



# **FR-09 Pro Ackermann Steering Drive-by-wire Chassis**

**User manual V2.2.0**



**Shenzhen Yuhesen Technology Co., Ltd.**



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# 1. Foreword

(1) Thank you for purchasing our product, this user manual is applicable to FR-09 Pro Ackerman Drive-by-wire Chassis (hereby referred to as "FR-09 Pro").

(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 FR-09 Pro 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~60°C.
- The chassis is not customized for IP protection grade, the IP protection grade of this chassis

is IP44.

### ■ Inspection:

- Inspecting to ensure that the batteries of the equipment are full.
- Ensuring that the chassis has no abnormality.
- Inspecting whether the battery of the remote controller is full.

### ■ Operation:

- In case of Commissioning with remote control, please make sure the remote control is on.  
And ensure that the vehicle can receive remote control commands.
- Ensuring that operation is conducted in a relatively open place. And remote control shall be conducted with sight distance.
- FR-09 Pro The maximum load is 300KG, during use, it shall be ensured that the effective load does not exceed 300KG.
- In case of alarm of low battery of the equipment, please charge timely. In case of equipment abnormality, please stop use immediately to avoid secondary damage.
- In case of equipment abnormality, please contact relevant technicians, DO NOT process without permission.
- Please use the equipment in the environment which meets the IP protection grade requirements of the equipment.
- During charging, please ensure that the environment temperature is higher than 0°C.

### ■ Maintenance:

- In case of serious tire wearing, please replace timely.
- If the battery will not be used for a long time, when the battery is fully charged, please charge the battery regularly in each month.
- The battery shall be used once a month at least.

## 2. Introduction

FR-09 Pro is a versatile drive-by-wire robotics mobile platform, it adopts Ackerman front steering, and rear drive form. Compared with the chassis of differential drive form on the ordinary pavement, FR-09 Pro has a faster traveling ability and relatively strong load capacity. At the same time, the wearing of tire is lighter, matching with whole bridge suspension, the chassis can pass through the common obstacles, such as speed bump, etc. Therefore, it is more applicable for long-term outdoor traveling; And this chassis is a underlayer control system structure based on VCU vehicles control, it uses CAN bus management, having the features of high precision and modularization, etc. By the modules and navigation systems of LiDAR, GPS and manipulator, etc., this chassis is widely used in autonomous driving, unmanned patrol, logistics, transportation distribution, 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

YUHESEN

FR-09 Pro Ackermann Steering  
Drive-by-wire Chassis

User manual V2.2.0





## 2.2. Performance parameters

Table 2 - 1 FR-09 Pro Performance Parameter Table

Parameter type	Performance	Parameter
Structural size and weight	Dimensions(W*D*L)	1,600*820*520mm
	Weight	156kg
	Drive	Ackermann front steering and rear wheel drive
	Suspension	Non independent suspension
	Material	Q235
	Ground clearance	110mm
	Wheelbase	850mm
	Wheel track	645mm
	Tire type/diameter	120/70-10, 420mm
Basic configuration	Driving motor	1,800W, brushless DC motor
	Steering motor	400W, servo motor
	Battery type	48V/40AH lithium battery/BMS management system
	Charging time	≤4h
	Charging method	48V/10A, manual charging adapter
	External power supply	48V/20A-24V/15A-12V/15A
	Braking mode	Hydraulic disc brake + motor brake
	Parking method	Electromagnetic power off parking
	Turn signal light	√
	Brake lamp/deceleration indicator/fault indicator	√
	Wheel speed sensor	√
Safety measures	Emergency stop button	√
	Front and rear bumper strip	√
	Command check	√
	Heartbeat protection	√
	Fault handling for steering system	√
	Fault handling for braking system	√
	Fault handling for driving system	√
	Emergency power down parking protection	√
	Battery fault monitoring and protection	√
	Online detection for whole vehicle CAN node	√
	Whole vehicle fault level division and processing	√
	Vehicle fault warning	√
	Prompt of fast vehicle deceleration	√
	Processing of remote controller disconnection	√
	Charging safety monitoring and protection	√
VCU configuration	Dominant frequency	168MHz
	flash	512KB
	Hardware floating point acceleration	√

	Movement control	√
	Communication interface	CAN interface
	Communication protocol	CAN 2.0B
Performance parameters	Remote control distance	100m
	Vertical load (level road)	300kg
	Speed	18km/h
	Mileage	40km (no load)
	Minimum turning radius	2.4m
	Wading depth	100mm
	Maximum climbing angle	10° (full load)
	Crossing width	200mm (full load)
	Obstacle surmounting height	60mm (full load)
Performance parameters	Steering accuracy	≤0.5°
	Protection level	IP44
	Operating temperature	-20°C~60°C
	Storage temperature	0°C~40°C

### 3. Product presentation

The contents in this part are only the basic introductions for FR-09 Pro Ackerman Drive-by-wire Chassis, facilitating the users and developers to know FR-09 Pro chassis basically. As shown in Figure 3-1 and Figure 3-2, there are the front and rear overall figure of the whole Ackerman drive-by-wire chassis.

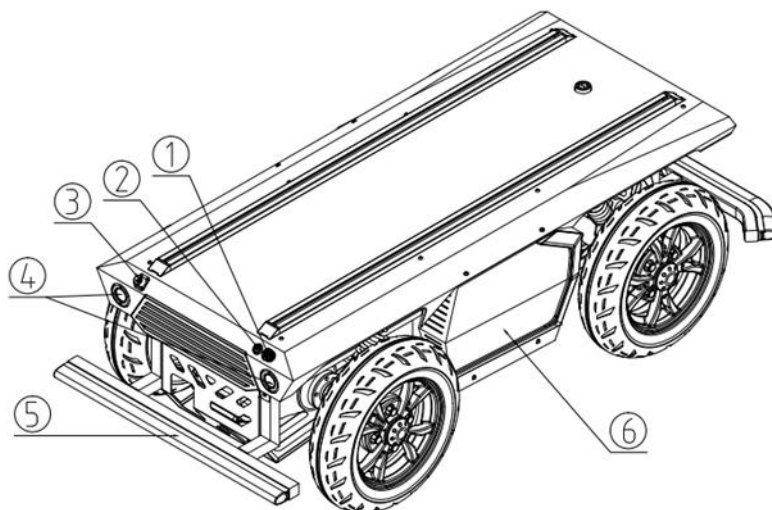


Figure 3 - 1 Tail Overall Figure

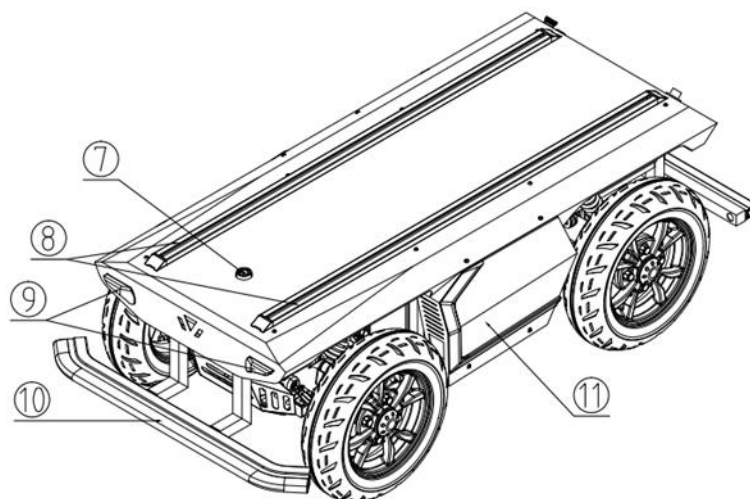


Figure 3 - 2 Front Overall Figure

Note: ①Emergency stop button; ②Power button; ③Charging interface; ④Rear lamp; ⑤Rear strip bumper ; ⑥Right battery compartment panel ; ⑦Top electrical interface ; ⑧Aluminum extrusion rail; ⑨Position lamp and front steering lamp; ⑩Front strip bumper; ⑪Left battery compartment panel

Overall, FR-09 Pro uses the thought of modular design, resulting in high safety and reliability. In structure, front Ackerman steering structure, rear whole bridge suspension and non-bearing vehicle body design make high vehicle body strength and high rigidity, so that the safety of the whole vehicle can be improved, bringing relatively strong impact resistance and performance of resistance to bump, so that the trafficability characteristics are excellent, and the vehicle can pass the pavement environments which are relatively complex.

The braking system adopts the design of motor + hydraulic disc brake, achieving safer and more effective braking. At the same time, emergency stop switch is installed at the tail of the vehicle body. In case emergency, the traveling of the vehicle can be stopped by beating, so as to control the whole vehicle. At the same time, the emergency stop switch supports functional inspection. If the emergency stop switch is damaged or in case of disconnection, VCU will control the vehicle driver to power off; Multi-protection, guaranteeing safe driving of vehicles.

The chassis is also equipped with integrated control. VCU analyzes and judges the vehicle signals uniformly, and forms closed-loop control, therefore, the faults can be diagnosed, and corresponding safety protection and processing can be conducted to reliably achieve unmanned vehicle status monitoring remotely. At the top of the vehicle body, there are electrical interfaces and communication interfaces of 48V, 24V and 12V. At the same time, the top is equipped with standard profile fixing support, so that the users can conduct secondary development quickly.

### 3.1. State indicator

Via voltage display on the remote controller and the starting sound, users can determine the status of the vehicle body. Refer to Figure 3-1 for details.

Table 3 - 1 Description of Vehicle Body Status

Status	Description
Battery voltage	The current battery voltage of the vehicle body can be checked by sliding left the displayed on the remote controller (Figure 3-3). the percentage of the remaining battery can be known by checking Table 3-2
Fault indicator	The fault status of the of the whole vehicle can be determined in accordance with the flashing frequency of the brake lamp under non-braking status and braking status. Once 1S: level I fault alarm; Twice 1S: level II fault alarm; Three time 1S: level III fault alarm

Note:

Fault level division and processing method:

Level 1 fault: CAN signal and indicator alarm;

Level 2 fault: CAN signal and indicator alarm, and the power of the whole vehicle drops;

Level 3 fault: CAN signal and indicator alarm, the driver powers off.

Remote controller displays the voltage

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

Figure 3-3 Interface of Vehicle Voltage on the Remote Controller

Note: The current interface appears by sliding the remote control screen left; Wherein, TX.V is the current battery voltage of the remote control; Int.V is the receiver power supply voltage; Sig.S is the receiver signal strength; Ext.V is the vehicle battery voltage; 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.

Comparison table for vehicle battery voltage and remaining percentage										
Voltage (V)	51.03	49.8	49.75	49.74	49.68	49.63	49.52	49.29	49.17	48.97
SOC (%)	100	95	90	85	80	75	70	65	60	55
Voltage (V)	48.96	48.95	48.91	48.82	48.65	48.45	48.19	47.83	47.53	42.65
SOC (%)	50	45	40	35	30	25	20	15	10	7 (Stop output)

Table 3-2 Comparison Table for Vehicle Battery Voltage and SOC

## 3.2. Instructions of electrical interface

### 3.2.1. Instructions of top electrical interface

FR-09 Pro is equipped with a WS32-11 electrical interface on the top. This electrical interface is set with three sets of different power supplies and a set of CAN communication interface, and the wires have been led out, so that, the users can provide power supplies and communication to different extension equipment. Refer to the schematic diagram of the top electrical position in Figure 3-4 for details

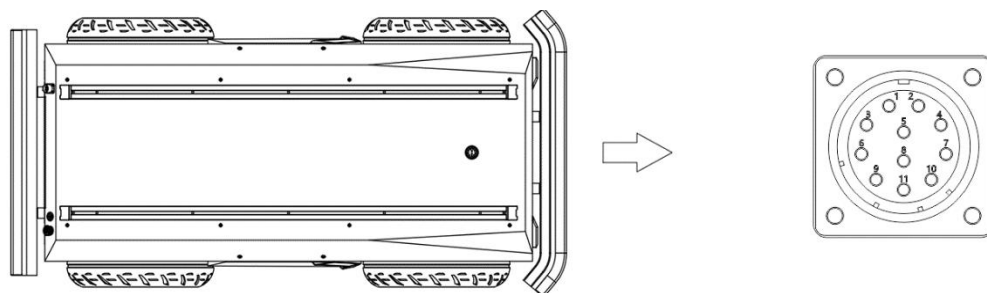


Figure 3 -4 Schematic Diagram of Top Electrical Position

The specific pin definitions of top electrical interfaces are shown in Table 3-3 below

Pin	Type	Definition	Remark
1	reserve	reserve	reserve
2	Power supply	48V-	Negative pole of 48V power supply
3		48V+	Positive pole of 48V/10A power supply
4		24V-	Negative pole of 24V power supply
5	reserve	CAN2_L	CAN2 bus - low
6	Power supply	24V+	Positive pole of 24V/15A power supply
7		12V-	Negative pole of 12V power supply
8	reserve	CAN2_H	CAN2 bus - high
9	Power supply	12V+	Positive pole of 12V/15A power supply
10	CAN	CAN_L	CAN bus - low
11		CAN_H	CAN bus - high

Table 3 -3 Pin Definitions of Top Electrical Interface

It shall be noted that, the power supply for expansion is controlled internally. When the battery voltage is under-voltage, BMS will protect, and the battery stops discharging. During use, users are required to charge.

### 3.2.2. Instructions of electrical panel at the tail

The electrical panel at the tail is shown as Figure 3-5. Wherein, B1 is emergency stop switch; B2 is starting switch; B3 is the interface for charging .

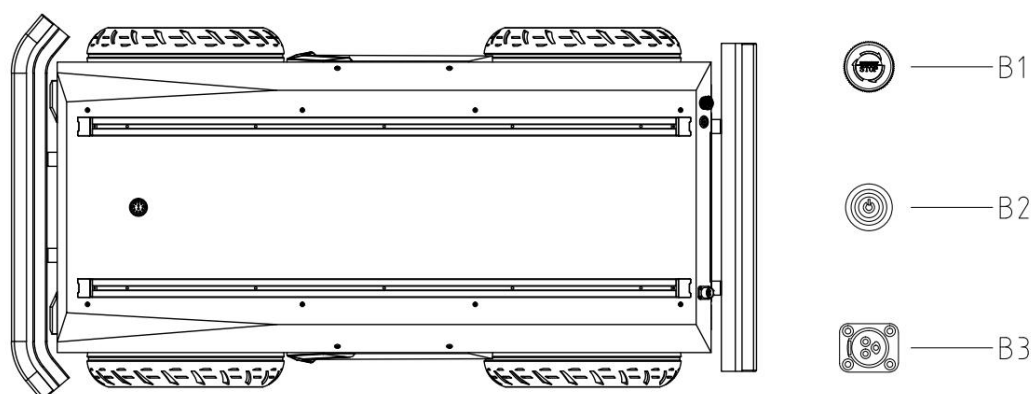


Figure 3 -5 Tail View and Electrical Panel

### 3.3. FS-i6S Remote control instructions

The remote controllers have been paired before delivery, there is no need to modify the setups. Modification of remote controller setups without permission may lead to the problems of chaos in control and being out of control, etc. DO NOT modify the remote controller setups at will; In case of parameter faults, please contact our customer service or technical support. In case of modification, professional technicians are required for setting of remote controller.

#### 3.3.1. Instructions of FS-i6S remote control

Each FR-09 Pro is equipped with a FS-i6S remote controller. With this remote controller, users can easily control FR-09 Pro. For FS-i6S remote controller of this product, we use the design of brake by the left hand, forward-backward acceleration, left-right rotation by the right hand. Refer to Figure 3-6 for the definitions and functions

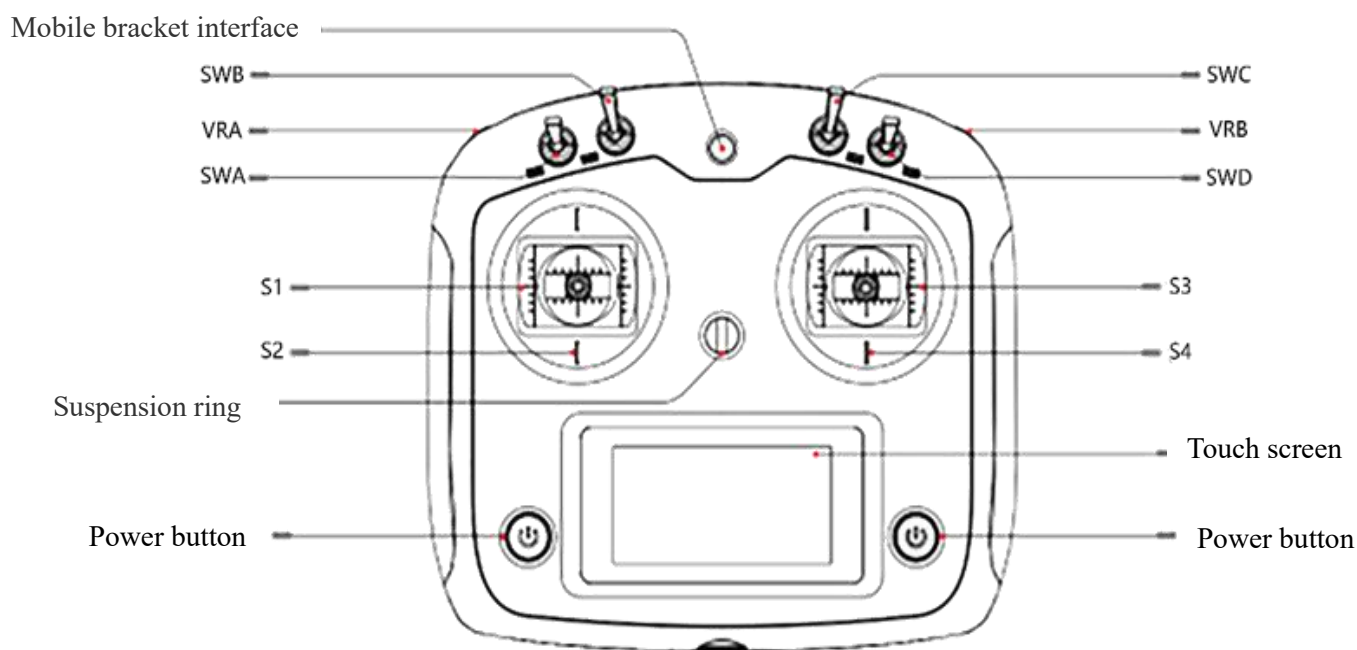


Figure 3 -6 Schematic Diagram of operation panel of FS-i6S remote controller

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 driving lever to switch the control mode. There are two control modes. For example, when the observe side of the remote controller is upward, and the driving lever of the SWA driving lever is upward, the control mode is remote controller control mode; when the SWA driving lever is downward, the control mode is command control mode;
- (2) SWB is the driving lever to switch the gear. There are three gears. When the driving lever is in the center, and the vehicle is under N gear, forward-backward movement control signals will not be received; When the driving lever is pulled upwards to switch to Gear D, can the chassis receive the front movement signal transmitted by S2 rocker and move forwards; When the driving lever is pulled downwards to switch to Gear R, can the chassis receive the reverse movement signal transmitted by S4 rocker and move backwards;
- (3) VRA is the driving knob of horn control, it will return automatically. When this driving knob is pulled downwards for one time, the horn will sound for one time;
- (4) VRB is the driving knob for parking request. When the driving knob is pulled upwards, parking request will be transmitted, and the park braking system starts; When the driving knob is pulled downwards, parking release request is transmitted, and the park braking system releases.
- (5) S2 is braking rocker, upward pushing for braking, and downward pushing to the bottom for braking release. The openness of the braker is determined in accordance with the position of S2 rocker. When S2 is pushed to the top, the braking force reaches the maximum value, and when it is pushed to the bottom, the braker is released;
- (6) S4 is the accelerator control rocker, controlling the forward movement speed and backward movement speed of FR-09Pro; Left and right movement of S3 control the steering of the front wheels;
- (7) SWC is the high, medium and low speed controller of S4 rocker. For example, S4 rocker controls the vehicle to run in low speed mode when SWC is in the top position; S4 rocker controls the vehicle to run in medium speed mode when SWC is in the middle position; S4 rocker controls the vehicle to run in high speed mode when SWC is in the lowest position;
- (8) The power button is the power control switch of the remote controller. When the remote controller is in the shutdown state., press and hold the power buttons on both sides of the monitor to turn it start; When the remote controller is in the boot state., press and hold the



power buttons on both sides of the monitor to turn it off. If the receiver of the remote controller is powered on and the power buttons on both sides of the monitor cannot be turned off, the battery needs to be unloaded to turn it off.

### 3.3.2. Instructions of remote controller buzzer alarm

Position switch alarm	During startup, if the driving levers of switch SWA/SWB/SWC/SWD are not in the default gears, alarm interface will appear, prompting to turn all switches up. And all switches will normally enter the main interface when they are in the default gear
Low-voltage alarm	When the voltage is lower than the alarm voltage, the system will give an alarm, and the display of the remote controller will start flashing. If the remote control voltage is too low, the TX icon flashes, and if the chassis voltage is too low, the RX icon flashes
Unusual communication alarm	When the control distance between the remote controller and the chassis is too far or the environment is blocked, the intensity of the remote control signal will be reduced. If the signal intensity is lower than 5, an unusual communication alarm will give an alarm to remind the user that the remote control signal intensity is weak
Remote control does not use alarm	When the remote controller is not used for a long time, the buzzer of the remote controller gives an intermittent alarm.
Shutdown alarm	When the remote controller 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 it is necessary to turn off the chassis power before turning off the remote controller. (If you need to turn off the remote controller forcibly when the chassis is not turned off, you can remove the battery. )

Table 3 -4 Instructions of Remote Controller Alarm Condition

### 3.3.3. Instructions of control commands and movement

In accordance with ISO 8855, we establish coordinate system as shown in Figure 3-7 for ground movement of the vehicle.

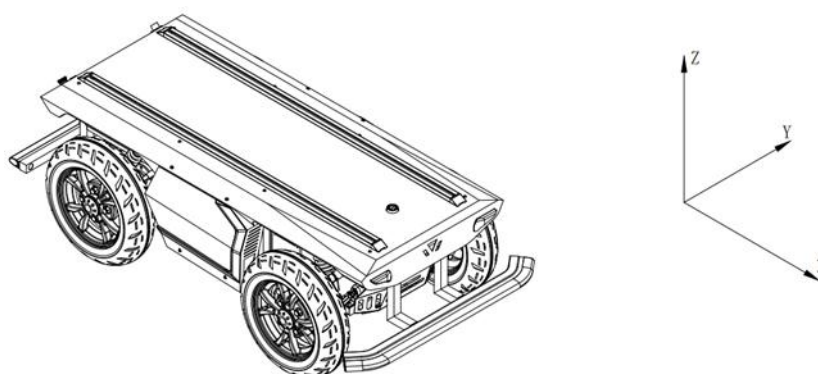


Figure 3 -7 The Vehicle Coordinate System

As shown in Figure 3-7, the vehicle body of FR-09 Pro is parallel to axis-X of the established coordinate system.

Under remote controller control mode, pull down the VRB knob to release the parking gear, switch the SWB lever to D gear, push the S4 rocker forward to move in the positive direction of X, switch the SWB lever to R gear, and push the S4 rocker backward to move in the negative direction of X; When the S4 rocker is pushed forward to the maximum value, it moves in the X direction to control the high, medium and low speed according to the high, medium and low speed set by SWC. When S4 rocker is pushed backwards to the maximum value, it moves in the negative direction of X, and the high, medium and low speed are controlled according to the high, medium and low speed set by SWC. Left and right movement of remote controller rocker S3 control the steering of the front wheels. When S3 is pushed leftwards, the vehicle turns left, and when it is pushed to the maximum value, at this time, the speed of turning left is the maximum; when S3 is pushed rightwards, the vehicle turns right, and when it is pushed to the maximum value, at this time, the speed of turning right is the maximum.

Under the control command mode, at the target gear, the value of 04 indicates that the target gear moves along the positive direction of axis-X, and the value of 02 indicates that it moves along the negative direction of axis-X.

## 4. Getting started

This part mainly introduces the basic operation and use of FR-09 Pro platform, and how to conduct secondary development to the vehicle body through CAN bus protocol.

### 4.1. Use and operation

**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 neutral position;

#### **Start-up**

- (1) Press and hold the power buttons on both sides of the monitor to turn on the remote controller.
- (2) Press B2 (starting switch)
- (3) Check the vehicle battery voltage of the remote controller to see that whether the battery voltage is normal. If the voltage is lower than 47.5V, please charge first.
- (4) Release the brake of the vehicle, switch to remote driving mode to observe that whether the brake lamp flashes and whether the vehicle is faulty. If there is any fault, connect to the CAN card to read the vehicle fault status and signal, and then, contact the after-sales personnel for solving.

#### **Close operation**

Press B2 (starting switch) again and release the switch to turn off the power supply;

#### **Emergency stop**

Beat the emergency stop switch on the electrical panel at the tail of FR-09 Pro vehicle body;

### 4.2. Charge

The chassis of the FR-09 Pro mobile robot is equipped with a 48V/10A charger in default, meeting the demands of charging of the users.

The specific operation processes of charging are as follows:

- 1) Before charging, please make sure that FR-09 Pro is shut down and powered off, and confirm that B2 (starting switch) on the electrical board at the tail is closed;
- 2) First, insert the output plug of the charger into the B1 charging interface on the electrical board at the tail; Then, plug the AC plug of the charger into the 220V AC socket.
- 3) After charging, operate in accordance with the reserve orders, unplug the AC plug first, and then, unplug the output plug.
- 4) The working status indicator of the charger is shown in Table 4-1.

Table 4 -1 Instructions of LED Indicator for Charger Status

LED indicator light status	Charger status
LED1 is in bright red	The input line plug of the charger has been powered on
LED2 is in bright red	Indicating that the charger is charging
LED2 is in bright green	Indicating that the battery has been fully charged

- 5) If the temperature of the charging environment is too high, the charger may enable temperature protection. Please move the charger to a cool or ventilated place for use, and resume normal charging when the internal temperature of the charger is lowered to 60°C. Refer to Table 4-2 for the instructions of charger protection status:

Table 4 -2 Instruction of Charger Protection Status

Protection function	Function description
Over-heating protection	When the internal temperature of the charger reaches the over-temperature protection point, the charger stops charging automatically.
Output short-circuit protection	When the charger output is short-circuited unexpectedly, the charger turns off output automatically.
Output reverse connection protection	When the battery is connected in reverse, the charger will cut off the connection between the internal circuit and the battery.
Output over-voltage protection	When the output of the charger is over-voltage, the charger automatically turns off the output.

Note:

When the vehicle is being charged, VCU will protect the charging state of the whole vehicle. If the vehicle is being charged when it is powered on, to ensure the charging safety, the vehicle will enable hydraulic braking and electromagnetic band-type parking brake. At the same time, the driver will be controlled to power off under high voltage. After charging, the driver will recover automatically. At the same time, the CAN signal will send the corresponding charging flag bit, and

when necessary, if release is required, corresponding commands can be sent for release.

### 4.3. Development

FR-09 Pro product provides CAN interface to users for development, and users can conduct command control to the vehicle body with CAN interface.

#### 4.3.1. CAN interface protocol

The communication of FR-09 Pro product 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, brake pedal openness and parking request of the chassis can be controlled. The FR-09 Pro will feed back the current movement state information and the system state information of the FR-09 Pro chassis in real time.

The specific protocol contents are shown as below:

**The motion command control frame includes gear control, vehicle speed control, steering angle control, brake pedal opening, parking request and inspection, etc. The specific protocol contents are shown in Table 4-3. Refer to 4.3.2 for wiring instructions, and 4.3.3 for CAN communication transmission requirements and test examples.**

Note: The CAN interface is a non-isolated interface. During use, please prevent the CAN line from being wrongly connected or prevent the CAN bus from being connected with the power line of the given type. In case of connection, VCU may be burned out.

CAN protocol is shown as below:

Table 4-3 Command Control Frame and System Feedback Frame

Chassis control command									
Message name			ID				Cycle (ms)		(Byte) Message length
ctrl_cmd			0x18C4D2D0				10		8
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	Offset	Unit	Signal value description
Target gear	Intel	0	0	4	Unsigned	1	0		00: disable 01: Gear P 02: Gear R 03: Gear N 04: Gear D
Target vehicle speed	Intel	0	4	16	Unsigned	0.001	0	m/s	0.001m/s/bit;
Targeted vehicle steering angle	Intel	2	20	16	signed	0.01	0	°	0.01°/bit;

Targeted vehicle braking	Intel	4	36	8	Unsigned	1	0		1%/bit
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6
Chassis I/O control command									
Message name			ID				Cycle (ms)	(Byte) Message length	
io_cmd			0x18C4D7D0				50	8	
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	Offset	Unit	Signal value description
I/O control enabling	Intel	0	0	1	Unsigned	1	0		0 = off 1 = on
Steering lamp switch	Intel	1	10	2	Unsigned	1	0		0 = Fully close 1 = left steering lamp on 2 = right steering lamp on
Position lamp switch	Intel	1	13	1	Unsigned	1	0		0 = off 1 = on
Loudspeaker switch	Intel	2	16	1	Unsigned	1	0		0 = off 1 = on

Enforced power-on flag bit for charging	Intel	5	40	1	Unsigned	1	0	When the flag bit is forced to be enabled under the charging state, the vehicle can be controlled to be powered on under 48V, and the vehicle can resume control. When the flag bit is enabled, the vehicle cannot reverse under the charging state.
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0	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	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			Cycle (ms)		(Byte) Message length
ctrl_fb			0x18C4D2EF			10		8

Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	Offset	Unit	Signal value description
Target gear	Intel	0	0	4	Unsigned	1	0		00: disable 01: Gear P 02: Gear R 03: Gear N 04: Gear D
Current vehicle speed feedback	Intel	0	4	16	Unsigned	0.001	0	m/s	0.001m/s/bit;
Current vehicle steering angle feedback	Intel	2	20	16	signed	0.01	0	°	0.01°/bit;
Current vehicle braking status feedback	Intel	4	36	8	Unsigned	1	0		
Current vehicle operation mode feedback	Intel	5	44	2	Unsigned	1	0		0x0: auto 0x1: remote 0x2: stop
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	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				Cycle (ms)	(Byte) Message length	
lr_wheel_fb			0x18C4D7EF				10	8	
Signal description	Arrangement format	Starting byte	Start bit	Signal Length	Data type	Precision	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 count feedback	Intel	2	16	32	signed	1	0	1	400 pluses for single wheel turn
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6
Right rear wheel information feedback									
Left rear wheel information feedback				ID			Cycle (ms)	(Byte) Message length	
rr_wheel_fb				0x18C4D8EF			10	8	
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	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 count feedback	Intel	2	16	32	signed	1	0	1	400 pluses for single wheel turn
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR

									Byte4 XOR Byte5 XOR Byte6
<b>Chassis I/O status feedback</b>									
<b>Message name</b>			<b>ID</b>				<b>Cycle (ms)</b>		<b>(Byte) Message length</b>
io_fb			0x18C4DAEF				50		8
<b>Signal description</b>	<b>Arrangement format</b>	<b>Starting byte</b>	<b>Start bit</b>	<b>Signal duration</b>	<b>Data type</b>	<b>Precision</b>	<b>Offset</b>	<b>Unit</b>	<b>Signal value description</b>
I/O control enabling status feedback	Intel	0	0	1	Unsigned	1	0		0 = off 1 = on
Steering lamp switch status feedback	Intel	1	10	2	Unsigned	1	0		0 = Fully close 1 = left steering lamp on 2 = right steering lamp on
Brake lamp switch status feedback	Intel	1	12	1	Unsigned	1	0		0 = off 1 = on
Position lamp switch status feedback	Intel	1	13	1	Unsigned	1	0		0 = off 1 = on
Loudspeaker switch status feedback	Intel	2	16	1	Unsigned	1	0		0 = off 1 = on
Center front bumper strip switch status feedback	Intel	3	25	1	Unsigned	1	0		0 = off 1 = on
Center rear bumper strip switch status feedback	Intel	3	28	1	Unsigned	1	0		0 = off 1 = on
Enforced power-on flag bit for charging	Intel	5	40	1	Unsigned	1	0		When the flag bit is forced to be enabled under the charging state, the vehicle can be controlled to be powered on under 48V, and the vehicle can resume control. When the flag bit is enabled, the

									vehicle cannot reverse under the charging state.
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6
Chassis speedometer feedback									
Message name			ID				Cycle (ms)	(Byte) Message length	
odo_fb			0x18C4DEEF				10	8	
Signal description	Arrangement format	Starting byte	Start bit	Signal Length	Data type	Precision	Offset	Unit	Signal value description
Accumulated mileage	Intel	0	0	32	signed	0.001	0	m	0.001m/bit Note: The VCU of this speedometer does not store, and it is automatically reset after it is powered on again
Battery BMS information feedback									
Message name			ID				Cycle (ms)	(Byte) Message length	
bms_Infor			0x18C4E1EF				100	8	
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	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	Intel	4	32	16	Unsigned	0.01	0	Ah	0.01Ah/bit;

remaining battery									
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6
Battery BMS mark status feedback									
Message name			ID				Cycle (ms)	(Byte) Message length	
bms_flag_Infor			0x18C4E2EF				100	8	
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	Offset	Unit	Signal value description
Percentage of current remaining battery	Intel	0	0	8	Unsigned	1	0	%	1%/bit;
Monomer over-voltage protection	Intel	1	8	1	Unsigned	1	0		0 = off 1 = on
Monomer under-voltage protection	Intel	1	9	1	Unsigned	1	0		0 = off 1 = on
Over-voltage protection of the whole group	Intel	1	10	1	Unsigned	1	0		0 = off 1 = on
Under-voltage protection of 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
Discharging over-temperature protection	Intel	1	14	1	Unsigned	1	0		0 = off 1 = on
Discharging low-temperature protection	Intel	1	15	1	Unsigned	1	0		0 = off 1 = on

Charging over-current protection	Intel	2	16	1	Unsigned	1	0		0 = off 1 = on
Discharge over-current protection	Intel	2	17	1	Unsigned	1	0		0 = off 1 = on
Protection against short circuit	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 locks up MOS	Intel	2	20	1	Unsigned	1	0		0 = off 1 = on
Charging flag bit	Intel	2	21	1	Unsigned	1	0		0 = discharge 1 = charge
Current highest temperature of the battery	Intel	3	28	12	signed	0.1	0	°C	0.1°C/bit;
Current lowest temperature of the battery	Intel	4	40	12	signed	0.1	0	°C	0.1°C/bit;
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

### Chassis driver and encoder signal feedback

Message name			ID				Cycle (ms)		(Byte) Message length
Drive_fb_MCUEncoder			0x18C4DCEF				10		8
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data type	Precision	Offset	Unit	Signal value description
Walking driving motor encoder pulse feedback	Intel	0	0	32	signed	1	0		1024-wire encoder, the default reduction ratio of the vehicle is 13 reduction

									ratio
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0		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	8	Unsigned	1	0		Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

### Vehicle fault status feedback

Message name			ID				Cycle (ms)		(Byte) Message length
Veh_fb_Diag			0x18C4EAEF				10		8
Signal description	Arrangement format	Starting byte	Start bit	Signal duration	Data Type	Precision	Offset	Unit	Signal value description
Whole vehicle fault level	Intel	0	0	4	Unsigned	1	0		0: No fault 1: Level 1 fault 2: Level 2 fault 3: Level 3 fault Others are 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 disconnection fault	Intel	1	8	1	Unsigned	1	0		0 = normal 1 = fault
EPS fault	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 fault	Intel	1	11	1	Unsigned	1	0	0 = normal 1 = fault
EPS work fault	Intel	1	12	1	Unsigned	1	0	0 = normal 1 = fault
EPS over-current fault	Intel	1	13	1	Unsigned	1	0	0 = normal 1 = fault
EHB system ECU fault	Intel	2	20	1	Unsigned	1	0	0 = normal 1 = fault
EHB disconnection fault	Intel	2	21	1	Unsigned	1	0	0 = normal 1 = fault
EHB operation mode fault	Intel	2	22	1	Unsigned	1	0	0 = normal 1 = fault
EHB non-enabling fault	Intel	2	23	1	Unsigned	1	0	0 = normal 1 = fault
EHB angle sensor fault	Intel	3	24	1	Unsigned	1	0	0 = normal 1 = fault
EHB ECU over-temperature fault	Intel	3	25	2	Unsigned	1	0	0 = normal 1 = temperature Level I fault 2 = temperature Level II fault 3 = temperature Level III fault
EHB power supply fault	Intel	3	27	1	Unsigned	1	0	0 = normal 1 = fault
EHB sensor credibility abnormality	Intel	3	28	1	Unsigned	1	0	0 = normal 1 = fault
EHB motor fault	Intel	3	29	1	Unsigned	1	0	0 = normal 1 = fault
EHB oil pressure sensor fault	Intel	3	30	1	Unsigned	1	0	0 = normal 1 = fault
EHB oil tube fault	Intel	3	31	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor controller disconnection fault	Intel	4	32	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor controller over-heating fault	Intel	4	33	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor controller over-voltage fault	Intel	4	34	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor controller under-voltage fault	Intel	4	35	1	Unsigned	1	0	0 = normal 1 = fault

Driving motor controller short circuit fault	Intel	4	36	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor controller emergency stop fault	Intel	4	37	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor Hall sensor fault	Intel	4	38	1	Unsigned	1	0	0 = normal 1 = fault
Driving motor controller MOSFET fault	Intel	4	39	1	Unsigned	1	0	0 = normal 1 = fault
Drive fault of being out of control	Intel	4	40	1	Unsigned	1	0	0 = normal 1 = fault
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 = switch on
Remote controller close alarm	Intel	5	46	1	Unsigned	1	0	0 = normal 1 = fault
Remote controller receiver disconnection fault	Intel	5	47	1	Unsigned	1	0	0 = normal 1 = fault
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	4	Unsigned	1	0	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	8	Unsigned	1	0	Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

Note: Explanation of the fault feedback signal of the drive motor controller.

Signal Value	Signal Name	Description	Fault level
0x00		walking drive controller no faults	0
0x01	DiagMCU_DisOnlie	walking drive controlle CAN of	3



		communication signal is disconnected	
0x02	DiagMCU_UPhaseOverCurrent	walking drive controlle U-phase over current fault	2
0x03	DiagMCU_VPhaseOverCurrent	walking drive controlle V-phase over current fault	3
0x04	DiagMCU_WPhaseOverCurrent	walking drive controlle W-phase over current fault	3
0x05	DiagMCU_HardwareOverCurrent	walking drive controlle hardware over current fault	3
0x06	DiagMCU_PowerModuleFault	walking drive controlle power fault	3
0x07	DiagMCU_DCOverCurrent	walking drive controlle busbar over current fault	3
0x08	DiagMCU_DCOverVolt	walking drive controlle busbar over volt fault	3
0x09	DiagMCU_DCUnderVolt	walking drive controlle busbar under volt fault	3
0x0A	DiagMCU_MotorOverRPM	walking motor over RPM fault	3
0x0B	DiagMCU_MotorOverLoad	walking motor over load fault	3
0x0C	DiagMCU_MCUOverLoad	walking drive controlle over load fault	3
0x0D	DiagMCU_MotorOverTemp	walking motor over temperature fault	3
0x0E	DiagMCU_MCUOverTemp	walking drive controlle over temperature fault	3
0x0F	DiagMCU_MotorTempSensFault	walking motor temperature sensor fault	3
0x10	DiagMCU_MCUTempSensFault	walking drive controlle temperature sensor fault	3
0x11	DiagMCU_MotorEncoderFault	walking drive controlle motor encoder fault	3
0x12	DiagMCU_LockedRotorFault	walking drive controlle locked rotor fault	3
0x13	DiagMCU_PhCurrentSensorFault	walking drive controlle phase current sensor fault	3
0x14	DiagMCU_DCCurrentSensFault	walking drive controlle busbar current sensor fault	3
0x15	DiagMCU_DisCtrlFault	walking motor out of control fault	3

0x16	DiagMCU_PreChargeFault	walking drive controlle precharge fault	3
0x17	DiagMCU_CANFault	walking drive controlle communication fault	3
0x18	DiagMCU_LosePhaseFault	walking drive controlle lose phase fault	3
0x19	DiagMCU_PowerOnFault	walking drive controlle power on fault	3
0x1A	DiagMCU_ParkOpenFault	electromagnetic brake open fault	3
0x1B	DiagMCU_ParkOverCurrentFault	electromagnetic brake over current fault	3
0x1C	diagMCU_CurrentSensorErrLimt	busbar current sensor ErrLimt	2
0x1D	diagMCU_DCCurrentLimt	walking drive controlle busbar current limt	2
0x1E	diagMCU_DCCurrentSensErr	walking drive controlle busbar current sensor ErrLimt	2
0x1F	diagMCU_EcoderErrLimt	walking motor ecoder ErrLimt	2
0x20	diagMCU_MCUOverTempLimt	walking drive controlle over temperature	2
0x21	diagMCU_MotorOverCurrentLimt	walking drive controlle motor over current limt	2
0x22	diagMCU_MotorOverTempLimt	walking motor over temperature limt	2
0x23	diagMCU_OverRPMLimt	walking drive controlle moto over RPM limt	2
0x24	diagMCU_OverPowerLimt	walking drive controlle over power limt	2
0x25	diagMCU_OverLoadLimt	walking drive controlle over load limt	2
0x26	dianMCU_UnVoltageLimt	walking drive controlle under voltage limt	2

#### 4.3.2. CAN wire connection

CAN wires of FR-09 Pro have been welded out and marked, and users can directly connect them in accordance with the marks, as shown in Figure 4-1 below



Figure 4-1 Schematic Diagram of CAN Wire Position

Red is CAN\_H; Black is CAN\_L

### 4.3.3. Instructions of use of common VCU protocol

#### 1. Attentions during test:

- 1.1 During transmission, it shall be noted that, AliveCounter requires for continuous change and cycled transmission.
- 1.2 During transmission of AliveCounter, it shall be specially noted that, AliveCounter occupies four bits from No. 52 to No. 55.
- 1.3 BYTE[7] parity bit is the first 7 Byte XOR gates:  $\text{Checksum} = \text{Byte0} \text{ XOR } \text{Byte1} \text{ XOR } \text{Byte2} \text{ XOR } \text{Byte3} \text{ XOR } \text{Byte4} \text{ XOR } \text{Byte5} \text{ XOR } \text{Byte6}$
- 1.4 The following routine is a simple control command when USB CAN is used. Please control the vehicle in accordance with the communication protocol.
- 1.5 During the test, the remote controller is switched to automatic driving mode or turned off.
- 1.6 As the vehicle movement and other conditions may be tested during test by connecting to computer via CAN analyzer, please set up the vehicle during test, and after the vehicle is stably tested, put the vehicle down.
- 1.7 During the landing test, as the remote controller has the highest priority, it is best to turn on the remote controller for testing, facilitating to switch to the remote control

mode at any time during the test.

## 2. Instructions of vehicle control command ctrl\_cmd

For vehicle body control command, it is required to transmit corresponding commands, heartbeat signals and parity bits.

### (1) Targeted gear request ctrl\_cmd\_gear

The command of ctrl\_cmd\_gear is targeted gear signal, with a physical value range of 01-04. In default, 01 is Gear P for braking; 03 is Gear N, neutral gear; 02 is Gear R, reverse gear; 04 is Gear D, drive gear; And 01 is Gear P, parking gear.

For example: When target gear requests for drive 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 circulated at an interval of 10ms, and the gear can be controlled to be switched to the D gear.

Feedback:

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: Checkout and cyclic change of Alivecounter

### (2) Target vehicle speed request ctrl\_cmd\_velocity

The command of ctrl\_cmd\_velocity is the target value of vehicle speed, and the physical value range of CAN communication is 0-65.535m/s (13 speed ratio, and the maximum vehicle speed of the vehicle with a wheel diameter of 420mm is 5m/s). The target vehicle speed is determined by vehicle speed precision (0.001m/s/bit). Target vehicle speed driving vehicle = 0.001\* bus signal Forward and backward movement of vehicle shall be conducted in accordance with the gears.

Vehicle speed feedback is divided into three methods, they are:

- 1) Current vehicle speed feedback: Vehicle feedback is always positive.
- 2) Left and right wheel speed and vehicle speed feedback: It is the current vehicle speed corresponding to left and right wheels, during forward movement, the vehicle speed is

positive, and when the backward movement is negative.

- 3) Left and right wheel pulse count feedback: Forward movement is the accumulation of pulse count, and backward movement is the accumulative decrease of pulse count.

For example: When the given forward movement vehicle speed is 5m/s, the bus signal is 5000 0x1388

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2D0	0x84	0x38	0x01	0x00	0x00	0x00	0x00	0xBD
0x18C4D2D0	0x84	0x38	0x01	0x00	0x00	0x00	0x10	0xAD
0x18C4D2D0	0x84	0x38	0x01	0x00	0x00	0x00	0x20	0x9D

Note: The above three frames of signals are circulated at an interval of 10ms, so that the vehicle can be controlled to move forward at a speed of 5m/s speed.

Feedback:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2EF	0x84	0x38	0x01	0x00	0x00	0x00	0x00	0xBD

Note: Cyclic change of checkout Alivecounter, the feedback may not be absolute 5m/s due to the automatic adjustment of the running vehicle speed.

The IDs of the left wheel speed and the left wheel pulse feedback are: 0x18C4D7EF

The IDs of the right wheel speed and the right wheel pulse feedback are: 0x18C4D8EF

### (3) Target steering angle ctrl\_cmd\_steering

The command of ctrl\_cmd\_steering is the target steering angle request. The physical range of CAN communication is  $(-40.96)^{\circ}$  to  $(40.95)^{\circ}$ , the soft limit angle inside the vehicle is  $(-25)^{\circ}$  to  $(+25)^{\circ}$ . The left steering is positive and the right steering is negative. Target steering angle is determined by precision 0.01 °/bit. Target steering angle = bus signal \* 0.01

For example: Given angle - 25° target steering angle, the bus signal = -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 of signals are circulated at an interval of 10ms, the steering angle request can be -25°

Feedback:

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: Checkout and cyclic change of Alivecounter.

#### (4) Brake request ctrl\_cmd\_Brake

Ctrl\_cmd\_Brake is vehicle braking openness request, and the physical value range of CAN communication is 0-100%; 0 is to release the brake, 100% is the maximum brake openness request; The feedback status is from 0 to 100%, where 0 is fully released and 100% is the maximum brake openness request.

For example: When braking openness request is 100% 0x64

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2D0	0x00	0x00	0X00	0x00	0x40	0x06	0x00	0x46
0x18C4D2D0	0x00	0x00	0X00	0x00	0x40	0x06	0x10	0x56
0x18C4D2D0	0x00	0x00	0X00	0x00	0x40	0x06	0x20	0x66

Note: The above three frames of signals are circulated at an interval of 10ms, braking can be request.

Feedback: When the braking openness is 100%:

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
0x18C4D2EF	0x00	0x00	0X00	0x00	0x40	0x06	0x00	0x46

Note: Checkout and cyclic change of Alivecounter.

### 3. Instructions of auxiliary control commands

Taking the enabling of the position lamp as an example, the control of other accessories is the same as the enabling control of the position lamp. IO port enabling control needs to send the enabling flag bit, heartbeat signal and parity bit at the same time. (If IO control is not enabled, all lighting controls will be conducted by VCU)

For example: io\_cmd\_clearance\_lamp position lamp enabling 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 circulated at an interval of 50ms, high beam lighting can be requested remotely.

Feedback:

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

0x18C4DAEF	0x01	0x20	0X00	0x00	0x00	0x00	0x00	0x21
------------	------	------	------	------	------	------	------	------

Note: Checkout and cyclic change of Alivecounter.

Auxiliary enabling control supports position lamp control and left and right steering lamp control; Horn control can be conducted when the IO port enable signal is set to 1 or 0; The brake lamp is not controlled by CAN signal, but completely controlled by VCU, feeding back that whether the signal is enabled or not.

## 5. Attention

This section contains some matters to be noted during use, storage and development of FR-09 Pro.

### 5.1. Attentions for battery

▲ The battery of FR-09 Pro products may not be fully charged when they are delivered. The specific situations CAN be read through FR-09 Pro 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  $-20^{\circ}\text{C}\sim 60^{\circ}\text{C}$ , 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  $10^{\circ}\text{C}\sim 45^{\circ}\text{C}$ . 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;

### 5.3. Attentions for usage environment

▲ The working temperature of FR-09 Pro is -20°C~60°C, DO NOT use in the environment with the temperature of lower than -20°C or higher than 60°C;

▲ The best storage temperature for FR-09 Pro is 0°C~25°C;

▲ 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 FR-09 Pro is limited. DO NOT use FR-09 Pro in the environment with deep ponding;

### 5.4. Attentions for remote operation

▲ When debugging with the remote controller, please ensure that the remote controller is turned on and that the vehicle can receive the control instructions of the remote controller;

▲ Make sure that all dip switch are placed at the top before starting the machine; The emergency stop switch is released; The throttle remote lever returns to zero, that is, the chassis speed is 0;

▲ Please give priority to the low-speed gear for remote control, and then conduct the medium-speed or high-speed control test after you are familiar with the vehicle.

### 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.

## 6. Common Q&A

**Q: FR-09 Pro starts normally, however, the vehicle body does not move under the control of the remote controller?**

**A:** Firstly, confirm that whether the emergency stop switch at the tail has been released; And then, check that whether the SWA shift lever is in remote control mode, then check whether the VRB knob is controlled to unlock. Finally, check whether the SWB shift lever is the same as the control command.

**Q: FR-09 Pro 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: Can the chassis enclosure be removed due to the modification of the vehicle body enclosure?**

**A:** This chassis is not used to bear load, and the body does not bear the internal parts. The removal of the enclosure will not greatly impact the internal parts, so it is not recommended to remove it. If necessary, please make professionals to remove, and our company undertakes no responsibilities for the losses caused by unauthorized removal.

**Q: Both of charger led1 and led2 are 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.

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.

**Q: How to turn off the remote controller when the receiver of the remote controller is not powered off?**

**A:** Please remove the remote control electromagnetic and then reinstall it, and then you can turn off the remote control without power off the remote control receiver.



Tel.: 0755-28468956

Fax: 0755-28468956

Web: [www.yuhesen.com](http://www.yuhesen.com) Email: [sales01@yuhesen.com](mailto:sales01@yuhesen.com)

Address: Floor 5, Building 1, Chuangwei Qunxin Industrial Park, No. 1, Baolong 6th Road, Longgang District, Shenzhen City

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The logo for YUHESEN, featuring the company name in a bold, blue, sans-serif font.

Shenzhen Yuhesen Technology Co., Ltd.