YUHESEN

FW-mid Omnidirectional Drive-by-wire Chassis

User manual V2.2.2

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CONTENTS

1. Foreword

(1) Thank you for purchasing our product, this user manual is applicable to FW-mid Omnidirectional Drive-by-wire Chassis (hereby referred to as "FW-mid").

(2) Before use, please carefully read this user manual and attentions, and correctly use strictly in accordance with this manual.

(3) For the loses caused by serious violation of this user manual, we undertake no responsibilities.

(4) Please well keep this manual for user reference during your operation.

(5) Professionals are required for commissioning, connection and installation of the chassis equipment to avoid irretrievable loses.

(6) DO NOT install, remove or replace equipment lines with electricity. If it is necessary to commission this product with electricity, please select the special commissioning tools with good insulation.

(7) Please use this product under the conditions allowed by laws and regulations, so that the public property or life safety will not be affected.

(8) We will irregularly update this product, the contents of update will be added into the new manual without notification.

(9) This manual may contain the contents which are not correct in technology or which do not comply with the operation. In case of problems which cannot be solved during use of this manual, please contact with the customer service or technical department of us.

(10) As for the contents of this manual, we will try our best to ensure that they are correct and accurate. In case of any improper or incorrect contents, please contact us for confirmation, thank you!

Safety Information

The information herein does not include how to design, install or operate a complete robot, nor the peripheral equipment which may affect the safety of this complete system. The design and use of the complete system comply with the safety requirements formulated in the national standards and specifications. The integrators and end customers of FW-mid are responsible for being sure to comply with practical laws and regulations of relevant countries to ensure that the application of the complete robot will not cause any major danger. These include but are not limited to the following:

■ Effectiveness and responsibilities:

- A risk evaluation shall be conducted to the complete robot system. All the additional safety equipment of other machineries defined by risk evaluation shall be connected. It shall be ensured that, the design and installation of the peripheral equipment of the whole robot system, including software and hardware system, are correct.
- This robot is not equipped with relevant safety functions that a complete autonomously moveable robot shall have, including but not limited to automatic collision avoidance, fall prevention and alarm for creature approaching, etc. For relevant functions, the integrators and end customers are required to conduct safety evaluation in accordance with relevant regulations and feasible laws and regulations to ensure that the developed robot has no any major danger or potential safety hazard during actual application.
- Collecting all the documents of technical files: Including risk evaluation and this manual. Before operation and use of equipment, the existing safety risks may be known.

■ Environments:

- For first use, please carefully read this manual to understand the basic contents and operation specifications.
- For remote operation, please select the areas which are relevantly open. This chassis is not equipped with any sensor for automatic obstacle avoidance.
- This chassis shall be used under the temperature of -20°C~50°C.
- The chassis is not customized for IP protection grade, the IP protection grade of this chassis

is IP33.

■ Inspection:

- Inspecting whether the battery of chassis is fully charged.
- Ensuring that the chassis has no abnormality.
- Inspecting whether the battery of remote controller is fully charged.

■ Operation:

- When using the remote control for debugging, please make sure the remote control is turned on and the vehicle can receive the remote control commands.
- Ensuring that operation is conducted in a relatively open place. And remote control shall be conducted with sight distance.
- FW-mid The maximum load is 50KG, during use, it shall be ensured that the effective load does not exceed 50KG.
- When the device reports low battery, please charge it in time. When the device malfunctions, please stop using it immediately to avoid secondary injuries.
- When the device malfunctions, please contact the relevant technical personnel and do not handle it without authorization.
- Please use the equipment in the environment which meets the IP protection grade requirements of the equipment.
- When charging, please ensure that the environment temperature is above 0°C.

■ Maintenance:

- If the tire wear is severe, please replace it in time.
- If the battery is not used for a long time, it needs to be periodically charged every month when it is fully charged.
- The battery needs to be charged at least once a month.

2. Introduction

FW-mid is an omnidirectional drive-by-wire robotics chassis. It adopts swerve steering motor drive structure, which is a four-wheel independent drive and independent steering to realize precise and flexible control of chassis. FW-mid has an excellent traveling ability and off-road performance. With multiple moving modes, it can be used in indoor and outdoor applications. Meanwhile it combining the advantages of Ackermann steering and differential drive form. Compared with these drive form, the wearing of tire is lighter, the noise of driving is lower and vehicle operating more stable. By the modules and navigation systems of LiDAR, GPS and manipulator, etc., this chassis is widely used in inspection, patrol, detection, transportation, logistics, scientific research and various new applications and explorations requiring for mobile chassis.

2.1. Product list

After delivery, please carefully confirm the product list:

Chassis *1	Remote controller *1
	
Charger (48V) *1	Product manual *1
	

2.2. Performance parameters

Table 2 - 1 FW-mid performance parameter table

Parameter type	Performance	Parameter
Structural size and weight	Dimensions(W*D*L)	680*550*440mm
	Weight	68kg
	Drive	Swerve Steering Motor Drive
	Suspension	Independent suspension
	Material	Aluminium Alloy
	Ground clearance	120mm
	Wheelbase	400mm
	Wheel track	420mm
	Tire type/diameter	240mm
Basic configuration	Driving motor	350W*4 wheel hub motor
	Battery type	48V/20AH lithium battery/BMS management system
	Charging time	4-5h
	Charging method	48V/5A manual charger
	External power supply	24V/15A-12V/15A
	Braking mode	Motor brake
	Parking method	Motor parking
Safety measures	Emergency stop button	√
	Command check	√
	Heartbeat protection	√
	Current protection	√
	Temperature protection	√
VCU configuration	Dominant frequency	168MHz
	Hardware floating point acceleration	√
	Kinematic analysis	√
	Communication interface	CAN interface
	Communication protocol	CAN 2.0B
Performance parameters	Remote control distance	100m
	Vertical load (level road)	50kg
	Speed	0-5.4km/h
	Mileage	40km (without load)
	Minimum turning radius	0m
	Wading depth	100mm
	Maximum climbing angle	15° (full load)
	Crossing width	120mm (full load)
	Obstacle surmounting height	50mm (full load)
	Protection level	IP33
	Operating temperature	-20°C~50°C

3. Product Presentation

This section provides a basic introduction to the FW-mid mobile robot chassis, aiming to give

users and developers a fundamental understanding of the FW-mid chassis. The FW-mid chassis adopts a modular and automotive-grade design approach, featuring independent omni-directional steering, allowing all four wheels to achieve 360° rotation in place. It supports lateral movement, Ackermann steering mode, diagonal movement mode, and pivot turning mode, providing agile maneuverability. The tires are durable and resistant to wear, enabling precise control over the chassis steering. With four independent wheel drives, the FW-mid chassis delivers powerful and ample power, excelling in climbing performance and minimizing slippage. It adapts well to various road conditions and utilizes the standard CAN communication protocol, offering multiple application modules and universal standard interfaces. This allows users to quickly integrate camera gimbals, robotic arms, infrared modules, and other components, facilitating rapid development and customization.

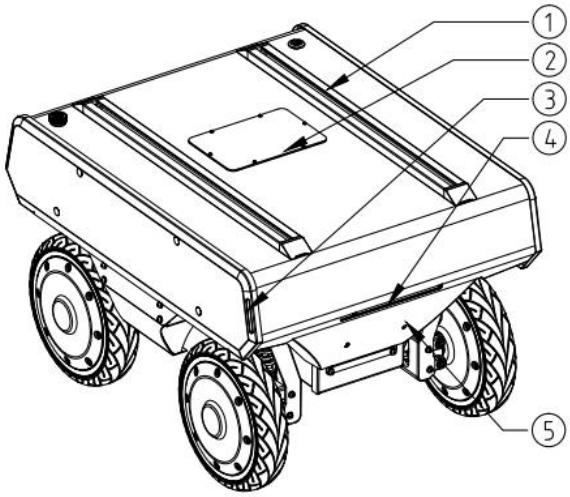


Figure 3 - 1 Tail overall figure

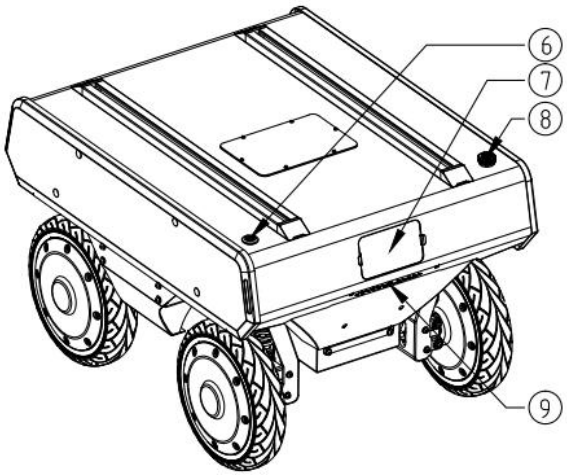


Figure 3 - 2 Front overall figure

Note: ①aluminium profile; ②power supply/comminucation wire port; ③turn signal lights;

④head lightl; ⑤battery power button(internal); ⑥start up button; ⑦debugging/charging quick detach board; ⑧emergancy stop button; ⑨rear tail light/brake light.

3.1. Instructions of electrical interface

3.1.1. Instructions of tail electrical board

There is an electrical board located at the rear of the chassis. To operate, you need to open the cover of the electrical board at the rear. Once the electrical board cover is opened, it will appear as shown in Figure 3-3. In the diagram, B1 and B4 represent USB debugging ports, B2 and B6 are Ethernet ports (B6 is the internal CAN debugging port of the chassis), B3 is the HDMI debugging port, and B5 is the manual charging interface.

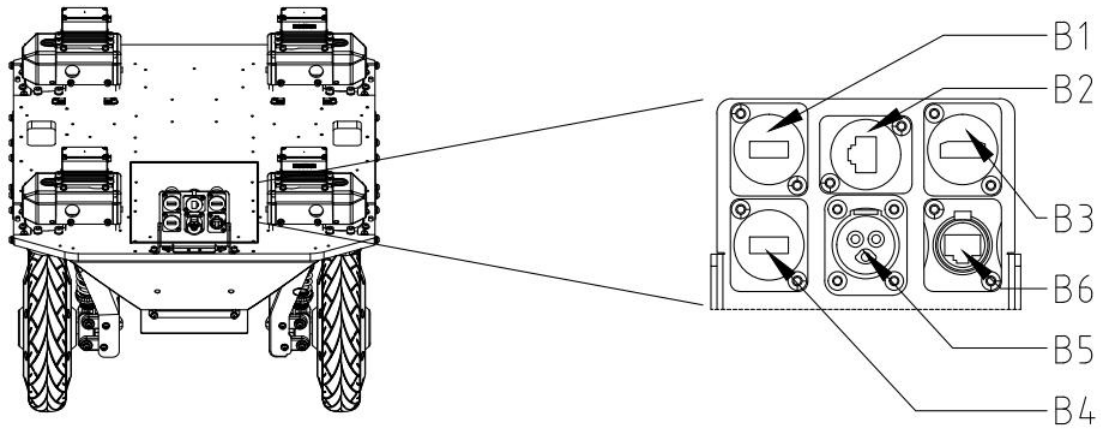


Figure 3 -3 Schematic Diagram of Top Electrical Position

3.2. Instructions of FW-mid remote control

3.2.1. FS-i6S remote control operation

Each FW-mid is equipped with an FS-i6S remote controller, allowing users to easily control the FW-mid. In this product, the remote controller is designed with left-hand control for left and right directions and right-hand control for forward and backward throttle. The definitions and functions can be referred to in Figure 3-4.

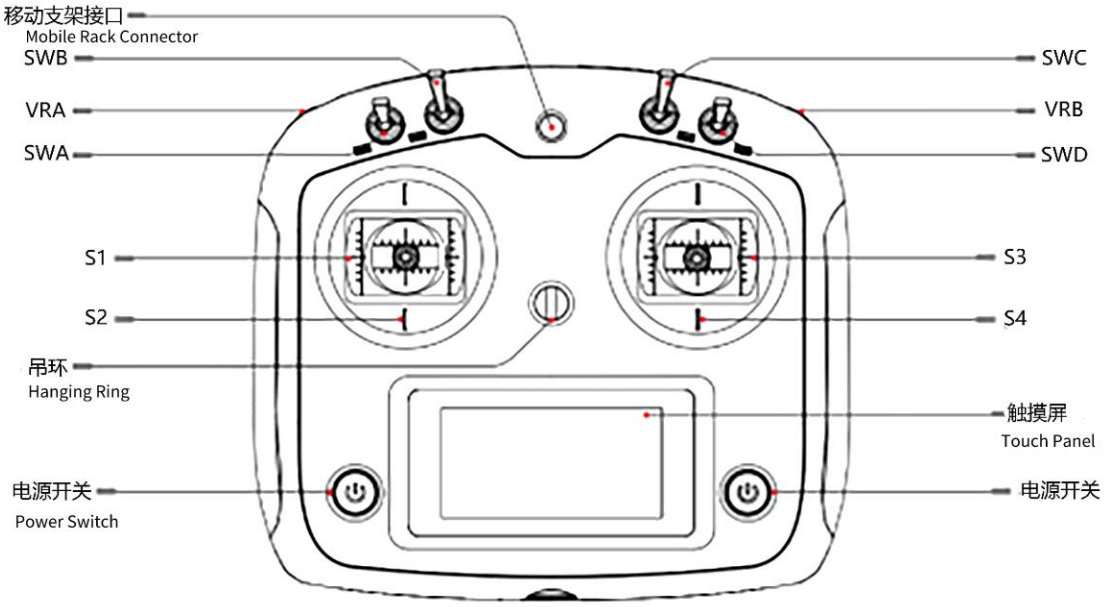


Figure 3-4 Schematic diagram of FS-i6S remote controller keys

The parameters of the remote controller have been configured before delivery. DO NOT modify the system configuration of the remote controller without permission, or, the robot may be out of control and in controlling chaos, etc. In case of any question, please contact the customer services or after-sales personnel for answering:

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

(2) The SWB is the gear shift lever with three positions. When the lever is moved up, it switches to the parking gear, causing the chassis wheels to enter the parking state, preventing the chassis from moving. When the lever is in the middle position, it switches to the four-wheel drive mode (4T4D), operating in a dual Ackermann steering mode. When the lever is moved down, it switches to the lateral movement gear, where the chassis steering mode allows for lateral movement.

(3) The SWC is the speed switch lever with three positions. When the lever is moved up, it activates the low-speed mode. When the lever is moved down, it activates the high-speed mode. When the lever is in the middle position, it activates the medium-speed mode.

(4) The VRA (Vehicle Release Actuator) is the safety parking unlock dial used to release the safety parking feature. When the collision sensor detects a collision, it triggers the safety parking function. To release the safety parking, you need to turn the VRA dial once (or move the right joystick S4 in the opposite direction of the collision). This action will unlock the safety parking and allow you to continue operating the vehicle.

(5) The VRB is the operational protection dial. When operating the joystick, you need to simultaneously hold down the VRB dial. If you don't hold down the VRB dial, the chassis will not receive any motion commands from the joystick. This serves as a safety measure to prevent unintentional or unauthorized control of the vehicle.

(6) The left joystick is the direction control joystick. Joystick S1 controls the left and right steering of the chassis through its left and right movements. Joystick S2, when moved up or down, does not affect the chassis movement and is not currently in use. Its up and down movements have no impact on the chassis motion.

(7) The right joystick is the throttle control joystick. Joystick S4 controls the forward and backward movement of the chassis through its front and back movements. Joystick S3, when moved left or right, is not currently in use and does not affect the chassis movement. Its left and right movements have no impact on the chassis motion.

(8) There are power buttons on the left and right sides. By simultaneously long-pressing both power buttons, you can perform the power on/off operation.

(9) The standby interface is explained as follows:

The start page is divided into four sections. The top left section displays two timers, T1 and T2. The bottom left section indicates the flight mode. The top right section shows the battery level, with TX representing the remote controller battery and RX representing the robot's battery. The bottom right section includes the unlock button and fine-tuning buttons.

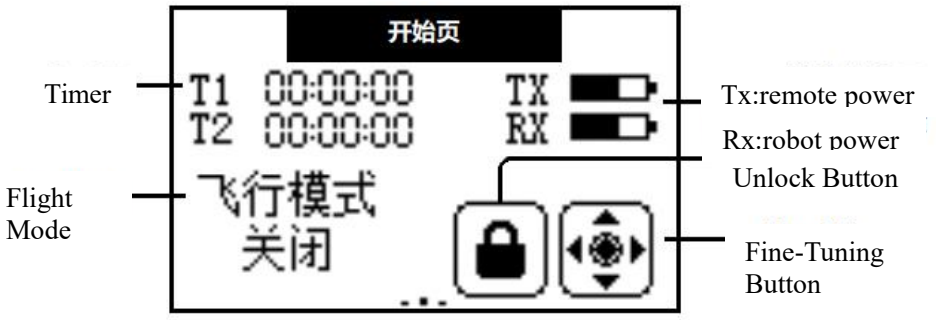


Figure 3-5 Remote controller monitor display interface

The left side of the remote controller's start page is the channel interface, as shown in the figure 3-6:

Figure 3-6 remote controller channel interface

The corresponding relationships between each channel and the remote controller operating components are as table 3-1:

Table 3-1 The corresponding relationships between channel and remote controller

Channel No.	1	2	3	4	5	6	7	8	9	10
Remote controller parts	S3	S2	S4	S1	VRA	VRB	SWA	SWB	SWC	SWD

The right side of the remote controller's start page is the sensor list page, which includes the following information:

TX.V: Remote Controller Battery Voltage

Int.V: Receiver Voltage

Sig.S: Signal Strength (Normal signal strength is 10)

Ext.V: Robot Chassis Battery Remaining Capacity (Note: the unit show is V, actually should be %, for example, as figure 3-7 show is 66%)

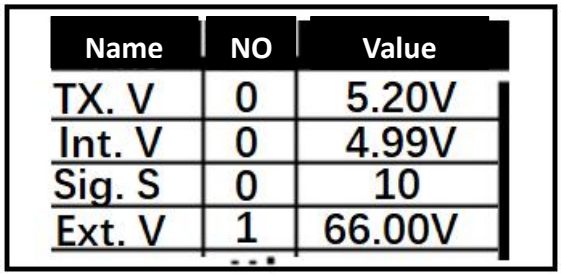


Figure 3-7 The sensor list page of remote controller

- **The control authority regarding the remote controller and communication commands is as follows:**

(1) In scenarios where no remote controller is present: upon startup, the FW-mid mobile robot chassis will receive communication commands and execute them accordingly. It will rely solely on these instructions for its operation.

(2) In scenarios where both the remote controller and communication commands are present: the remote controller takes priority in controlling the FW-mid mobile robot chassis. It will control the device based on the mode set by the SWA switch on the remote controller. The control authority can be easily obtained by using the SWA switch.

(3) When only the remote controller is present: the control of the FW-mid mobile robot chassis is determined by the remote controller's mode, which is controlled by the remote controller itself.

3.2.2. Remote control buzzer warning instructions

Table 3-3 Instructions of remote controller alarm condition

Switch position alarm	When the remote control is turned on and the lever switches SWA/SWB/SWC/SWD are not in their default positions, an alarm interface will appear, prompting the user to move all the switches to the upward position. Once all the switches are in their default positions, the main interface will appear normally.
Low voltage alarm	When the voltage drops below the alarm voltage, the system will emit an alarm, and the remote control screen will start flashing. If the voltage of the remote control is too low, the TX icon will flash, and if the voltage of the chassis is too low, the RX icon will flash.
Communication abnormal alarm	When the distance between the remote control and the chassis is too far or there is obstruction interference in the environment, the strength of the remote control signal will decrease. If the signal strength drops below 5, it will trigger a communication abnormal alarm, reminding the user that the remote control signal strength is weak.
Remote control unused alarm	When the remote control is unused for a long time, the remote control buzzer will emit intermittent alarms.
Power off alarm	When the remote control is turned off, it will check whether the chassis is also turned off. If the chassis is not turned off, a warning interface will pop up, and the chassis power must be turned off before the remote control can be turned off. (If it is necessary to force the remote control to shut down while the chassis is still on, the battery must be removed.)

3.2.3. Instructions of control commands and movement

We will establish a coordinate reference system for ground moving vehicles according to the ISO 8855 standard, as shown in Figure 3-8.

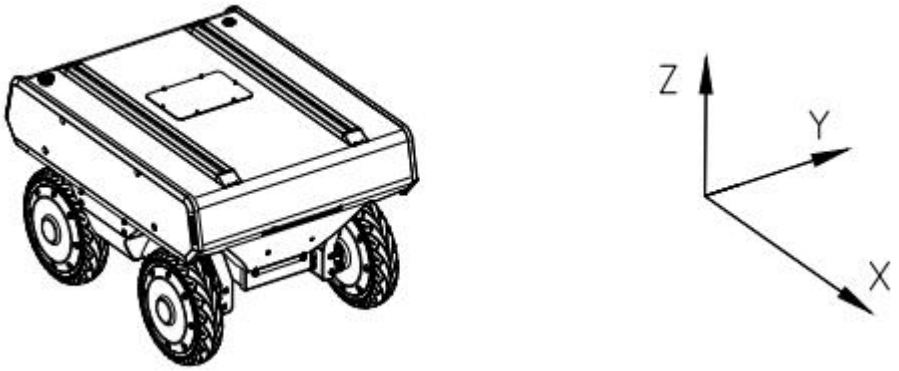


Figure 3-8

As shown in Figure 3-8, the FW-mid chassis is parallel to the X-axis of the established reference coordinate system.

In the remote controller control mode, while holding down the VRB (Vehicle Release Actuator) for operational protection, pushing the right-hand throttle joystick S4 forward on the remote controller will move the chassis in the positive X-direction. Pulling it backward will move the chassis in the negative X-direction. When the S4 joystick is pushed to its maximum value, the speed of movement in the X-direction is the highest. When pushed to its minimum value, the speed of movement in the negative X-direction is the highest.

The left-hand direction joystick S1 on the remote controller is used to control the steering movement of the chassis. When the SWB (Shift-Wheel Button) lever is in the four-wheel drive mode (4T4D), pushing the S1 joystick to the left will make the chassis turn left. Pushing it to the maximum left position will result in the highest left turning angular velocity. Likewise, pushing the S1 joystick to the right will make the chassis turn right, and pushing it to the maximum right position will result in the highest right turning angular velocity.

4. Use and Operation

This part mainly introduces the basic operation and use of FW-mid platform, and how to conduct secondary development to the vehicle body through CAN bus protocol.

4.1. Use and Operation

4.1.1. The basic operations flow of remote operation are as follows:

Inspection

(1) Check the status of the vehicle body. Check that whether the vehicle body has obvious abnormality; If any, please contact after-sales support;

(2) Check the status of the emergency stop button, and confirm that the emergency stop button at the tail is under the released state;

(3) Check that all gears of the remote controller are in default position;

Start-up

(1) Press Power Button

(2) Check the battery voltage to see if the battery voltage is normal, if the voltage is too low, please charge it first.

4.2. Charging

FW-mid mobile robot is equipped with a 36V/10A charger in default, meeting the demands of charging of the users.

The specific operation processes of charging are as follows:

(1) Before charging, make sure that the FW-mid is powered off and that the main power switch is off.

(2) First, insert the output plug of the charger into the charging interface on the electrical board at the tail; Then, plug the AC plug of the charger into the 220VAC socket.. When the indicator light is red, it enters the charging state, and when the indicator light is green, the charging is completed..

(3) Reverse the process after charging is completed. Unplugging the AC plug first, then the output plug.

(4) The charger protection status description is shown in Table 4- 1:

Table 4 - 1 charger protection status description

Protective Function	Functional Description
Overheating Protection	When the internal temperature of the charger reaches the over-temperature protection point, the charger will automatically stop

	charging.
Output Short Circuit Protection	The charger will automatically shut off the output when the charger output is accidentally short-circuited.
Output Reverse Connection Protection	When the battery is reversed, the charger cuts off the connection between the internal circuit and the battery.
Output Over-Voltage Protection	The charger automatically shuts off the output when over-voltage occurs at the charger output.

ATTENTION:

The charging process must be operated in order to prevent the charger and socket from being electrified and the battery charging port from short-circuiting, resulting in damage to the robot's battery, charger, or unnecessary personal injury.

4.3. CAN Wire Connection

FW-mid chassis provides CAN interface to users for development, and users can conduct command control to the vehicle body with CAN interface by connecting the CAN analyzer to USB port on electrical board at the tail of vehicle body.

4.4. CAN Interface Protocol

The communication of FW-mid chassis is conducted by CAN2.0B extended frame, and the message format is Intel format with a baud rate of 500K. Through the external CAN bus interface,the vehicle speed, steering angle and steering angular speed of the chassis can be controlled. The FW-mid will feed back the current movement state information and the system state information of the chassis in real time.

The specific protocol contents are shown as below:

The motion command control frame includes gear control, linear speed control, steering angle control, steering angular speed control, light control, parking request and inspection, etc. The specific protocol contents are shown in Table 4-2.

Table 4-2 Command Control Frame and System Feedback Frame

Movement control command - control frame									
Message Name			**ID**			**Type**	**Cycle（ms）**		**Message Length（Byte）**
ctrl_cmd			0x18C4D1D0			Cycle	10~50		8
Signal Description	**Format**	**Starting Byte**	**Starting Bit**	**Signal Transmission Type**	**Signal Duration**	**Data Type**	**Precision**	**Unit**	**Signal Value Description**
Target gear	Intel	0	0	Cycle	4	Unsigned	1		00: disable 01: Gear Parking 02: Gear Neutral 06: Gear 4T4D 07: Gear Parallel Moving
Target vehicle linear speed	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit
Target vehicle angular speed	Intel	2	20	Cycle	16	signed	0.01	°/s	(0.01°/s)/bit
Target vehicle slip angle	Intel	4	36	Cycle	16	signed	0.01	°	0.01°/bit
Alive Rolling Counter Heartbeat Signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.

Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Movement control command - control frame									
Message Name		**ID**				**Type**		**Cycle (ms)**	**Message Length (Byte)**
steering_ctrl_cmd		0x18C4D2D0				Cycle		10~50	8
Signal Description	**Format**	**Starting Byte**	**Starting Bit**	**Signal Transmission Type**	**Signal Duration**	**Data Type**	**Precision**	**Unit**	**Signal Value Description**
Target gear	Intel	0	0	Cycle	4	Unsigned	1		00: disable 01: Gear Parking 02: Gear Neutral 05: Gear 4T4D 07: Gear Parallel Moving
Target vehicle linear speed	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit;
Target vehicle angular speed	Intel	2	20	Cycle	16	signed	0.01	°	0.01°/bit;
Target vehicle slip angle	Intel	4	36	Cycle	16	signed	0.01	°	0.01°/bit;
Alive Rolling Counter Heartbeat Signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.

Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

I/O control command - control frame										
Message Name		**ID**				**Type**		**Cycle (ms)**	**Message Length (Byte)**	
io_cmd		0x18C4D7D0				IfActive		10	8	
Signal Description	**Format**	**Starting Byte**		**Starting Bit**	**Signal Transmission Type**	**Signal Duration**	**Data Type**	**Precision**	**Unit**	**Signal Value Description**
Lamp control	Intel	0	0	IfActive	1	Unsigned	1		0 = automatic control according to status 1 = free control	
Safety parking unlock switch	Intel	0	1	IfActive	1	Unsigned	1		0 = invalid 1 = unlock enable	
Headlight switch	Intel	1	8	IfActive	1	Unsigned	1		0 = off 1 = on	
Steering lamp switch	Intel	1	10	IfActive	2	Unsigned	1		0 = off 1 = left steering lamp on 2 =right steering lamp on	
Braking lamp switch	Intel	1	12	IfActive	1	Unsigned	1		0 = off 1 = on	
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.	

Check BCC XOR checkout for message	Intel	7	56	Cy-cle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Movement control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle (ms)**	**Message Length (Byte)**	
ctrl_fb			0x18C4D1EF			Cycle	10	8	
Signal Description	**Format**	**Starting Byte**	**Starting Bit**	**Signal Transmission Type**	**Signal Duration**	**Data Type**	**Precision**	**Unit**	**Signal Value Description**
Current gear feedback	Intel	0	0	Cycle	4	Unsigned	1		00: disable 01: Gear Parking 02: Gear Neutral 06: Gear 4T4D 07: Gear Parallel Moving
Current linear speed feedback	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit
Current angular speed feedback	Intel	2	20	Cycle	16	signed	0.01	°/s	(0.01°/s)/bit
Current slip angle feedback	Intel	4	36	Cycle	16	signed	0.01	°	0.01°/bit
Alive Rolling Counter Heartbeat (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.

Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Movement control status - feedback frame									
Message Name			**Msg ID**		**Type**	**Cycle（ms）**		**Message Length (Byte)**	
steering_ctrl_fb			0x18C4D2EF		Cycle	10		8	
Signal Descrip-tion	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-mission Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Current gear feedback	Intel	0	0	Cycle	4	Unsi-gned	1		00：disable 01：Gear Parking 02：Gear Neutral 05：Gear 4T4D 07：Gear Parallel Moving
Current speed feedback	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit；
Current steering angle feedback	Intel	2	20	Cycle	16	signed	0.01	°/s	(0.01°/s)/bit；
Current slip angle feedback	Intel	4	36	Cycle	16	signed	0.01	°	0.01°/bit；
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsig ned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection

Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Wheels control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
lf_wheel_fb			0x18C4D6EF			Cycle	10		8
Signal Descrip-tion	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-mission Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Current left front wheel speed feedback	Intel	0	0	Cycle	16	signed	0.001	m/s	0.001m/s/bit；
Current left front wheel pulse feedback	Intel	2	16	Cycle	32	signed	1	1	N pulses for single wheel per turn,N = encoder lines * reduction ratio
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Wheels control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
lr_wheel_fb			0x18C4D7EF			Cycle	10		8
Signal Descrip-tion	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-missio n Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Current left rear wheel speed feedbac k	Intel	0	0	Cycle	16	signed	0.00 1	m/s	0.001m/s/bit；
Current left rear wheel pulse feedbac k	Intel	2	16	Cycle	32	signed	1	1	N pulses for single wheel per turn, N = encoder lines * reduction ratio
Alive Rolling Counter Heartbe at Signal(l oop counter)	Intel	6	52	Cycle	4	Unsi -gned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkou t for message	Intel	7	56	Cycle	8	Uns -igned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Wheels control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
rr_wheel_fb			0x18C4D8EF			Cycle	10		8
Signal Descrip -tion	**For- mat**	**Start -ing Byte**	**Start -ing Bit**	**Signal Trans- missio n Type**	**Signal Dura -tion**	**Data Type**	**Preci -sion**	**Unit**	**Signal Value Description**
Current right rear wheel speed feedback	Intel	0	0	Cycle	16	signed	0.00 1	m/s	0.001m/s/bit；
Current right rear wheel pulse feedback	Intel	2	16	Cycle	32	signed	1	1	N pulses for single wheel per turn,N = encoder lines * reduction ratio
Alive Rolling Counter Heartbea t Signal(lo op counter)	Intel	6	52	Cycle	4	Unsig ned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsig ned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Wheels control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
rf_wheel_fb			0x18C4D9EF			Cycle	10		8
Signal Descrip-tion	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-missio n Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Current right front wheel speed feedback	Intel	0	0	Cycle	16	signed	0.001	m/s	0.001m/s/bit；
Current right front wheel pulse feedback	Intel	2	16	Cycle	32	signed	1	1	N pulses for single wheel per turn,N = encoder lines * reduction ratio
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Wheels control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
front_angle_fb			0x18C4DCEF			Cycle	10		8
Signal Descrip -tion	**For- mat**	**Star t-ing Byte**	**Start -ing Bit**	**Signal Trans- mission Type**	**Signal Dura -tion**	**Data Type**	**Preci -sion**	**Unit**	**Signal Value Description**
Front left servo joint angle feedback	Intel	0	0	Cycle	16	signed	0.01	°	0.01°/bit;
Front right servo joint angle feedback	Intel	2	16	Cycle	16	signed	0.01	°	0.01°/bit;
Alive Rolling Counter Heartbea t Signal(lo op counter)	Intel	6	52	Cycle	4	Unsign ed	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsign ed	1		Checksum = Byte0 XOR Bye3 XOR te1 XOR Byte2 XOR BytByte4 XOR Byte5 XOR Byte6

Wheels control status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
rear_angle_fb			0x18C4DDEF			Cycle	10		8
Signal Descrip -tion	**For - mat**	**Start -ing Byte**	**Start -ing Bit**	**Signal Trans- missio n Type**	**Signal Dura -tion**	**Data Type**	**Preci -sion**	**Unit**	**Signal Value Description**
Rear left servo joint angle feedback	Inte l	0	0	Cycle	16	signed	0.01	°	0.01°/bit;
Rear right servo joint angle feedback	Inte l	2	16	Cycle	16	signed	0.01	°	0.01°/bit;
Alive Rolling Counter Heartbeat Signal(loo p counter)	Inte l	6	52	Cycle	4	Unsig ned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Inte l	7	56	Cycle	8	Unsig ned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

I/O control command - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
io_fb			0x18C4DAEF			Cycle	50		8
Signal Descrip -tion	**For- mat**	**Start -ing Byte**	**Start -ing Bit**	**Signal Trans- mission Type**	**Signal Dura -tion**	**Data Type**	**Preci -sion**	**Unit**	**Signal Value Description**
Light control status feedback	Intel	0	0	Cycle	1	Unsign ed	1		0 = automatic control according to status 1 = free control
Unlock status feedback	Intel	0	1	IfActiv e	1	Unsign ed	1		0 = invalid 1 = Unlock succeeded (only prompt once)
Headligh t power on/off status feedback	Intel	1	8	Cycle	1	Unsign ed	1		0 = off 1 = on
Steering lamp power on/off status feedback	Intel	1	10	Cycle	2	Unsign ed	1		0 = off 1 = left steering lamp on 2 =right steering lamp on 3 =left and right steering lamp on
Braking lamp power on/off status feedback	Intel	1	12	Cycle	1	Unsign ed	1		0 = off 1 = on
Emergen cy stop status feedback	Intel	5	40	Cycle	1	Unsign ed	1		0 = off 1 = on
Remote controlle r status feedback	Intel	5	41	Cycle	1	Unsign ed	1		0 = command control status 1 = remote controller control status
Charging station status feedback	Intel	5	42	Cycle	1	Unsign ed	1		0 = non charging station connect 1 = charging station connect

Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Battery status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
bms_fb			0x18C4E1EF			Cycle	100		8
Signal Descrip-tion	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-mission Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Battery voltage	Intel	0	0	Cycle	16	Unsigned	0.01	V	0.01V/bit；
Battery current	Intel	2	16	Cycle	16	signed	0.01	A	0.01A/bit；
Battery remaining capacity	Intel	4	32	Cycle	16	Unsigned	0.01	Ah	0.01Ah/bit；
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Battery flag bit status - feedback frame									
Message Name			**Msg ID**			**Type**	**Cycle（ms）**		**Message Length (Byte)**
bms_flag_fb			0x18C4E2EF			Cycle	100		8
Signal Description	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-mission Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Battery SOC	Intel	0	0	Cycle	8	Unsigned	1	%	1%/bit；Unit %
Single cell overvoltage protection	Intel	1	8	Cycle	1	Unsigned	1		0 = off 1 = on
Single cell undervoltage protection	Intel	1	9	Cycle	1	Unsigned	1		0 = off 1 = on
Overvoltage protection for the entire battery pack	Intel	1	10	Cycle	1	Unsigned	1		0 = off 1 = on
Undervoltage protection for the entire battery pack	Intel	1	11	Cycle	1	Unsigned	1		0 = off 1 = on
Charging over temperature protection	Intel	1	12	Cycle	1	Unsigned	1		0 = off 1 = on
Charging under temperature protection	Intel	1	13	Cycle	1	Unsigned	1		0 = off 1 = on
Discharging over temperature protection	Intel	1	14	Cycle	1	Unsigned	1		0 = off 1 = on
Discharging under temperature	Intel	1	15	Cycle	1	Unsigned	1		0 = off 1 = on
Charging over current protection	Intel	2	16	Cycle	1	Unsigned	1		0 = off 1 = on
Discharging over current	Intel	2	17	Cycle	1	Unsigned	1		0 = off 1 = on

protection									
Short circuit protection	Intel	2	18	Cycle	1	Unsigned	1		0 = off 1 = on
Fore-end IC error detection	Intel	2	19	Cycle	1	Unsigned	1		0 = off 1 = on
Software locks up MOS	Intel	2	20	Cycle	1	Unsigned	1		0 = off 1 = on
Charging flag bit	Intel	2	21	Cycle	1	Unsigned	1		0 = discharge 1 = charge
The highest temperature of battery	Intel	3	28	Cycle	12	signed	0.1	℃	0.1℃/bit;
The lowest temperature of battery	Intel	5	40	Cycle	12	signed	0.1	℃	0.1℃/bit;
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Front ultrasonic radar - feedback frame				
Message Name	**Msg ID**	**Type**	**Cycle (ms)**	**Message Length (Byte)**
front_ultrasonic_fb	0x18C4E8EF	Cycle	50	8

Signal Description	For-mat	Start-ing Byte	Start-ing Bit	Signal Trans-mission Type	Signal Dura-tion	Data Type	Preci-sion	Unit	Signal Value Description
No.1 ultrasonic radar probe's distance	Intel	0	0	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
No.2 ultrasonic radar probe's distance	Intel	1	12	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
No.3 ultrasonic radar probe's distance	Intel	3	24	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
No.4 ultrasonic radar probe's distance	Intel	4	36	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Rear ultrasonic radar - feedback frame				
Message Name	**Msg ID**	**Type**	**Cycle（ms）**	**Message Length (Byte)**
rear_ultrasonic_fb	0x18C4E9EF	Cycle	50	8

Signal Description	For-mat	Start-ing Byte	Start-ing Bit	Signal Trans-mission Type	Signal Dura-tion	Data Type	Preci-sion	Unit	Signal Value Description
No.5 ultrasonic radar probe's distance	Intel	0	0	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
No.6 ultrasonic radar probe's distance	Intel	1	12	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
No.7 ultrasonic radar probe's distance	Intel	3	24	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
No.8 ultrasonic radar probe's distance	Intel	4	36	Cycle	12	Unsigned	1	mm	1mm/bit within the detection range; 200mm = blind zone 2540mm = over range 2560mm = no probe detection
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Fault Alarm- feedback frame				
Message Name	**Msg ID**	**Type**	**Cycle（ms）**	**Message Length (Byte)**

error_fb			0x18C4EAEF			Cycle	100		8
Signal Description	**For-mat**	**Start-ing Byte**	**Start-ing Bit**	**Signal Trans-mission Type**	**Signal Dura-tion**	**Data Type**	**Preci-sion**	**Unit**	**Signal Value Description**
Fault level	Intel	0	0	Cycle	8	Unsigned	1		00：no fault E0：slightly fault E1：general fault E2：serious fault E3：fatal fault
Fault components	Intel	1	8	Cycle	8	Unsigned	1		00：no fault B0：battery C0：VCU D1：driving system D2：steering system D3：braking system F0：sensors 80：others
Fault components ID	Intel	2	16	Cycle	8	Unsigned	1		00：default/no 06：front left 07：rear left 08：front right 09：rear right
Fault code	Intel	3	24	Cycle	24	Unsigned	1		Please check withYUHESEN’s after-sale techical engineer
Alive Rolling Counter Heartbeat Signal(loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each sent frame, the value will increase by 1, after the maximum value is reached, the value will be reset to 0 to check packet loss and disconnection.
Check BCC XOR checkout for message	Intel	7	56	Cycle	8	Unsigned	1		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

4.5. Instruction of using the CAN communication protocol

1. Notes during the test:

1.1 Note that the AliveCounter needs to be sent continuously and cyclically during the sending process.

1.2 Send AliveCounter process, pay special attention to AliveCounter occupies 52 to 55 four bits.

1.3 BYTE [7] check bits for the first 7 Byte checksum: Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6.

1.4 The following routine is a simple control command when using USB CAN, please control the vehicle in accordance with the communication protocol to control the command.

1.5 During the test, please switch the remote control to the command control mode or choose to turn off the remote control.

1.6 Use the computer to connect the CAN card test process due to the possibility of testing the vehicle movement and other conditions, in the test process, please set up the vehicle, such as the vehicle test after the stability of the vehicle test with the procedures for testing when the vehicle is put down.

1.7 Due to the highest priority of the remote control during the landing test, it is advisable to turn on the remote control test, so that it is convenient to switch to the remote control mode at any time during the test.

2.Vehicle control command description ctrl_cmd

Vehicle control commands need to send the corresponding command, heartbeat signal and checksum bit at the same time.

(1) Target gear request ctrl_cmd_gear

The ctrl_cmd_gear command signals the target gear, the physical value range is from 00 to 03, the default gear position is 00 that is, disable gear; the target gear is parked when given as 01; neutral when given as 02; and kinematics control gear when given as 03.

Example: when the target gear request is kinematics control gear -03 0x03

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D1D0	0x03	0x00	0x00	0x00	0x00	0x00	0x10	0x13
0x18C4D1D0	0x03	0x00	0x00	0x00	0x00	0x00	0x20	0x23
0x18C4D1D0	0x03	0x00	0x00	0x00	0x00	0x00	0x30	0x33

Note: The above three frames of signals are cycled down at 10ms intervals, and the controllable gear

is switched to the kinematics control gear.

Feedback:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D1EF	0x03	0x00	0x00	0x00	0x00	0x00	0x00	0x03

Note: Checksums and Alivecounter cycle change

(2) Target vehicle speed request ctrl_cmd_liner

The ctrl_cmd_liner command is the target value of the line speed of the drive vehicle. The physical value of CAN communication ranges from -32.767 to 32.767m/s (the maximum speed of the vehicle is 4.5m/s for a 50-speed ratio and a 400mm wheel diameter), and the target line speed is determined by the accuracy of the vehicle speed (0.001m/s/bit). The target line speed of the driven vehicle = 0.001*bus signal. Vehicle forward and reverse is used in conjunction with the gear.

Vehicle speed feedback is categorized into three vehicle speed feedback methods,which are as follows :

(1)Feedback of current vehicle speed: this vehicle speed feedback is always positive.

(2) Feedback of the left and right wheel speed: the speed corresponding to the current left and right wheels respectively, the speed is positive when moving forward and negative when moving backward.

(3) Feedback of pulse number of left and right wheels: the pulse number is added when moving forward and subtracted when moving backward.

Example: given 1m/s forward speed request, then 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]
0x18C4D1D0	0x83	0x3E	0x00	0x00	0x00	0x00	0x00	0XBD
0x18C4D1D0	0x83	0x3E	0x00	0x00	0x00	0x00	0x10	0XAD
0x18C4D1D0	0x83	0x3E	0x00	0x00	0x00	0x00	0x20	0x9D

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

Feedback：

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

0x18C4D2EF	0x83	0x3E	0x00	0x00	0x00	0x00	0x00	0xBD

Note: Due to the automatic adjustment of the running speed, the checksum and Alivecounter cyclic changes may not feedback an absolute 1m/s.

1.Left front wheel speed and left front wheel pulse feedback ID is: 0x18C4D6EF

2.Left rear wheel speed and left rear wheel pulse feedback ID is: 0x18C4D7EF

3.Right front wheel speed and right front wheel pulse feedback ID is: 0x18C4D8EF

4.Right rear wheel speed and right rear wheel pulse feedback ID is: 0x18C4D9EF

(3) Target angular velocity ctrl_cmd_angular

The ctrl_cmd_angular command is a target angular velocity request with a CAN communication physical range of (-327.68) degrees to (327.67) degrees, with positive left steering and negative right steering. The target angular velocity is determined by the precision (0.01°/s)/bit. Target angular velocity = bus signal * 0.01

Example: Given a target angular velocity of -25°/s 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]
0x18C4D1D0	0x03	0x00	0XC0	0x63	0x0F	0x00	0x00	0xAF
0x18C4D1D0	0x03	0x00	0XC0	0x63	0x0F	0x00	0x10	0xBF
0x18C4D1D0	0x03	0x00	0XC0	0x63	0x0F	0x00	0x20	0x8F

Note: The above three frames of signals are sent out cyclically at 10ms intervals, and the angular velocity can be requested to be -25°/s.

Feedback：

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D1EF	0x03	0x00	0XC0	0x63	0x0F	0x00	0x00	0xAF

Note: Check sums and Alivecounter cycle changes.

3. Explanations of auxiliary control commands

Take the safe parking unlock switch as an example to illustrate, IO port enable control needs to send enable flag bit, heartbeat signal and check bit at the same time.

Example: io_cmd_unlock safety parking unlock switch 0x02

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D7D0	0x02	0x00	0X00	0x00	0x00	0x00	0x00	0x02
0x18C4D7D0	0x02	0x00	0X00	0x00	0x00	0x00	0x10	0x12
0x18C4D7D0	0x00	0x00	0X00	0x00	0x00	0x00	0x20	0x20
0x18C4D7D0	0x00	0x00	0X00	0x00	0x00	0x00	0x30	0x30

Note: The above signals (falling edge) are sent down at 20ms intervals to request unlocking of the safety stop switch.

Feedback：

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4DAEF	0x02	0x00	0X00	0x00	0x00	0x00	0x00	0x02

Note: Checksums and Alivecounter cycle changes.

5. Attention

This section contains some matters to be noted during use, storage and development of FW-mid.

5.1. Attentions for battery

▲ The battery of FW-mid products may not be fully charged when they are delivered. The specific situations CAN be read through FW-mid remote controller vehicle chassis voltage display or CAN bus communication interface. As for charging time, when the green indicator is on, indicating that the product has been fully charged;

▲ DO NOT charge the battery after it is exhausted, and please charge in time when the battery voltage is too low;

▲ The working temperature of the battery under discharging is -20°C~50°C, the battery can work normally within the specified temperature range, and the capacity loss is within the error range:

▲ Excessive discharge of the battery is prohibited during use to avoid damage to the battery;

▲ Avoid excessive impact on the battery; the impact beyond the specification may damage the battery, which may lead to battery leakage, heat, smoke, fire or explosion;

▲ In case of obvious battery abnormalities, please stop using the battery immediately!

5.2. Attentions for charging

▲ Charging can only be conducted by the charger matching with the battery. DO NOT use the non-original battery, power supply or charger;

▲ Charging can only be conducted under 0°C~45°C. Charging out of this temperature range will lead to battery leakage, heating or serious damage, which may lead to deterioration of battery performance and life;

▲ During charging, if the charger or battery is abnormal or damaged, please remove the charger input line and output line immediately;

▲ If charging cannot be completed within the specified time, please stop charging immediately. Or, the battery may heat, have smoke or get on fire (or explode);

▲ It is not allowed charge the battery of the vehicle body in thunderstorm weather;

▲ It not allowed to charge the battery of the vehicle body in the place which is wet or with rain;

▲ It is not allowed to charge the battery of the vehicle body with high temperature, such as heat source or direct sunlight, etc.;

▲ Charging shall be conducted in the place which is ventilated and without dust;

▲ During charging, it is not allowed to block the air inlet and outlet of the charger, there shall be a space of 10cm at least;

▲ You should follow the charging process in the specified order to prevent the charging plug of the charger from being live when connecting and disconnecting it with the battery charging port. This will help avoid short circuits, potential damage to the robot's battery and charger, as well as any unnecessary personal injuries.

5.3. Attentions for usage environment

▲ The working temperature of FW-mid is -20℃~50℃, DO NOT use in the environment with the temperature of lower than -20℃ or higher than 50℃;

▲ The best storage temperature for FW-mid is 0℃~40℃;

▲ DO NOT store or user in the environment with corrosive, inflammable and explosive gas;

▲ During use and storage, please keep away from heat resources and fire resources;

▲ Excepting for special edition (with customized IP protection level), the water-proof function of FW-mid is limited. DO NOT use FW-mid in the environment with deep ponding;

5.4. Attentions for remote operation

▲ When operating the chassis in remote control mode, it is necessary to hold down the VRB safety switch. Releasing the VRB will automatically stop the chassis and it will no longer respond to the controls of the left-hand direction and right-hand gas pedal rocker.

▲ The emergency stop switch is released; The throttle remote lever returns to zero, that is, the chassis speed is 0;

▲ When controlling the vehicle to move forward using the S4 joystick, if you need to perform a backward operation, you should first return the S4 joystick to the neutral position before engaging the reverse gear. It is prohibited to quickly move the joystick to the reverse position without returning it to neutral. The same principle applies to left and right turns. When changing directions, always return the joystick to neutral before changing.

▲ DO NOT turn off the power of the remote controller while the vehicle is in normal operation. If the battery of the remote controller runs out, the communication will be interrupted, and the protective program will activate, causing the chassis to stop moving after 3 seconds. Once the remote controller is powered on again, communication will be automatically restored, and normal operation can resume.

5.5. Attentions for external electrical extension

▲ The top power supply current shall be the battery voltage and current strictly selected. Over-current is not allowed;

▲ When the system detects that the battery voltage is lower than the safe voltage, protection procedure will be started automatically. If the external extension equipment involves storage of important data, and there is not automatic storage function for powering off, please charge timely.

5.6. Other attentions

▲ During handling or setting, DO NOT fall or invert;

▲ In case of no professionals, DO NOT disassemble without permission;

▲ If the remote controller end will not be used for a long time, the battery shall be removed;

▲ The tires shall be replaced timely in accordance with the wearing conditions of the patterns on the wheel tread.

▲ When making a customs consignment, press the button on the inside of the left hole in the edge of the skirt with a thin lever tool to turn off the main battery switch.

6. Common Q&A

Q：FW-mid starts normally, however, the vehicle body does not move under the control of the remote controller?

A：First, make sure that the emergency stop switch at the rear is released.Next, ensure that the SWA joystick is in remote control mode and the SWB gear is not in the parking position. Confirm that you are holding down the VRB safety switch during the operation. Finally, make sure that you are not charging through the charging port.

Q: FW-mid What should I do that the battery of the remote controller is low, and the vehicle body stops running?

A：Please replace the battery of the remote control immediately, after that, normal communication will recover soon.

Q: The charger led (green) is off

A：Please firstly check that whether the connection of the charger input interface is correct and firm; And then, check that whether there is AC input.

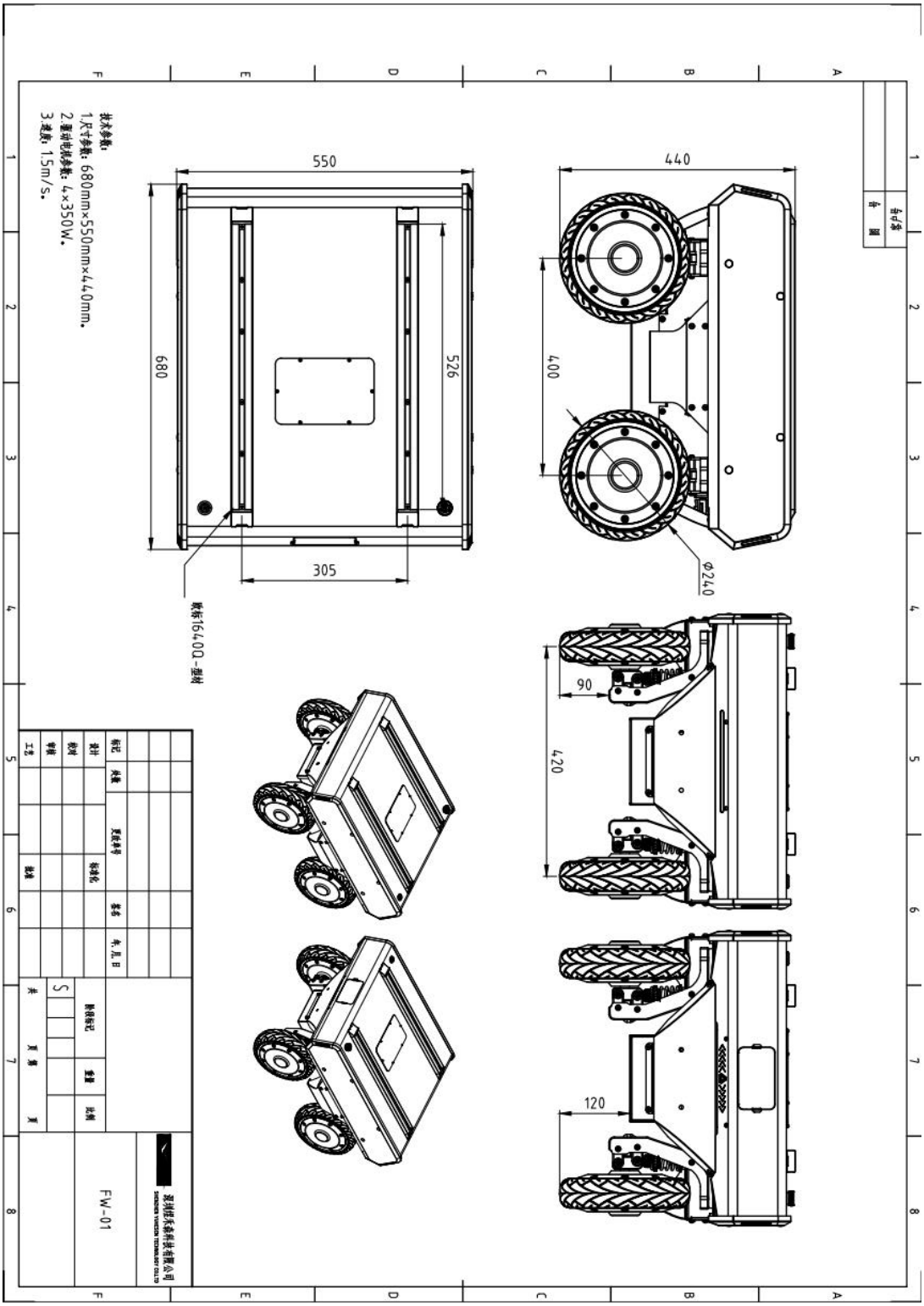
Q: The charger led (red) is off

A：Please firstly check that whether the connection of the charger input interface is correct and firm;

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

Re-plug the plugger of input and output line with a time interval of larger than 10s to judge that whether the charger is being protected.

7. Drawing



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