YUHESEN

DT-mini Lightweight Four-wheels Differential Steering Chassis

User manual V2.1.0

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CONTENT

1. Foreword

(1) Thank you for purchasing our product, this user manual is applicable to DT-mini differential steering drive-by-wire chassis (hereby referred to as "DT-mini").

(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 DT-mini 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 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:

- Ensuring that operation is conducted in a relatively open place. And remote control shall be conducted with sight distance.
- The maximum load of DT-mini is 10KG, during use, it shall be ensured that the effective load does not exceed 10KG.
- 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.
- DO NOT directly push the chassis.
- During charging, please ensure that the environment temperature is higher than 0°C.

■ Maintenance:

- In case of serious track 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 charged once a month at least.

2. Introduction

DT-mini is a lightweight versatile drive-by-wire robotics mobile platform, it adopts differential steering and motor drive form. DT-mini has a relatively flexible compact body and lightweight load capacity. 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 equipping with the modules of navigation systems, GPS and IMU, cameras etc., this chassis is widely used in unmanned patrol, logistics, transportation, 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 Control*1
	
Charger*1	User manual*1
	

2.2. Performance parameters

Table 2 - 1 DT-mini Performance Parameter Table

Parameter type	Performance	Parameter
Structural size and weight	Dimensions(W*D*L)	600*500*200mm
	Weight	20kg
	Drive form	Differentia steering and motor drivel
	Material	AL5052
	Ground clearance	57mm
	Wheelbase	360mm
	Wheel track	448mm
	Tire type/diameter	200mm
Basic configuration	Driving motor	100W*2, DC brush motor
	Battery type	24V/10AH lithium battery with BMS
	Charging time	2-3h
	Charging method	24V/5A, manual charging by charger
	External power supply	12V/10A
	Braking mode	Motor brake
Safety measures	Emergency stop button	√
	Command check	√
	Heartbeat protection	√
	Electric current protection	√
	Temperature protection	√
VCU configuration	Dominant frequency	168MHz
	Kinematic analysis	√
	Hardware floating point acceleration	√
	Communication interface	CAN interface
	Communication protocol	CAN interface protocol
Performance parameters	Remote control distance	100m
	Vertical load (level road)	10kg
	Speed	0-3km/h
	Mileage	10km (without load)
	Minimum turning radius	0m
	Maximum climbing angle	10° (full load)
	Wading depth	40mm
	Crossing width	120mm (full load)
	Obstacle surmounting height	50mm (full load)
	Protection level	IP33
	Operating temperature	-20°C~60°C

3. Product presentation

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

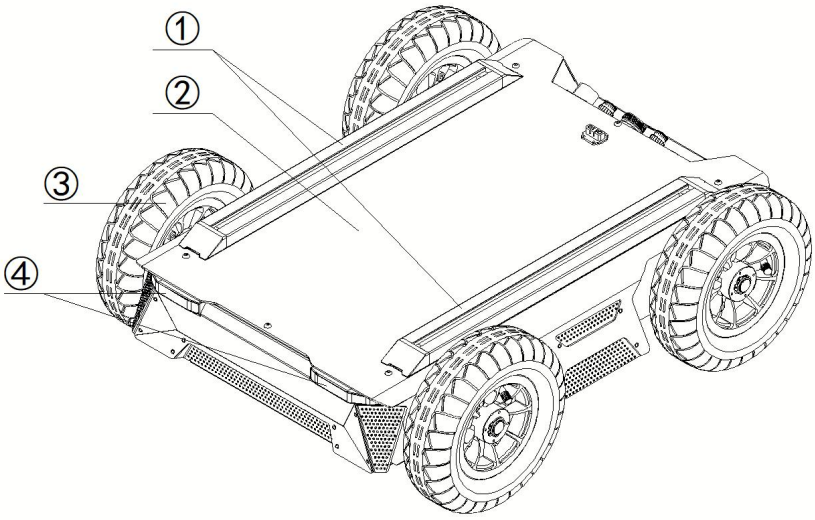


Figure 3 - 1 Front Overall Figure

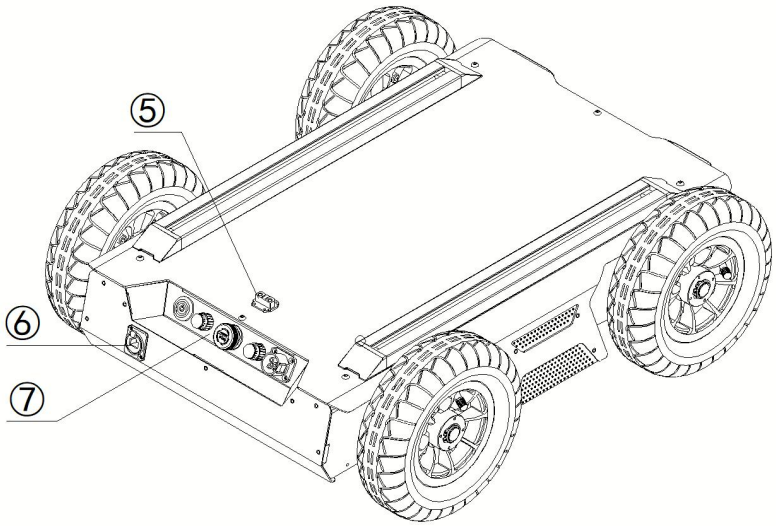


Figure 3 - 2 Tail Overall Figure

Note: ①mounting profile; ②top cover; ③tire; ④clearance lamp; ⑤power supply interface; ⑥Tail debugging network port; ⑦Rear electrical panel.

The product of the utility model belongs to a four-wheel carrier platform, which is an actuator that can be used to carry an automatic driving navigation kit to realize autonomous walking; It is used to carry control equipment, detection equipment and safe operation devices in industrial applications. Its working principle is to connect the vehicle controller VCU through the power on of the motor, issue the walking command, and the command drives the PID to control the motor rotation. The motor rotation drives the reducer to control the mechanical movement and realize the walking function.

The DGT Mini robot mobile platform aims to provide users with a complete, high-performance, high reliability, rich interfaces, easy to use, strict protection level, and long-term uninterrupted robot system. DGT Mini is a four wheel differential gear train robot platform, equipped with a powerful drive system, which can adapt to various application environments and realize various motions with high performance. The chassis is made of aluminum alloy, anti-corrosion paint, driven by two brush motors and equipped with independent brush drivers. The chassis supports can interface and provides users with a complete device communication protocol, enabling users to quickly get started with DGT Mini.

3.1. Function description of electrical board

3.1.1. Instruction of tail electrical board

There is an electrical panel installed at the tail of the DT-mini, as shown in Figure 3-3. B1 is the power supply interface 12V10A; B2 is the start switch, press the start button to power on and disconnect the power supply from the vehicle body; B3 is the main fuse; B4 is the emergency stop switch, press the knob to stop the vehicle body; B5 is a shunt fuse; B6 is a manual charging port; Its specific location is shown in Figure 3-3.

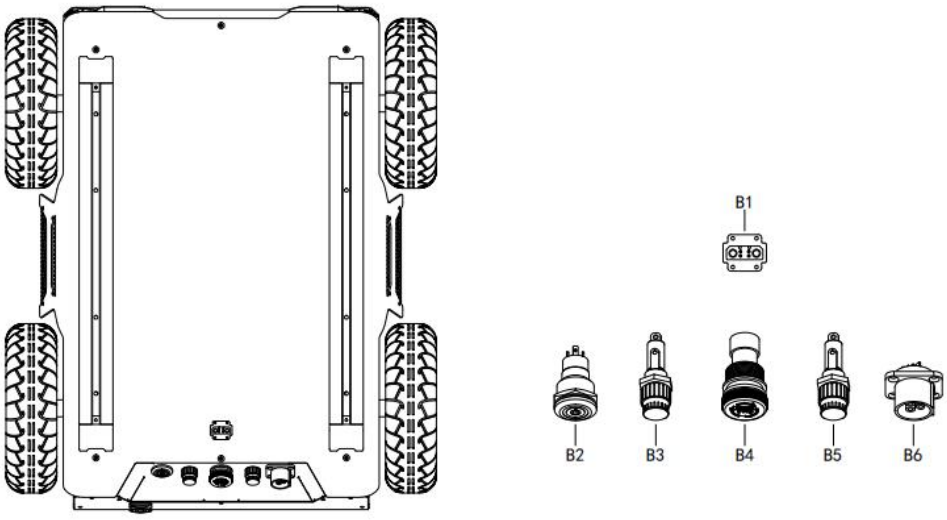


Figure 3-3 Top View Electrical Location Diagram

3.2. Instructions of DT-mini remote control

3.2.1. FS-i6S remote control operation

Each DT-mini is equipped with a FS-i6S remote control, which allows users to easily control DT-mini. In this product, the FS-i6S remote control is designed with left hand left/right direction control and right hand front/rear throttle control. Its definition and function can be referred to Figures3-4:

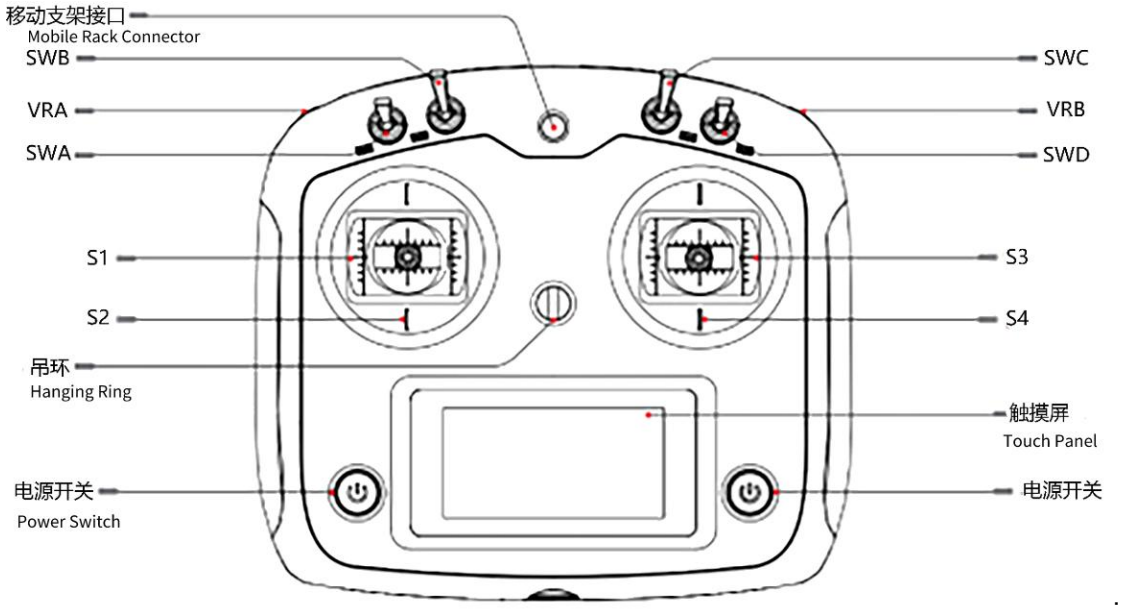


Figure 3 -4 Schematic Diagram of FS-i6S Remote Controller Keys

The parameter settings of the remote control have been set before leaving the factory. Please do not modify the system settings without authorization, otherwise it may cause problems such as robot loss of control and chaos. If there are any problems, it is

recommended to return to the factory for repair; The detailed operating instructions for the remote control are as follows:

(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) SWC is the gear shift lever, with three gears, low speed gear when the lever is up; high speed gear when the lever is down; medium speed gear when the lever is in the center.

(3) VRA is the safety parking unlock dial, which is used to release the safety parking, the anti-collision bar will trigger the safety parking after sensing the collision. After triggering the safety parking, toggle the VRA dial once (or pull the right rocker S4 once in the opposite direction of the collision) to release the safety parking and continue the operation.

(4) VRB is dial for operation protection. **When operating the rocker, press and hold VRB at the same time**. Otherwise, the chassis will not receive the motion command issued by the rocker.

(5) The left rocker is the direction control rocker, rocker S1 moves left-right to control the left-right steering of the chassis, rocker S2 up-down control is not enabled, and up-down toggling has no effect on the chassis movement.

(6) The right rocker is the throttle control rocker, rocker S4 moves forward and backward to control chassis forward and backward, rocker S3 left and right control is not enabled, left and right toggle has no effect on chassis motion.

(7) There is a power button on the left and right side, press and hold both power buttons at the same time, you can switch on and off the machine.

(8) The instructions of the displayed home screen are shown as below:

The start page is divided into four sections, with two timers T1 and T2 on the upper left, flight mode on the lower left, power display on the upper right, where TX is the remote control power and RX is the robot power, and the unlock button and fine-tuning button on the lower right.

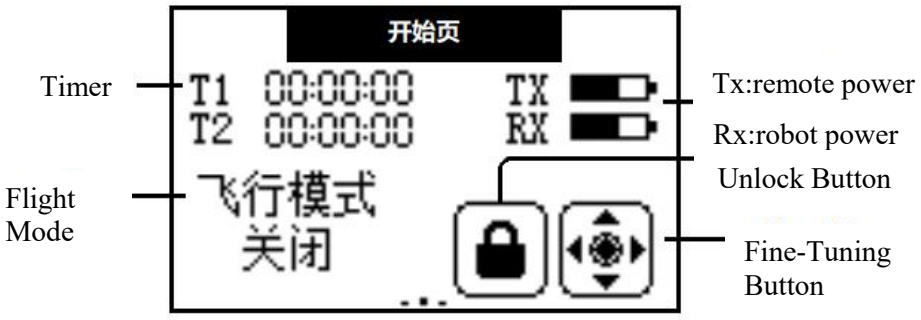


Figure 3-5 Remote Control Start Page

The left page of the remote control start page is the channel screen, as shown:

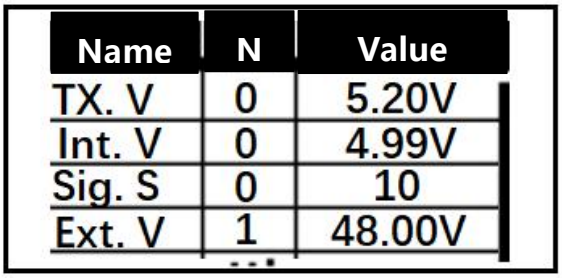
Figure 3-6 Remote Control Channel Page

Each of these channels corresponds to the operating parts of the remote control as follows:

Table 3-2 Remote Control Channel Correspondence

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 page of the remote control start page is the sensor list page, where the TX.V item is the remote control battery voltage, the Int.V item is the receiver voltage, the Sig.S item is the signal strength, with a normal signal strength of 10, and the Ext.V item is the robot chassis voltage, noting that the unit is V there.



Name	N	Value
TX. V	0	5.20V
Int. V	0	4.99V
Sig. S	0	10
Ext. V	1	48.00V

Figure 3-7 Remote Control Sensor List Page

Refer to Table 3-3 for specific SOC:

Table 3-2 Comparison table for vehicle battery voltage and SOC

Comparison table for vehicle battery voltage and SOC										
Voltage（V）	27.19	26.13	26.11	26.08	26.05	26.01	25.96	25.91	25.85	25.81
SOC（%）	100	95	90	85	80	75	70	65	60	55
Voltage (V)	25.77	25.72	25.67	25.61	25.54	25.44	25.31	25.12	24.93	24.5
SOC（%）	50	45	40	35	30	25	20	15	10	5（Stop Output）

◆ **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 DT-mini 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 DT-mini 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 DT-mini 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.

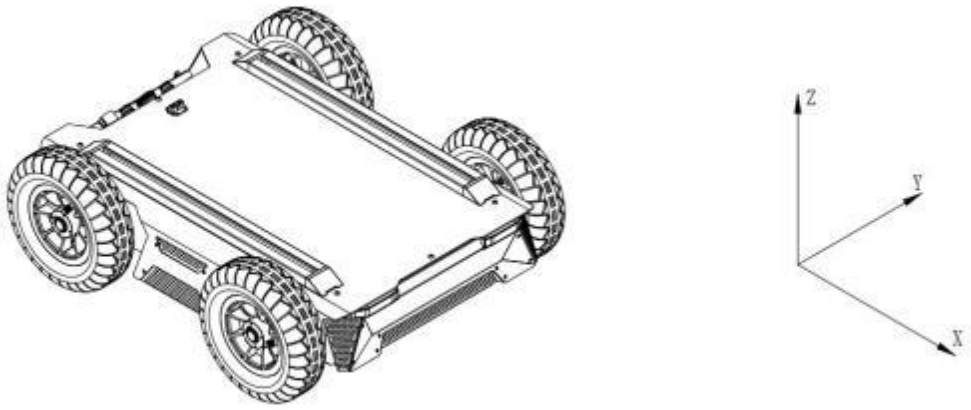


Figure 3-8 Body Coordinate System

As shown in Figure 3-8, the DT-mini vehicle body is parallel to the established reference coordinate system's X-axis.

In remote control mode, hold the VRB to operate the protective dial, and pushing the right-hand throttle joystick S4 forward will move the vehicle in the positive X-direction. Pushing it backward will move the vehicle in the negative X-direction. When the joystick S4 is pushed to its maximum value, the speed of movement in the X-direction is the highest, and when pushed to its minimum value, the speed of movement in the negative X-direction is the highest.

The left-hand direction joystick S1, when pushed left or right, controls the turning motion of the vehicle. Pushing the direction joystick S1 to the left will make the chassis turn left, and when pushed to the maximum left, the left turning angular velocity is the highest. Pushing the direction joystick S1 to the right will make the chassis turn right, and when pushed to the maximum right, the right turning angular velocity is the highest.

4. Getting Started

This section mainly introduces the basic operation and use of the DT-mini platform, how to operate through a remote control, and how to conduct secondary development of the vehicle body through the CAN protocol.

4.1. Use and operation

4.1.1. The basic operation process of remote control operation is 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

DT-mini mobile robot is equipped with a 24V/5A 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 DT-mini 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; Then, plug the AC plug of the charger into the 220VAC socket.

(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 Description of Charger Status LED Indicators

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

1) 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: The charging process must be carried out in sequence to prevent the charging port of the charger from being charged and the battery charging port from being short circuited, causing damage to the robot battery and charger, or unnecessary personal injury.

4.3. Development

The DT-mini product provides a standard CAN communication protocol for user development, allowing users to command and control the vehicle body based on the provided CAN interface.

4.3.1. CAN interface protocol

The communication in DT-mini product adopts the CAN2.0B standard, with a baud rate of 500K, and the message format adopts Intel format. The linear speed, angular speed, etc. of chassis movement can be controlled through an external CAN interface; At the same time, it will provide real-time feedback on the current motion status information and the system status information of the DT-mini chassis.

There are two control modes of motion command control: kinematics control and free control. Users can select the corresponding command control mode according to their needs, and only one mode can be used for control. The protocol content includes control frames and feedback frames, and the specific protocol content is shown in the table:

Motion Control Command - Control Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
ctrl_cmd			0x18C4D1D0			Cycle	10		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Target gear	Intel	0	0	Cycle	4	Unsigned	1		00: disable 01: Gear P 02: Gear N 03: Kinematics control gear
Target speed	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit ;
Target angular speed	Intel	2	20	Cycle	16	signed	0.01	°/s	(0.01°/s)/bit;
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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

Free Control Instruction - Control Frame								
Message Name			**ID**			**Type**	**Cycle (ms)**	**Length (Byte)**
free_ctrl_cmd			0x18C4D2D0			Cycle	10	8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Target gear	Intel	0	0	Cycle	4	Unsigned	1		00: disable 01: Gear P 02: Gear N 04: Free control gear
Left wheel target speed	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit;
Right wheel target speed	Intel	2	20	Cycle	16	signed	0.001	m/s	0.001m/s/bit;
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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 Instructions - Control Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
io_cmd			0x18C4D7D0			IfActive	10		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Safe parking unlock switch	Intel	0	1	IfActive	1	Unsigned	1		0 = Invalid 1 = Unlock Enable
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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

Motion Control Status - Feedback Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
ctrl_fb			0x18C4D1EF			Cycle	10		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Current gear feedback	Intel	0	0	Cycle	4	Unsigned	1		00: disable 01: Gear P 02: Gear N 03: Kinematics control gear 04: Free control gear
Current vehicle linear speed feedback	Intel	0	4	Cycle	16	signed	0.001	m/s	0.001m/s/bit;
Current vehicle angular speed feedback	Intel	2	20	Cycle	16	signed	0.01	°/s	(0.01°/s)/bit;
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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

Wheel Train Control Status - Feedback Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
l_wheel_fb			0x18C4D7EF			Cycle	10		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Current left wheel speed feedback	Intel	0	0	Cycle	16	signed	0.001	m/s	0.001m/s/bit;
Current left wheel pulse feedback	Intel	2	16	Cycle	32	signed	1	1	N pulses per wheel turn, N=encoder lines * reduction ratio
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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

Wheel Train Control Status - Feedback Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
r_wheel_fb			0x18C4D8EF			Cycle	10		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Current right wheel speed feedback	Intel	0	0	Cycle	16	signed	0.001	m/s	0.001m/s/bit;
Current right wheel pulse feedback	Intel	2	16	Cycle	32	signed	1	1	N pulses per wheel turn, N=encoder lines * reduction ratio
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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 Status - Feedback Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
io_fb			0x18C4DAEF			Cycle	50		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Safe parking unlock switch	Intel	0	1	IfActive	1	Unsigned	1		0 = invalid 1 = unlock enable
Emergency stop switch status feedback	Intel	5	40	Cycle	1	Unsigned	1		0 = off 1 = on
Remote control status feedback	Intel	5	41	Cycle	1	Unsigned	1		0 = Command control status 1 = Remote control status
Alive Rolling Counter Heartbeat signal (loop counter)	Intel	6	52	Cycle	4	Unsigned	1		For each frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
bms_fb			0x18C4E1EF			Cycle	100		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Current 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;
Current battery 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 frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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 Status - Feedback Frame									
Message Name			**ID**			**Type**	**Cycle (ms)**		**Length (Byte)**
bms_flag_fb			0x18C4E2EF			Cycle	100		8
Signal description	**Arrangement format**	**Starting byte**	**Start bit**	**Signal transmission type**	**Signal Length**	**Data type**	**Accuracy**	**Unit**	**Signal value description**
Current remaining battery percentage	Intel	0	0	Cycle	8	Unsigned	1	%	1%/bit;
Individual overvoltage protection	Intel	1	8	Cycle	1	Unsigned	1		0 = off 1 = on
Individual undervoltage protection	Intel	1	9	Cycle	1	Unsigned	1		0 = off 1 = on
Whole group overvoltage protection	Intel	1	10	Cycle	1	Unsigned	1		0 = off 1 = on
Whole group undervoltage protection	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 low temperature protection	Intel	1	13	Cycle	1	Unsigned	1		0 = off 1 = on
Discharge over temperature protection	Intel	1	14	Cycle	1	Unsigned	1		0 = off 1 = on
Discharge low temperature protection	Intel	1	15	Cycle	1	Unsigned	1		0 = off 1 = on

Charging overcurrent protection	Intel	2	16	Cycle	1	Unsigned	1		0 = off 1 = on
Discharge overcurrent protection	Intel	2	17	Cycle	1	Unsigned	1		0 = off 1 = on
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 locked MOS	Intel	2	20	Cycle	1	Unsigned	1		0 = off 1 = on
Charging flag position	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 highest 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 frame sent, the value is incremented by 1. After reaching the maximum value, it is counted again from 0 to detect 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

4.3.2. Instructions for using CAN communication protocol

1.Precautions during the testing process:

1.1 During the sending process, note that AliveCounter needs to continuously change and send in a cyclic manner.

1.2 During the process of sending AliveCounter, pay special attention to the four bits occupied by AliveCounter ranging from 52 to 55.

1.3 The check bits of BYTE [7] are XOR checks of the first 7 Bytes: Checksum = Byte0 XOR Byte1 XOR Byte2 XOR Byte3 XOR Byte4 XOR Byte5 XOR Byte6

1.4 The following routine is a simple control command for issuing commands using USB CAN. Please control and issue commands according to the communication protocol when controlling the vehicle.

1.5 During the testing process, switch the remote control to command and control mode or turn off the remote control.

1.6 During the testing process of using a computer to connect the CAN analyzer, due to the possibility of testing vehicle movement and other situations, please set up the vehicle during the testing process and let it down when using the program to test after the vehicle has stabilized.

1.7 During the road test, as the remote control has the highest priority, it is best to turn on the remote control for testing to facilitate switching to remote control mode at any time during the testing process.

2.Vehicle control command description ctrl_cmd

The vehicle control command needs to send corresponding commands, heartbeat signals, and check bits simultaneously.

(1) Target gear request ctrl_cmd_gear

ctrl_cmd_gear command is the target gear signal, with a physical value range of 00 to 03. The default gear position is 00, which is the disable gear; When the target gear is set to 01, it is in parking gear; When the target gear is given 02, it is in neutral; When the target gear is set as 03, it is the kinematics control gear.

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 sent circularly every 10ms, and the control gear can be 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: Checksum and Alivecounter cyclic change.

(2) Target speed request ctrl_cmd_liner

ctrl_cmd_liner command is the target value for driving the vehicle's liner speed. The physical value range of CAN communication is -32.767 to 32.767 m/s. The target line speed is determined by the vehicle speed accuracy (0.001 m/s/bit). The target line speed of the driving vehicle is 0.001 * bus signal. The vehicle is used in combination with gears for forward and backward movement.

There are three types of vehicle speed feedback methods, namely:

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

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

3) Feedback of left and right wheel pulse number: Forward is the accumulation of pulses, and backward is the accumulative decrease of pulses.

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

ID	D[0]	D[1]	D[2]	D[3]	D[4]	D[5]	D[6]	D[7]
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 in cycles with 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: Checksum and Alivecounter cyclic change. Due to the automatic adjustment of the operating speed, the feedback may not be absolute 1m/s.

The left front wheel speed and left front wheel pulse feedback ID: 0x18C4D7EF

The left front wheel speed and left front wheel pulse feedback ID: 0x18C4D8EF

(3) Target angular speed ctrl_cmd_angular

ctrl_cmd_angular command is the target angular velocity request, with a physical range of (-327.68) degrees to (327.67) degrees for CAN communication. The left turn is positive, and the right turn is negative. The target angular velocity is determined by the accuracy (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 in cycles with an interval of 10ms, 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: Checksum and Alivecounter cyclic change.

5. Attention

This section contains some precautions to be taken when using and developing DT-mini.

5.1. Attentions for Battery

▲ When the DT-mini product leaves the factory, the battery may not be fully charged. The specific battery level can be read through the remote control voltage display or the CAN bus communication interface. The charging time is indicated by the green indicator light on the charger indicating that the charging is complete;

▲ Please do not charge the battery after it has been completely used up. When the battery voltage is too low, please charge it in a timely manner;

▲ The working temperature of the battery under discharge conditions is -20 ℃~50 ℃, and the battery can operate normally within the specified temperature range, with capacity loss within the error range;

▲ During use, excessive discharge of the battery is prohibited to avoid damage to the battery;

▲ Avoid excessive impact on the battery. Impact beyond specifications may damage the battery, which may cause leakage, heat, smoke, fire, or explosion.;

▲ If obvious abnormalities are found in the battery, please stop using it immediately!

5.2. Attentions for Charging

▲ It is necessary to use a dedicated battery charger for charging. Do not use batteries, power supplies, or chargers that are not standard from the original factory at will;

▲ Charge only in an environment of 0 ° C to 45 ° C. Charging outside this temperature range may lead to battery leakage, heating, or serious damage, and it may also lead to deterioration of battery performance and lifespan;

▲ When charging, if the charger or battery is abnormal or damaged, please immediately unplug the input power cord and output power cord of the charger;

▲ If the charging process cannot be completed within the specified time, stop the charging process. Batteries may generate heat, smoke, fire (or explosion);

▲ It is strictly prohibited to charge the vehicle battery in thunderstorm weather;

▲ It is strictly prohibited to charge the vehicle battery in damp or rainy areas;

▲ It is strictly prohibited to charge the vehicle battery in areas with high temperatures such as heat sources and direct sunlight;

▲ Charging should be carried out in a ventilated and dust-free area;

▲ During charging, it is strictly prohibited to block the air inlet and outlet of the charger, leaving at least 10cm of space;

5.3. Attentions for Usage Environment

▲ The working temperature of DT-mini is -20 ℃~50 ℃. Do not use it in environments with temperatures below -20 ℃ or above 50 ℃;

▲ Do not store or use in environments with corrosive, flammable, and explosive gases;

▲ Do not store or use near fire sources;

▲ Except for the specially customized version (IP protection level customization), DT-mini has limited waterproof function. Please do not use it in waterlogged environments at will;

5.4. Attentions for Remote Control Operation

▲ Under the remote control mode, all chassis motion control requires holding down the VRB operation protection dial. When the VRB is released, the chassis will automatically stop and no longer respond to left hand direction and right hand throttle rocker control.

▲ Emergency stop knob is released; the throttle remote rock is returned to the zero position, i.e.: the chassis speed is in the 0 state;

▲ When the S4 remote rock at the remote control end is pushed forward to control the vehicle's forward movement, if it is necessary to perform a reverse operation on the vehicle body, the S4 remote rock should be reset to zero before proceeding with the reverse operation. It is prohibited to quickly shift to the reverse gear when pushing forward; The operation of left and right turn control is the same, and both sides need to return to center and return to zero before changing direction.

▲ Do not turn off the power supply of the remote control terminal during normal driving of the vehicle. When the remote control terminal runs out of battery, the interruption of communication will activate the protection program, and the chassis will

stop walking after 3 seconds; After the remote control is powered on again, communication will automatically resume and the vehicle can be used normally.

5.5. Attentions for External Electrical Extension

▲ The current of the top expansion power supply should be strictly used according to the selected battery voltage and current, and should not be overloaded;

▲ When the system detects that the battery voltage is lower than the safe voltage, it will start the protection program. If the external expansion device involves the storage of important data and there is no automatic power down storage function, please charge it in a timely manner.

5.6. Other Attentions

▲ Do not fall or invert during handling and setting up operations;

▲ Non professional personnel, please do not disassemble without permission;

▲ If the remote control terminal is not used for a long time, the dry battery should be removed;

▲ The track should be replaced in a timely manner based on the wear of the tread pattern.

6. Q&A

Q: DT-mini starts normally, use the remote control to control the vehicle body not to move?

A: Firstly, confirm whether the rear emergency stop switch has been released;

Check if the remote control SWA is in the remote control mode again;

Then check if the V2 operation protection dial is simultaneously pressed during operation.

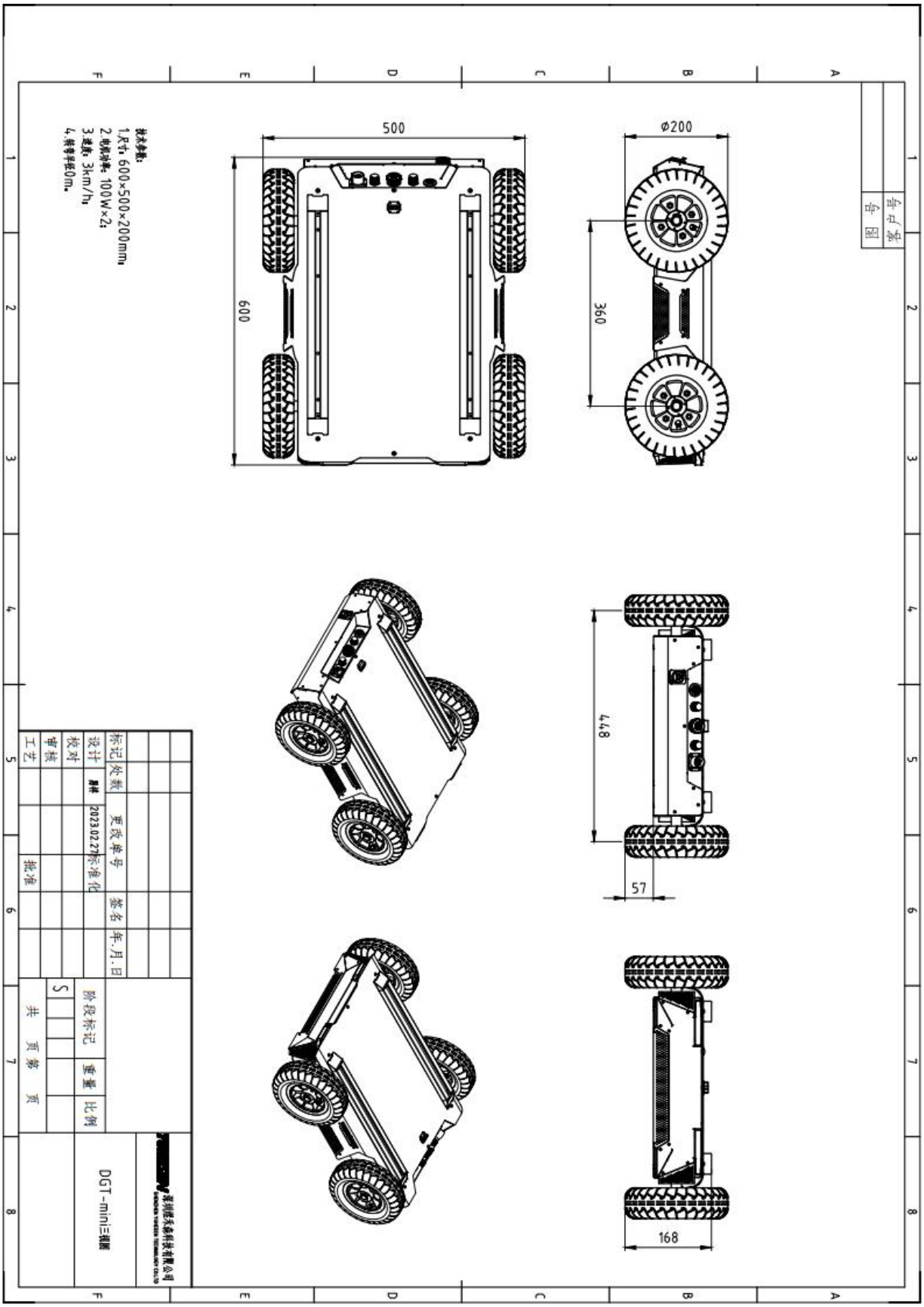
Q:Using the remote control to control the DT-mini, what should I do when the remote control runs out of power and the car stops running?

A: Please replace the remote control batteries immediately. Normal communication can be resumed after replacing the batteries.

Q: Control interruption during remote control operation?

A: When using the remote control, the control range is 100 meters. Please confirm if it is within the remote control range; Then check if the remote control handle has sufficient power.

7. DT-mini Drawing



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