
	Wheelbase	600 mm
	Front/Rear Track	600 mm
	Tire Model/Diameter	13*6.50-6 , 324 mm
Basic Configuration	Drive Motor	2*400W, brushless servo drive motor
	Gear Ratio	20 speed ratio
	Steering Motor	400W, brushed servo motor
	Battery	48V/ 18 Ah LiFePO4 battery with BMS CAN communication
	Charging Time	≤4H
	Charging Type	48V/5A charger manual charging
	External Power Supply	48V/10A- 24V/15A-12V/15A
	Braking Type	Motor brake
	Parking Method	Electromagnetic Parking Brake with Power-Off Activation
	Turn Signal	√
	Hazard Warning Flashers	√
	Brake Light/Deceleration Indicator Light/Malfunction Indicator Light	√
Safety Measures	Emergency Stop Switch	√
	Instruction Checksum	√
	Alive Counter Protection	√
	Steering System Troubleshooting	√
	Drive System Troubleshooting	√
	Emergency Power-Off Parking Protection	√
	Battery Fault Monitoring Protection	√
	Online Detection Of Chassis Can Nodes	√

	Chassis Fault Classification And Processing	√
	Chassis Fault Alarm	√
	Chassis Rapid Deceleration Reminder	√
	Remote Control Offline Processing	√
	Charging Safety Monitoring And Protection	√
VCU Configuration	Frequency	168MHz
	Hardware Floating Point Acceleration	√
	Communication Interface	CAN interface
	Communication Type	CAN 2.0B
	Kinematic Analysis	√
Performance Parameters	Remote Control Distance	100 m
	Vertical Load	80kg
	Running Speed	9.7km/h
	Range	25km (full loaded)/35km (no load)
	Minimum Turning Radius	1.6 m
	Maximum Climbing Angle	10 °
	Span Width	180 mm
	Obstacle Clearance Height	50 mm
	Steering Accuracy	≤ 0.5 °
	Protection Level	IP 42
	Operating Temperature	-20 ℃ ~ 50 ℃
	Storage Temperature	0℃~ 40℃

4. Product Presentation

This section provides a basic introduction to the MK-mid Ackerman Robot Chassis, which will help users and developers to have a basic understanding of the MK-mid chassis. As shown in Figures 4-1 and 4-2 below, they are the front and back overviews of the entire MK-mid Ackerman Robot Chassis.

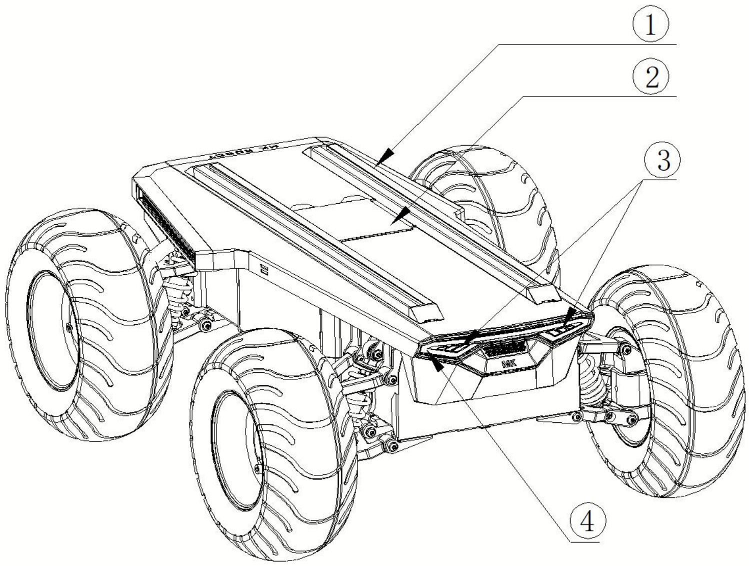

Figure 4-1 Front Overview

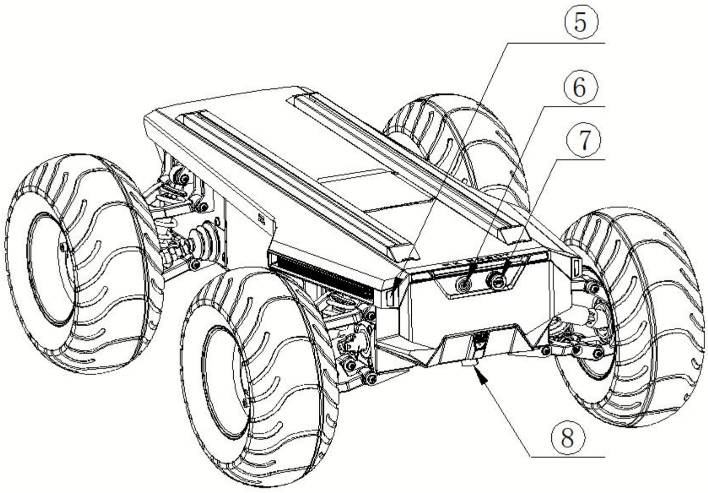

Figure 4-2 Tail Overview

Description: ① Standard profile bracket; ② Customer electrical compartment; ③ Front left and right turn signals, hazard warning flashers; ④ Clearance lights; ⑤ Rear left and right turn signals, hazard warning flashers; ⑥ Start switch; ⑦ Emergency stop switch; ⑧ Charging port.

MK-mid adopts a modular design concept with high safety and reliability. It adopts a front Ackerman steering structure, rear wheel dual motor independent drive mechanism, front and rear double wishbone independent suspension mechanism, and a non-load-bearing body design. The body has high rigidity, strong stability, and impact resistance, and can pass through a more complex ground environment.

An emergency stop switch is installed at the rear of the chassis, which can stop the robot chassis in an emergency to control the whole robot. At the same time, the emergency stop switch supports functional detection. For example, when the emergency stop switch is damaged or not connected, the VCU controls the driver not to powering on; the front and rear anti-collision bumper design provides multiple protections to ensure safe driving.

The robot chassis has multiple lighting control systems, including front and rear left and right turn signals, front clearance lights, hazard warning flashers, emergency deceleration warning lights, brake lights, robot chassis running breathing lights, fault indicator lights, and other multiple indicator lights. During the operation, the safety tips for pedestrians and around the robot chassis are given to the maximum extent, ensuring the safe operation of the robot chassis to the maximum extent; among them, the front clearance lights, front and rear left and right turn signals support multi-modal control such as VCU control and CAN communication, and customers can develop lighting control modes according to personal needs.

The robot chassis adopts a modular design concept; the front section of the chassis integrates the steering system EPS, sensor components, and steering system controller (EPS-ECU), which is convenient for the maintenance and replacement of EPS mechanical parts and sensors. The chassis drive system controller (MCU), battery pack, and battery management system (BMS) are integrated in the chassis to facilitate the replacement of the chassis battery system and ensure the chassis's stability. The rear section of the chassis integrates the motor and the robot's electrical part, including an integrated electric control box, which ensures the maintenance and replacement of the electrical part to ensure the stability of the chassis' operation. The chassis adopts an automotive-grade wiring harness and automotive-grade connectors to maximize the stability of chassis operation.

The robot chassis adopts integrated control, and the VCU uniformly analyzes and judges the signals to form a closed-loop control, which can perform fault diagnosis and corresponding safety protection processing, and realize remote unmanned status monitoring. 48V, 24V, and 12V electrical interfaces and communication interfaces are configured on top of the robot chassis, and a standard profile fixing bracket is equipped, so that users can quickly carry out secondary development.

4.1 Status Indicator

The user can determine the status of the chassis through the voltage display on the remote control and the startup sound. For details, please refer to Table 4-1.

State	Describe
Battery voltage	The current remaining battery capacity percentage (SOC) can be viewed by swiping the remote control display screen to the left and clicking on the Value in Ex tV (Figure 4-3)
Fault indicator light	The robot chassis fault status is determined based on the flashing frequency of the brake lights in the non-parking state and the braking state. Once for 1 second is a first-level fault alarm; twice for 1 second is a second-level fault alarm; three times for 1 second is a third-level fault alarm.

Table 4-1 Chassis status description

Note:

Fault level classification and processing method:

Level 1 fault: CAN signal and indicator light alarm;

Level 2 fault: CAN signal, indicator light alarm and robot chassis power reduction;

Level 3 fault: CAN signal, indicator light alarm, and driver power-off processing.

Name	ID	Value
TX. V	0	5.55V
Int. V	0	4.96V
Sig. S	0	10
Ext. V	1	48.62V

Figure 4-3 Remote controller chassis voltage monitoring interface

Note: The current interface appears by swiping the remote control screen to the left; TX.V is the current battery voltage of the remote control; Int. V is the power supply voltage of the receiver; Sig.S is the signal strength of the receiver; Ext. ,V is the remaining capacity percentage (SOC) of the external battery; ID 0 is the transmitter or receiver signal of the remote control; ID 1 is the first sensor connected to the receiver, and so on.

4.2 Electrical Interface Of The Top Electrical Compartment

MK-mid is equipped with a customer power supply electrical compartment on top. There are three 48V, 24V, and 12V power supply DT-type plug-ins arranged in the customer power supply electrical compartment, each with a corresponding power supply voltage label. The red wire harness of the power supply plug-in is the positive pole of the power supply, and the black one is the negative pole. The electrical compartment is also fixed with a DB9 female plug-in, which is a customer secondary development communication plug-in. The pin definition is shown in Table 4-2, and the corresponding power supply wiring harness and DB9 wiring harness have been prepared as shown in Figure 4-4, which is convenient for users to provide power to different expansion devices and use for communication.

Figure 4-4 Customer power harness

The specific pin definitions of the top electrical interface are as shown in Table 4-2.

Plugins	Pinout	Type	Definition	Remark
DB9	7	CAN	CAN_H	CAN bus high
	2		CAN_L	CAN bus low
DT	48V	Power Supply	Red Line	48V positive
			Black Line	G
	24V		Red Line	24V positive
			Black Line	G
	12V		Red Line	12V positive
			Black Line	G

Table 4-2 Top electrical interface pin definition

It should be noted that the extended power supply here is controlled internally. When the battery voltage is too low, the BMS will stop the battery from discharging. Users should pay attention to charging. During use, please note that 48V is the battery output power supply, and the output voltage is affected by the battery voltage fluctuation.

4.3 FS -i 6S Remote Control

The remote control parameters are pre-configured at the factory, and there is no need to change the settings. Changing the remote controller settings at will may cause control confusion, loss of control, etc., so please do not change the remote controller settings easily; if there is any problem with the parameter settings, please contact our customer service or technical support. If you need to make changes, you should ask professional technicians to set up the remote controller.

4.3.1 FS -i 6S Remote Control Instructions

MK-mid is equipped with an FS-i6S remote controller, which allows users to easily control MK-mid. We use the FS-i6S remote controller with the right-hand front and rear throttle and left and right steering. For its definition and functions, please refer to Figure 4-5.

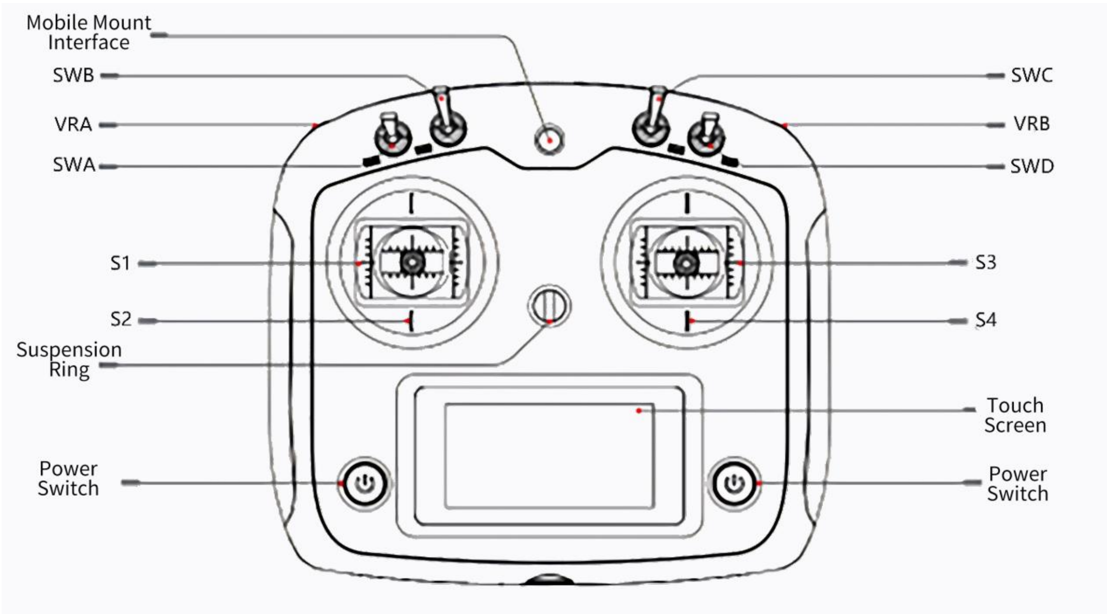

Figure 4-5 FS-i6S remote control operation panel diagram

The remote control parameters are pre-configured at the factory. Please do not modify the remote control system settings without permission, otherwise it may cause the robot to lose control, control confusion, and other problems. If there is any problem, it is recommended to return to the factory for repair. The detailed operation instructions of the remote control are as follows:

(1) SWA is the control mode switching lever with two gears. Take the remote control facing up as an example: when the SWA lever is in the upper position, it is the remote control mode, and when the SWA lever is in the lower position, it is the command control mode.

(2) SWB is the gear switching lever with three gears. When the lever is in the middle, the body is in N gear and does not receive forward and backward motion control signals. When the lever is moved upward, it switches to D gear, and the chassis can receive the forward motion control signal sent by the S4 joystick and move forward; when the lever is moved downward, it switches to R gear, and the chassis can receive the reverse motion control signal sent by the S4 joystick and move backward.

(3) VRB is the parking request control knob. When the knob is moved upward, a parking request is sent to activate the parking brake device; when the knob is moved downward, a parking release request is sent to release the parking brake device; at the same time, VRB is used as the remote control speed joystick control enable knob. When VRB is continuously pulled down, the speed control runs according to the joystick S4 request speed.

(4) The S4 joystick is used for throttle control, which controls the forward and reverse speed of the MK-mid; the S3 joystick controls the steering of the front wheels.

(5) SWC is the high, medium and low speed control mode of the S4 joystick. Taking the forward gear as an example: when SWC is at the top, the VRB knob is continuously pulled down, and the S4 joystick controls the robot chassis's highest speed to drive in low speed mode; when SWC is in the middle position, the VRB knob is continuously pulled down, and the S4 joystick controls the robot chassis to drive in medium speed mode; when SWC is at the bottom position, the VRB knob is continuously pulled down, and the S4 joystick controls the robot chassis to drive in high speed mode.

(6) The power switch is the power control switch of the remote control. When the remote control is in the off state, press and hold the power switches on both sides of the display to turn on the remote control; when the remote control is in the on state, press and hold the power switches on both sides of the display to turn off. If the remote control receiver is in the powered-on state, pressing and holding the power switches on both sides of the display at the same time cannot turn it off, and the battery needs to be removed to turn it off.

4.3.2 Remote Control Buzzer Warning Instructions

Switch position alarm	If the SWA /SWB / SWC / SWD lever switch is not in the default position when the device is turned on, an alarm interface will appear, prompting you to move all switches upward. When all switches are in the default position, the device will enter the main interface normally.
Low voltage alarm	When the voltage is lower than the alarm voltage, the system will sound an alarm and the remote control screen will start flashing. If the remote control voltage is too low, the TX icon will flash, and if the chassis voltage is too low, the RX icon will flash.
Communication abnormality alarm	When the control distance between the remote control and the chassis is too far or there is interference from the environment, the remote control signal strength will be reduced. If the signal strength is lower than 5, a communication abnormality alarm will be issued to remind the user that the remote control signal strength is weak.
Remote control not in use alarm	When the remote control is not used for a long time, the remote control buzzer will sound an intermittent alarm.
Shutdown alarm	When the remote control is turned off, it will detect whether the chassis is turned off. If the chassis is not turned off, a warning interface will pop up and you need to turn off the chassis power to turn off the remote control. (If you need to force the remote control to turn off when the chassis is not turned off, you can remove the battery.)

Table 4-3 Remote control alarm status description

4.3.3 Control And Motion Instructions

We establish the coordinate reference system of the ground mobile robot chassis according to the ISO 8855 standard as shown in Figure 4-6.

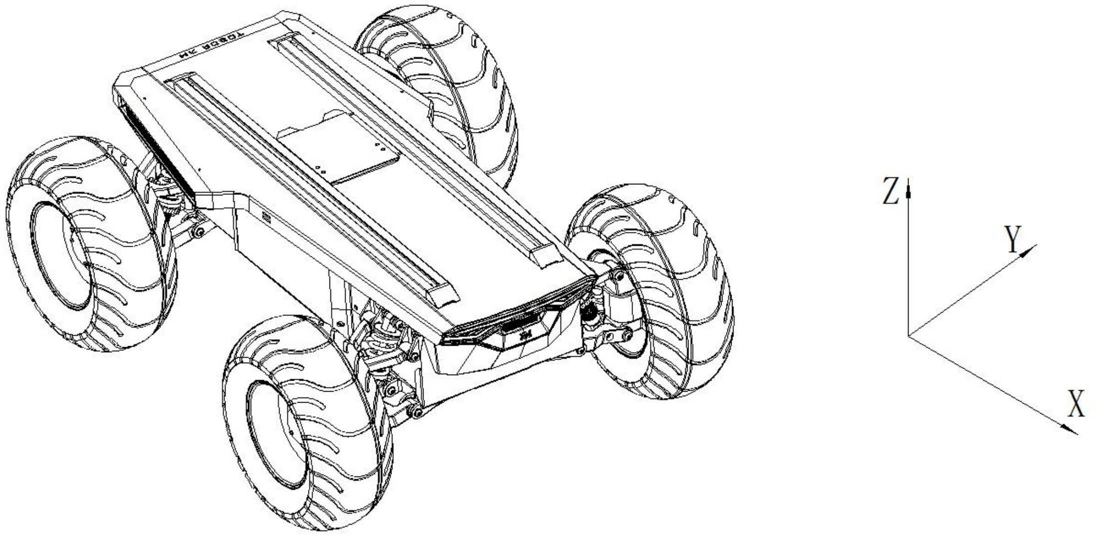

Figure 4-6 Chassis coordinate system

As shown in Figure 4-6, the MK-mid chassis body is parallel to the X axis of the established reference coordinate system.

In the remote control mode, pull down the VRB knob to release the parking gear, and continue to pull down the VRB knob, the SWB lever switches to the D gear, the remote control S4 joystick is pushed forward to move in the positive direction of X, the SWB lever is switched to the R gear, and the S4 joystick is pushed backward to move in the negative direction of X; when the S4 joystick is pushed forward to the maximum value, the movement in the X direction is controlled according to the high, medium and low speeds set by SWC; when the S4 joystick is pushed backward to the maximum value, the movement in the negative direction of X is controlled according to the high, medium and low speeds set by SWC; the remote control S3 joystick controls the steering movement of the front wheels of the chassis body left and right. When the S3 joystick is pushed to the left, the chassis turns left. When it is pushed to the maximum, the left steering angle is the largest. When the S3 joystick is pushed to the right, the chassis turns right. When it is pushed to the maximum, the right steering angle is the largest.

In the control command mode, the target gear command value of 04 indicates movement in the positive direction of the X axis, and the value of 02 indicates movement in the negative direction of the X axis.

5. Getting Started

This section mainly introduces the basic operation and use of the MK-mid platform, and how to perform secondary development of the robot chassis body through the CAN bus protocol.

5.1 Operation

Robot chassis inspection

(1) Check if there are any obvious abnormalities on the robot chassis; if so, please contact after-sales support.

(2) Check the emergency stop switch status and confirm that the top emergency stop switches are in the released state.

(3) Check that all gears of the remote control are in the neutral position.

Robot chassis start

(1) Long-press the power switches on both sides of the display to turn on the remote control.

(2) Press the start switch.

(3) Check whether the chassis battery voltage is normal. If the voltage is lower than 47.5V, please charge it first.

(4) Release the parking brake and switch to the remote control driving mode to observe whether the brake lights flash. If there is a fault, connect the CAN card to read the robot chassis fault status and signal, and then contact after-sales personnel to solve it.

Robot chassis shut down

Press the start switch again to release the start switch to turn off the power.

Robot chassis emergency stop

Take a picture of the emergency stop switch in the electrical panel at the rear of the MK-mid robot chassis body.

5.2 Charging

The MK-mid mobile robot chassis is equipped with a 48V/5A charger by default, which can meet the charging needs of users.

The specific charging operation process is as follows:

1) Before charging, please make sure that MK-mid is in the shutdown and power-off state, and

confirm that the start switch in the tail electrical panel is in the off state.

2) First, insert the output plug of the charger into the charging interface of the tail electrical panel; Then insert the AC plug of the charger into the 220V AC socket.

3) After charging is completed, unplug the AC plug first, and then unplug the output plug.

4) The working status of the charger is indicated in Table 5-1.

LED Status	Charger status
LED1 bright red	The charger input cable connector is powered
LED2 bright red	Indicates that is charging
LED2 lights up green	Indicates that the battery is fully charged

Table 5-1 Charger status LED indicator description

5) If the charging environment is too high, the charger may enter the temperature protection state. Please move the charger to a cool or ventilated place. When the internal temperature of the charger reaches 50°C, normal charging will resume. The charger protection state description is shown in Table 5-2:

Protection Function	Functional Description
Overheat protection	When the internal temperature of the charger reaches the over-temperature protection point, the charger automatically stops charging.
Output short circuit protection	When the charger output is accidentally short-circuited, the charger automatically shuts down the output.
Output reverse polarity protection	When the battery is connected reversely, the charger will cut off the connection between the internal circuit and the battery.
Output overvoltage protection	When the charger output is over-voltage, the charger automatically shuts down the output.

Table 5-2 Charger protection status description

Note:

The charging process must be performed in sequence to prevent the charger socket from being charged and short-circuited with the battery charging port, causing damage to the robot battery and charger, or unnecessary personal injury.

When the robot chassis is charging, the VCU will protect the charging status. If charging is performed in the power-on state, the robot chassis will enable the electromagnetic parking brake to ensure charging safety, and automatically recover after disconnecting the charging state. At the same time, the CAN signal sends the corresponding charging flag bit and sends the corresponding command to release the charging power if it is necessary to release the charging power.

5.3 Development

MK-mid products provide a CAN interface for user development, and users can use the CAN interface to control the robot chassis.

5.3.1 CAN Interface Protocol

The communication in MK-mid products uses CAN 2.0 B extended frame, the message format uses Intel format, and the baud rate is 500K. The external CAN interface can control the gear position, body speed, steering angle, parking request, and other functions of the chassis movement; MK-mid will feed back the current motion status information and chassis system status information in real time.

The specific content of the protocol is as follows:

The motion command control frame includes gear control, body speed control, steering angle control, parking request, Alive counter, and checksum etc. The specific protocol content is shown in Table 5-3; please refer to 5.3.2 for wiring instructions, and refer to 5.3.3 for CAN communication sending requirements and test examples.

Note: The CAN interface is a non-isolated interface. During use, please prevent the CAN line from being connected incorrectly or the CAN bus from being short-circuited with various power supplies. If short-circuited, the VCU may be burned.

The CAN protocol is as follows:

Table 5-3 Command control frame and system feedback frame

Chassis Control Commands			
Message Name	ID	Period (ms)	Message Length (Byte)
ctrl_cmd	0x18C4D2D0	10	8

Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Target gear	Intel	0	0	4	Unsigned	1	0		00: disable 01: P position 02: R block 03: N gear 04: D The rest of the data is invalid, the default is parking
Target robot chassis speed	Intel	0	4	16	Unsigned	0.001	0	m/s	0.001m/s/bit;
Target robot chassis steering angle	Intel	2	20	16	Signed	0.01	0	°	0.01°/bit;
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Chassis I /O Port Control Instructions									
Message Name			ID				Period (ms)		Message Length (Byte)
io_cmd			0x18C4D7D0				50		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
I/O Control Enable	Intel	0	0	1	Unsigned	1	0		0 = Off: Turn signal and position light are controlled by VCU 1 = On: Turn signal and position light are controlled by CAN signal
Turn signal and hazard warning flasher switch	Intel	1	10	2	Unsigned	1	0		0 = All off 1 = Turn on the left turn signal 2 = Turn on the right turn signal 3 = Hazard warning flashers (turn signals take priority over hazard warning flashers)
Clearance light switch	Intel	1	13	1	Unsigned	1	0		0 = Off 1 = On
Charging forced power-on flag	Intel	5	40	1	Unsigned	1	0		When the flag is forced to be enabled in the charging state, the robot chassis can be

									powered on at 48V high voltage, and the robot chassis can resume driving control. When the flag is enabled and the robot chassis is in the charging state, it cannot move backwards.
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Chassis Control Feedback Command									
Message Name			ID				Period (ms)		Message Length (Byte)
ctrl_fb			0x18C4D2EF				10		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Target gear	Intel	0	0	4	Unsigned	1	0		00: disable 01: P position 02: R block 03: N gear 04: D The rest of the data is invalid, the default is parking
Current robot chassis speed feedback	Intel	0	4	16	Unsigned	0.001	0	m/s	0.001m/s/bit;
Current robot chassis steering angle feedback	Intel	2	20	16	Signed	0.01	0	°	0.01°/bit;
Current robot chassis operating mode feedback	Intel	5	44	2	Unsigned	1	0		0x0: auto 0x1: remote 0x2: stop
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting

									again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Left Rear Wheel Information Feedback									
Message Name			ID				Period (ms)		Message Length (Byte)
lr_wheel_fb			0x18C4D7EF				10		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Current left rear wheel speed feedback	Intel	0	0	16	Signed	0.001	0	m/s	0.001m/s/bit;
Current left rear wheel pulse number feedback	Intel	2	16	32	Signed	1	0		Wheel single turn 200000 pulses, encoder 2500 lines, 4 times frequency, 20 reduction ratio
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts

									counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Right Rear Wheel Information Feedback									
Message Name			ID				Period (ms)		Message Length (Byte)
rr_wheel_fb			0x18C4D8EF				10		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Current right rear wheel speed feedback	Intel	0	0	16	Signed	0.001	0	m/s	0.001m/s/bit;
Current right rear wheel pulse number feedback	Intel	2	16	32	Signed	1	0	1	Wheel single turn 200000 pulses, encoder 2500 lines, 4 times frequency, 20 reduction ratio
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is

									reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Chassis I/ O Port Status Feedback									
Message Name			ID				Period (ms)		Message Length (Byte)
io_fb			0x18C4DAEF				50		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
I/O control enable status feedback	Intel	0	0	1	Unsigned	1	0		0 = Off 1 = On
Turn signal switch status feedback	Intel	1	10	2	Unsigned	1	0		0 = All off 1 = Turn on the left turn signal 2 = Turn on the right turn signal 3 = Hazard warning flashers on
Brake light switch status feedback	Intel	1	12	1	Unsigned	1	0		0 = Off 1 = On

Charging forced power-on flag	Intel	5	40	1	Unsigned	1	0		When the flag is forced to be enabled in the charging state, the robot chassis can be powered on at 48V high voltage, and the robot chassis can resume driving control. When the flag is enabled and the robot chassis is in the charging state, it cannot move backwards.
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.

Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Chassis Odometer Feedback									
Name			ID				Period (ms)		Message Length (Byte)
odo_fb			0x18C4DEEF				10		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Mileage	Intel	0	0	32	Signed	0.001	0	m	0.001m/bit

Battery BMS Information Feedback									
Name			ID				Period (ms)		Message Length (Byte)
bms_Infor			0x18C4E1EF				10		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Current battery voltage	Intel	0	0	16	Unsigned	0.01	0	V	0.01V/bit;
Current battery current	Intel	2	16	16	Signed	0.01	0	A	0.01A/bit;
Current remaining battery capacity	Intel	4	32	16	Unsigned	0.01	0	Ah	0.01Ah/bit;

Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Battery BMS Status Feedback									
Name			ID				Period (ms)		Message Length (Byte)
bms_flag_Infor			0x18C4E2EF				100		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Current remaining battery percentage	Intel	0	0	8	Unsigned	1	0	%	1%/bit;
Single overvoltage protection	Intel	1	8	1	Unsigned	1	0		0 = Off 1 = On
Single cell undervoltage protection	Intel	1	9	1	Unsigned	1	0		0 = Off 1 = On
Overvoltage protection for the whole group	Intel	1	10	1	Unsigned	1	0		0 = Off 1 = On

Undervoltage protection for the whole group	Intel	1	11	1	Unsigned	1	0		0 = Off 1 = On
Charging over-temperature protection	Intel	1	12	1	Unsigned	1	0		0 = Off 1 = On
Charging low temperature protection	Intel	1	13	1	Unsigned	1	0		0 = Off 1 = On
Discharge over temperature protection	Intel	1	14	1	Unsigned	1	0		0 = Off 1 = On
Discharge low temperature protection	Intel	1	15	1	Unsigned	1	0		0 = Off 1 = On
Charging overcurrent protection	Intel	2	16	1	Unsigned	1	0		0 = Off 1 = On
Discharge overcurrent protection	Intel	2	17	1	Unsigned	1	0		0 = Off 1 = On
Short circuit protection	Intel	2	18	1	Unsigned	1	0		0 = Off 1 = On
Front-end detection IC error	Intel	2	19	1	Unsigned	1	0		0 = Off 1 = On
Software Lock MOS	Intel	2	20	1	Unsigned	1	0		0 = Off 1 = On
Charging status	Intel	2	21	2	Unsigned	1	0		0 = Not charging 1 = Manual charging 2 = Charging at the front charging station 3 = Rear charging station charging
SOC too low alarm	Intel	2	23	1	Unsigned	1	0		0 = Normal 1 = Too low
Low battery alarm	Intel	2	24	1	Unsigned	1	0		0 = Normal 1 = Too low

Current maximum battery temperature	Intel	1	28	12	Signed	0.1	0	℃	0.1℃/bit;
Current minimum battery temperature	Intel	1	40	12	Signed	0.1	0 *	℃	0.1℃/bit;
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Ultrasonic Radar Feedback 1									
Name			ID				Period (ms)		Message Length (Byte)
ultrasonic_1_fb			0x18C4E8EF				100		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Ultrasonic radar probe 1 distance feedback	Intel	0	0	12	Unsigned	1	0	mm	This frame signal exists when there is an ultrasonic radar connected, otherwise the
Ultrasonic radar probe 2 distance	Intel	1	12	12	Unsigned	1	0	mm	

feedback									frame signal is reserved
Ultrasonic radar probe 3 distance feedback	Intel	3	24	12	Unsigned	1	0	mm	
Ultrasonic radar probe 4 distance feedback	Intel	4	36	12	Unsigned	1	0	mm	
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Ultrasonic Radar Feedback 2									
Name			ID				Period (ms)		Message Length (Byte)
ultrasonic_2_fb			0x18C4E9EF				100		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
Ultrasonic radar probe	Intel	0	0	12	Unsigned	1	0	mm	This frame signal exists

5 distance feedback									when there is an ultrasonic radar connected, otherwise the frame signal is reserved
Ultrasonic radar probe 6 distance feedback	Intel	1	12	12	Unsigned	1	0	mm	
Ultrasonic radar probe 7 distance feedback	Intel	3	24	12	Unsigned	1	0	mm	
Ultrasonic radar probe 8 distance feedback	Intel	4	36	12	Unsigned	1	0	mm	
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Vehicle Fault Status Feedback			
Name	ID	Period (ms)	Message Length (Byte)

Veh_fb_Diag			0x18C4EAEF				10		8
Signal Description	Arrangement Format	Start Byte	Start Bit	Signal Length	Data Types	Accuracy	Offset	Unit	Signal Value Description
robot chassis fault level	Intel	0	0	4	Unsigned	1	0		0: No fault 1: Level 1 fault 2: Level 2 fault 3: Level 3 failure Other invalid
Auto control CAN communication error	Intel	0	4	1	Unsigned	1	0		0 = Normal 1 = Fault
Auto IO control CAN communication error	Intel	0	5	1	Unsigned	1	0		0 = Normal 1 = Fault
EPS offline fault	Intel	1	8	1	Unsigned	1	0		0 = Normal 1 = Fault
EPS Failure	Intel	1	9	1	Unsigned	1	0		0 = Normal 1 = Fault
EPS MOSFET over temperature	Intel	1	10	1	Unsigned	1	0		0 = Normal 1 = Fault
EPS alarm failure	Intel	1	11	1	Unsigned	1	0		0 = Normal 1 = Fault
EPS working malfunction	Intel	1	12	1	Unsigned	1	0		0 = Normal 1 = Fault
EPS overflow fault	Intel	1	13	1	Unsigned	1	0		0 = Normal 1 = Fault
Left wheel motor drive failure	Intel	4	32	6	Unsigned	1	0		Reference Note: robot chassis Fault Status Feedback Note ①
Right wheel motor drive failure	Intel	4	38	6	Unsigned	1	0		Reference Note: robot chassis Fault Status Feedback

									Note ①
BMS CAN communication disconnection fault	Intel	5	44	1	Unsigned	1	0		0 = Normal 1 = Fault
Emergency stop fault	Intel	5	45	1	Unsigned	1	0		0 = On 1 = Closed
Remote control off warning	Intel	5	46	1	Unsigned	1	0		0 = Normal 1 = Fault
Remote controller receiver offline failure	Intel	5	47	1	Unsigned	1	0		0 = Normal 1 = Fault
Alive Rolling Counter	Intel	6	52	4	Unsigned	1	0		The value increases by 1 for each frame sent. When the maximum value is reached, it starts counting again from 0. It is used to detect packet loss and disconnection.
Check BCC	Intel	7	56	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Note: Description of left wheel motor and right wheel motor drive fault signal.

Note_Signal_Value	Note_Signal_Name	Note_Sign al_Description	Failure_level
0x00		Travel drive has no fault	0
0x01	DiagMCU_DisOnlie	The CAN communication signal of the travel drive is disconnected	3
0x02	DiagMCU_EbrSL	The resistance of the walking driver discharge resistor is too small	2
0x03	DiagSCMCU_EcoUt	Travel drive communication timeout	3
0x04	DiagSCMCU_EcotS	Travel drive drops offline and stops	3
0x05	DiagSCMCU_EcStp	Travel drive autonomous parking	3
0x06	DiagSCMCU_EdnRE	Travel drive no response error alarm	3
0x07	DiagSCMCU_EEnAb	Travel drive encoder AB signal alarm	2
0x08	DiagSCMCU_Eencu	Travel drive encoder UVW signal alarm	2
0x09	DiagSCMCU_EFrAE	Walking drive FRAM data write operation verification error	3
0x0A	DiagSCMCU_EGEAr	The electronic gear parameters of the travel drive are abnormal	3
0x0B	DiagSCMCU_ELUdc	Travel drive undervoltage alarm	2
0x0C	DiagSCMCU_EocA	Travel drive A phase overcurrent alarm	2
0x0D	DiagSCMCU_EocB	Travel drive B phase overcurrent alarm	2
0x0E	DiagSCMCU_EocC	Travel drive C phase overcurrent alarm	2
0x0F	DiagSCMCU_EoLoad	Travel drive overload alarm	2
0x10	DiagSCMCU_EoSPE	Travel motor exceeds maximum speed alarm	2
0x11	DiagSCMCU_EoUdc	Travel drive overvoltage alarm	2
0x12	DiagSCMCU_EoUP	Abnormal phase voltage alarm of travel drive	2
0x13	DiagSCMCU_EPArA	Travel driver FRAM parameter overflow error	3
0x14	DiagSCMCU_EorEr	Travel drive zero timeout alarm	3

0x15	DiagSCMCU_EPEOU	Travel drive position deviation counter overflow	2
0x16	DiagSCMCU_Ehot	The temperature of the power device of the travel drive is too high	2
0x17	DiagSCMCU_EPosE	Travel drive position out-of-tolerance alarm	2
0x18	DiagSCMCU_EPS1E	Walking drive 1 phase current ADC zero point abnormal alarm	3
0x19	DiagSCMCU_EPS2E	Walking drive 2-phase current ADC zero point abnormal alarm	3
0x1A	DiagSCMCU_ESPEE	Travel drive stall alarm	3
0x1B	DiagSCMCU_EUSPn	The travel drive motor model does not support alarm	3
0x1C	DiagSCMCU_E2LoS	Travel motor encoder Z pulse loss error alarm	3
0x1D	DiagSCMCU_E2EtE	Travel motor encoder Z pulse too much error alarm	3

5.3.2 CAN line connection

The CAN lines of MK-mid have been soldered and marked. Users can connect directly according to the markings, as shown in Figure 5-1 below.

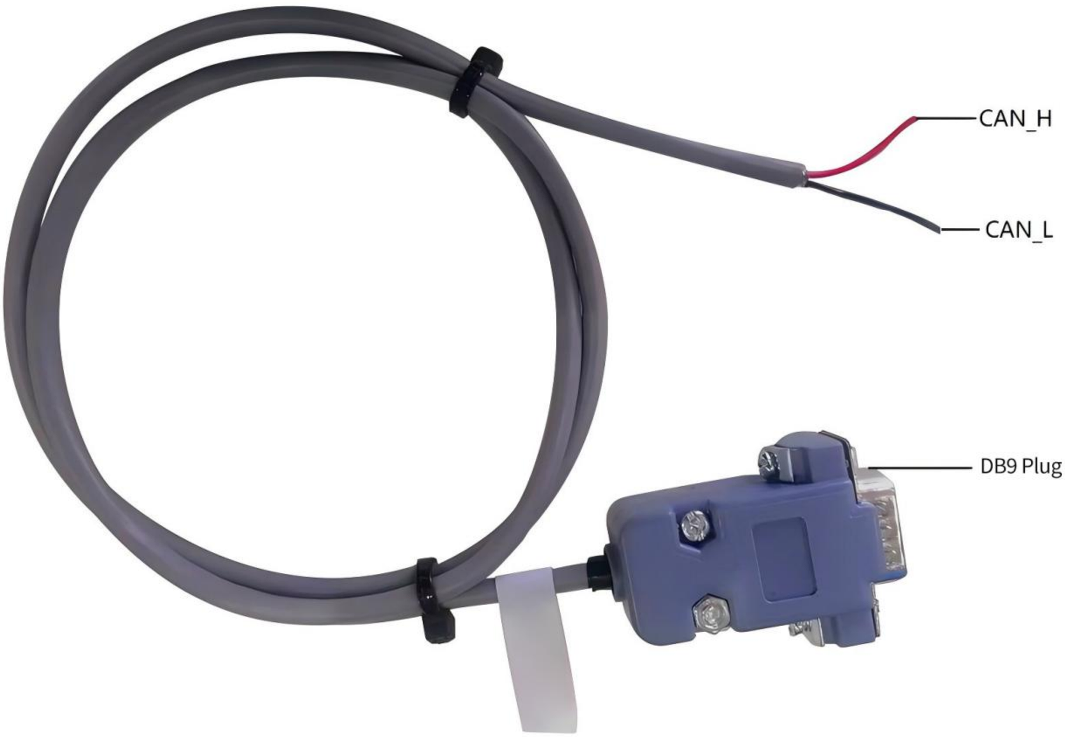

Figure 5-1 CAN line location diagram

5.3.3 VCU Common Protocol Instructions

5.3.3.1 Precautions during testing

1) During the sending process, please note that the Alive Counter needs to be sent continuously from 0 to 15.

2) During the sending process, pay special attention to the four bits from 52 to 55 occupied by the Alive Counter.

3) BYTE[7] check bit is the XOR check of the first 7 bytes: Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

4) The following routine is a simple control instruction when using USB CAN for sending. Please control and send instructions according to the communication protocol when controlling the robot chassis.

5) During the test, the remote control switches to the automatic driving mode or turns off the remote control.

6) During the test using a computer connected to the CAN card, please set up the robot chassis during the test because the robot chassis may be moving, etc., and put it down when the test is stable.

7) During the landing test, since the remote control has the highest priority, it is best to turn on the remote control test so that you can switch to the remote control mode at any time during the test.

5.3.3.2 Robot chassis control command description ctrl_cmd

The robot chassis control command needs to send the corresponding command, Alive counter and checksum at the same time.

(1) ctrl_cmd_gear

The ctrl_cmd_gear command is the target gear signal. The physical value range is: 01 to 04. The default gear position is 01 parking P gear; when the target gear is given as 03, it is neutral N; when the target gear is given as 02, it is reverse gear R; when the target gear is given as 04, it is forward gear D; when the target gear is given as 01, it is parking gear P gear.

Example: When the target gear request is forward gear -04 0x04

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2D0	0x04	0x00	0x00	0x00	0x00	0x00	0x10	0x14
0x18C4D2D0	0x04	0x00	0x00	0x00	0x00	0x00	0x20	0x24
0x18C4D2D0	0x04	0x00	0x00	0x00	0x00	0x00	0x30	0x34

Note: The above three frames of signals are sent cyclically at an interval of 10 ms , which can control the gear position to switch to D gear.

return:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2EF	0x04	0x00	0x00	0x00	0x00	0x00	0x00	0x04

Note: The Alive counter and checksum change cyclically

(2) ctrl_cmd_velocity

The ctrl_cmd_velocity command is the target value of the robot chassis speed. The CAN communication physical value range is 0 to 65.535m/s (20 speed ratio, 320mm wheel diameter, maximum speed is 2.7m/s). The target speed is determined by the speed accuracy (0.001m/s/bit). The target speed of the driving robot chassis = 0.001*bus signal. The robot chassis moves forward and backward in coordination with the gear.

There are three types of speed feedback, namely:

1) Current speed feedback: This speed feedback is always positive.

2) Left and right wheel speed feedback: It is the current speed corresponding to the left and right wheels, respectively. The speed is positive when moving forward and negative when moving backward.

Left and right wheel pulse number feedback: The pulse number is accumulated when moving forward, and the pulse number is accumulated when moving backward.

Example: Given a forward speed request of 1 m/s , the bus signal is equal to 1000 0x03E8

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2D0	0x84	0x3E	0x00	0x00	0x00	0x00	0x00	0xBA
0x18C4D2D0	0x84	0x3E	0x00	0x00	0x00	0x00	0x10	0xAA
0x18C4D2D0	0x84	0x3E	0x00	0x00	0x00	0x00	0x20	0x9A

Note: The above three frames of signals are sent cyclically at an interval of 10 ms , which can control the robot chassis to move forward at a speed of 1m/s .

return:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2EF	0x84	0x3E	0x00	0x00	0x00	0x00	0x00	0xBA

Note: The Alive counter and checksum change cyclically. Due to the automatic speed adjustment during operation, the feedback may not be absolute 1m/s, and there is a certain deviation.

The left rear wheel speed and left rear wheel pulse feedback ID are: 0x18C4D7EF

The right front wheel speed and right front wheel pulse feedback ID are: 0x18C4D8EF.

(3) ctrl_cmd_steering

The ctrl_cmd_steering command is a target steering angle request. The CAN communication physical range is (-327.68) degrees to (327.67) degrees. The robot chassis internal soft limit angle is (-34) degrees to (+34) degrees. Left steering is positive and right steering is negative. The target steering angle is determined with an accuracy of 0.01 °/bit. Target steering angle = bus signal*0.01.

Example: Given a target steering angle of -25 degrees, the bus signal is equal to -2500 0XF63C

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2D0	0x00	0x00	0XC0	0x63	0x0F	0x00	0x00	0xAC
0x18C4D2D0	0x00	0x00	0XC0	0x63	0x0F	0x00	0x10	0xBC
0x18C4D2D0	0x00	0x00	0XC0	0x63	0x0F	0x00	0x20	0x8C

Note: The above three frames are sent cyclically with an interval of 10 ms , and the steering angle request can be - 25 degrees.

return:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2EF	0x00	0x00	0XC0	0x63	0x0F	0x00	0x00	0xAC

Note : The Alive counter and checksum change cyclically

5.3.3.3 Auxiliary control instructions

Take the enablement of the clearance lights as an example. The control of other accessories is the same as the enablement control of the clearance lights. The IO port enablement control requires sending the enable flag, Alive counter, and checksum at the same time. (If the IO control is not enabled, all lights are controlled by the VCU).

Example: io_cmd_ clear ance_lamp clearance lamp enable control 0x01

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D7D0	0x01	0x20	0x00	0x00	0x00	0x00	0x00	0x21
0x18C4D7D0	0x01	0x20	0x00	0x00	0x00	0x00	0x10	0x31
0x18C4D7D0	0x01	0x20	0x00	0x00	0x00	0x00	0x20	0x01

Note: The above three frames of signals are sent cyclically with an interval of 50 ms , which can request the high beam to be turned on.

return:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4DAEF	0x01	0x 20	0x00	0x00	0x00	0x00	0x00	0x21

Note: The Alive counter and checksum change cyclically

Auxiliary enable control supports clearance light control and left and right turn signal control; the horn is controlled at the IO port and can be controlled when the enable signal is set to 1 or 0; the brake light is not controlled by CAN and is completely controlled by the VCU.

6. Attention

This section contains some notes on using, storing and developing the MK-mid.

6.1 Battery Usage Precautions

- The battery of the MK-mid products may not be fully charged when it leaves the factory. The specific situation can be read through the MK-mid remote control robot chassis chassis SOC display or the CAN bus communication interface. The charging time is indicated by the green indicator light of the charger to indicate that the charging is complete;
- Please do not charge the battery after it is exhausted. Please charge it in time when the battery voltage is too low;
- The operating temperature of the battery under discharge conditions is -20°C~50°C. The battery can work normally within the specified temperature range, and the capacity loss is within the error range;
- The battery is prohibited from over-discharging during use to avoid damaging the battery;
- Avoid excessive impact on the battery. Impact beyond the specification may damage the battery, which may cause battery leakage, heating, smoking, fire, or explosion;
- If the battery is found to be abnormal, please stop using the battery immediately!

6.2 Charging Precautions

- The battery must be charged with a matching battery charger. Do not use non-original standard batteries, power supplies, and chargers at will;
- Charge only at 10°C~45°C. Charging outside this temperature range may cause battery leakage, heating, or serious damage. It may also cause the performance and life of the battery to deteriorate;
- When charging, if the charger or battery is abnormal or damaged, please unplug the charger input power cord and output power cord immediately;
- If the charging process cannot be completed within the specified time, the charging process should be stopped. Otherwise, the battery may generate heat, smoke, fire (or explosion);
- It is strictly forbidden to charge the robot chassis battery in thunderstorms;
- It is strictly forbidden to charge the robot chassis battery in humid, rainy, and flooded places;

- It is strictly forbidden to charge the robot chassis battery in places with high temperatures such as heat sources and direct sunlight;
- It should be charged in a ventilated and dust-free place;
- It is strictly forbidden to block the air inlet and outlet of the charger during charging, and at least 10cm of space should be left;
- The charging process must be carried out to prevent the charger socket from being charged and short-circuited with the battery charging port, causing damage to the robot battery and charger, or unnecessary personal injury.

6.3 Usage Environment Precautions

- The operating temperature of MK-mid is -20℃~50℃. Do not use it in an environment below -20℃ or above 50℃;
- The optimal storage temperature of MK-mid is 0℃~25℃;
- Do not store or use it in an environment with corrosive, flammable, or explosive gases;
- Keep away from heat and fire sources during use and storage;
- Except for the specially customized version (IP protection level customization), the waterproof function of MK-mid is limited. Do not use it in rainy weather at will.

6.4 Remote Control Operation Precautions

- When debugging with the remote control, please make sure that the remote control is turned on to ensure that the robot chassis can receive the remote control command;
- Before turning on the machine, make sure that all the dial switches are at the top; the emergency stop switch is released; the throttle lever is returned to zero, that is, the chassis speed is 0;
- When operating with the remote control, please give priority to low-speed gear control, and then perform medium-speed or high-speed control tests after you are familiar with the robot chassis.

6.5 Electrical External Extension Precautions

- The top expansion power supply current should be used strictly by the selected battery voltage and current, and should not be overloaded;

- When the system detects that the battery voltage is lower than the safe voltage, the protection program will be activated. If the external expansion device involves the storage of important data and has no automatic storage function when power is off, please charge it in time.

6.6 Other

- Do not drop or invert the robot during transportation or setting up operations;
- Non-professionals, please do not disassemble it privately;
- The battery of the remote control terminal should be removed if it is not used for a long time;
- The tires should be replaced in time according to the wear of the tread pattern;
- During use, pay attention to keeping the tire pressure of the robot consistent. If there is a tire leak, the tire should be maintained or replaced in time; otherwise, it may cause damage to the robot.

7. Q&A

Q: MK-mid starts normally, but why does the robot chassis not move when controlled by the remote control?

A: First, confirm whether the tail emergency stop switch is released; check whether the SWA lever is in remote control mode, then check whether the VRB knob is unlocked, and finally check whether the SWB gear switch lever is consistent with the control command.

Q: What should I do if the MK-mid remote control stops working due to a lack of power?

A: Please replace the battery of the remote control, and restore normal communication immediately after the remote control is powered on.

Q: Both LED1 and LED2 indicators of the charger are off

A: Please first check whether the input line interface of the charger is connected correctly and firmly; then check whether there is AC input;

Whether the battery has not been used for a long time, is over-discharged, or damaged;

Re-plug the input and output line plugs, and the interval time is greater than 10 seconds to determine whether the charger is in protection state.

8. Specifications