Discovery Q2
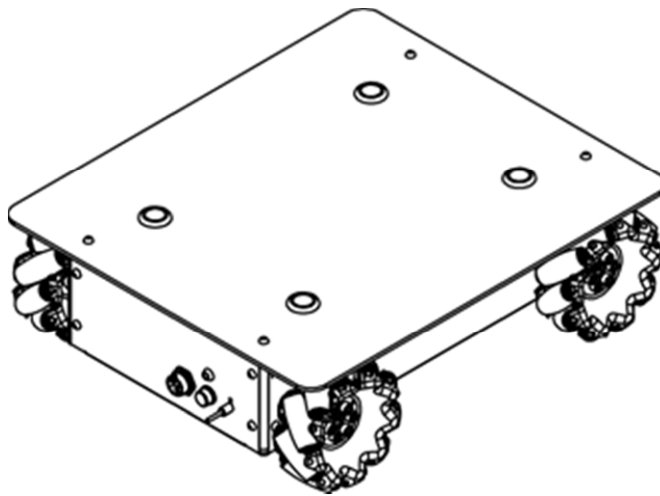# Four-wheel Omni-directional Robot Platform

User Manual v1.1

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Robot Division

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Safety Warnings

Please do not switch on power for the robot before you read and fully understand this Manual.

Please do not plug or dismount any part of the robot when the robot is powered on.

Please switch the main power off if any emergency happens.

Original power adaptor shall be used for charge.

The robot platform does not fireproof or waterproof, therefore please keep robot platform away from fire or water as far as possible.

Please keep a safe distance from robot platform, for errors might occur whether on the program itself or during manual operation.

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Table List

1 Description

As economical small robot platform, the Discovery Series are aimed at offering a complete, multi-interfaced and highly reliable moving robot system at the best cost-performance. Discovery Q2 is such a platform with 4 Discovery Q2 Mecanum wheels which is made by Hangfa itself. The wheels, compared to the traditional ones, are able to move laterally, rotate, or rotate when move laterally. Discovery Q2 is driven by 4 coreless servo motors with 4-axis servo driver, and supports CAN bus and RS232 serial ports. SDK is provided to the users with complete communication protocol and the samples and demonstration programs source code based on the STM32F407, so that the users could get it started as soon as possible.

2 Features

• to move to any direction freely
With 4 Mecanum wheels, the robot platform is able to move in all directions horizontally, and rotate in the same time.

• suspension system
Coaxial pendulous suspension structure enables the 4 wheels to touch the ground and be driven evenly; it performs well passing the rough ground.

• precise Mecanum wheel
The classic industrial QMA-10 wheels made by Hangfa, with 2 bearings inset in the small rubber rollers, move steadily and smoothly.

• wheels with bearing blocks
Each wheel is fixed on the bearing block by the transmission shaft; and the transmission shaft is connected to the motor shaft, rather than the wheel is connected to the motor shaft directly. Such design reduces the radial loading of the bearing shaft, to lengthen the work time of the motor and reduce the loading capacity of the whole platform.

• coreless DC servo motor
The 4 coreless DC servo motors realize the high power density, high torque and quick speed response.

• 4- axis servo driver
Such driver enables the motor to perform a good characteristic curve. The user could control the motor speed quick and accurately, not affected by the changes in the loading and ground, so that the robot performs accurately and reliably.

- DEMO development board

With STM32F407 as the core, the RHF407 development board offers the open source C# programming language SDK, to aid the users to operate on the robot. High computing performance and multiple ports enable the user to carry on it different application and development.

3 Get to know your Discovery Q2

3.1 Exterior structure
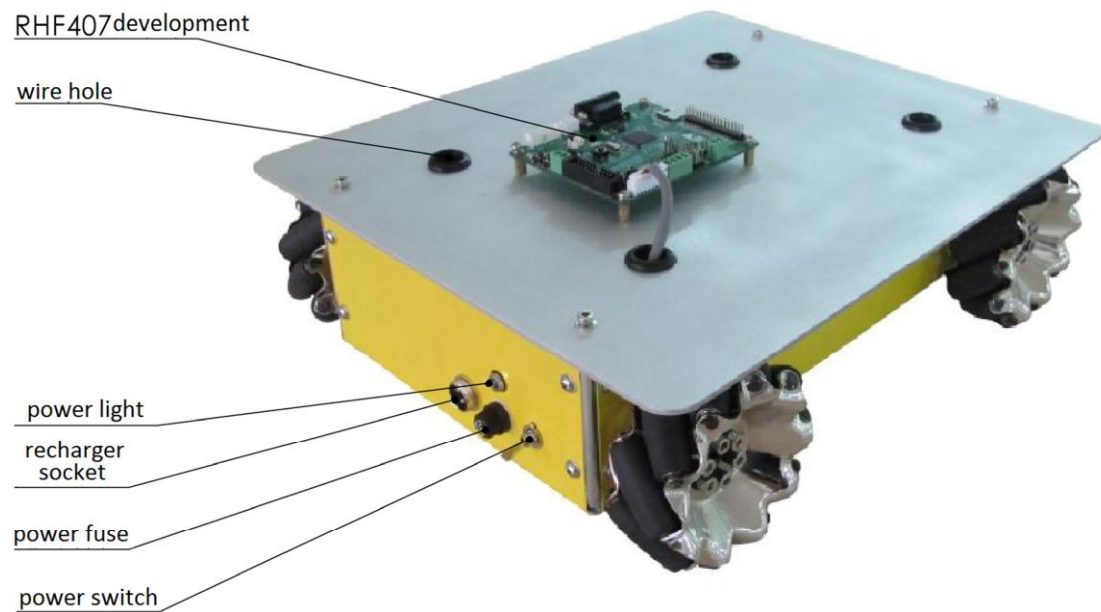
1. power switch

   To control whether the whole platform is on or off

2. power fuse

   The fuse will blow out for protection, in the case of short circuit or false operation.

3. recharger socket

   For recharging the robot; the recharging state is independent of power switch.

4. power light

   That the light is on/off indicates the robot is on/off.

5. wire hole

   For the wire from inside of the robot to outside.

6. RHF407 development board

   STM32F407 as the core of the development board, it offers the users demonstration program and application source code. For the details, please check the RHF407 User Manual.

3.2 Interior structure

Power Source and BIM

Lithium batteries

Four-wheel Drive

Encoder

Motor

QMA 10 Omni Wheel
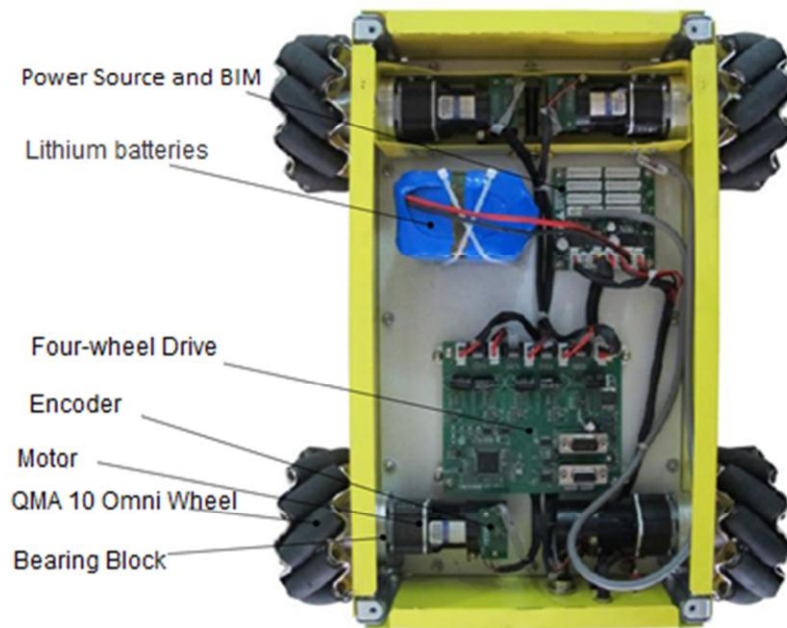
Bearing Block

1. Bearing block
2. QMA10 Mecaum wheel
3. Motor
4. Encoder
5. 4-axis driver
6. Li battery
7. Power source and bus ports modular

4   Let your Discovery Q2 robot platform move.

By RHF407 development board, discovery Q2 pre-builds two demonstration programs, which demonstrate the robot parallel movement function and self-movement function. The user can push SW2 and SW3 buttons on the development board to achieve action1 and action 2. It is necessary to install the RHF407 develop board onto the robot, connect the CN4 port to any 8pin plug of the IFB1205 BIM by incidental cable, and switch it on.

Step 1：Disassemble the top panel to check each component.

Step 2：Connect the battery plug to the J6 port of IFB1205 board

Step 3：Turn on the power switch, the power indicator light should be lighted up. If you push the robot platform slightly, you would feel the self-lock drag forth to the motor produced by servo driver.

Step 4：Connect one side of the single gray cable bus in the case to any 8PIN plug of IFB1205 board, and the other side to the RHF407 board from the top panel thread hole.

Step 5：Fix the RHF407 board on the set position and fix the top panel on the robot. Then connect the gray cable side which is out of the thread hole to the CN4 port of RHF407 board.

Step 6：Position the robot onto the vacant flat surface and turn on the power switch. After that, the LED1 on the RHF407 board will twinkle. Then separately click the SW2 and SW3 button on the RHF407 board to make two demonstration movement programs operate.
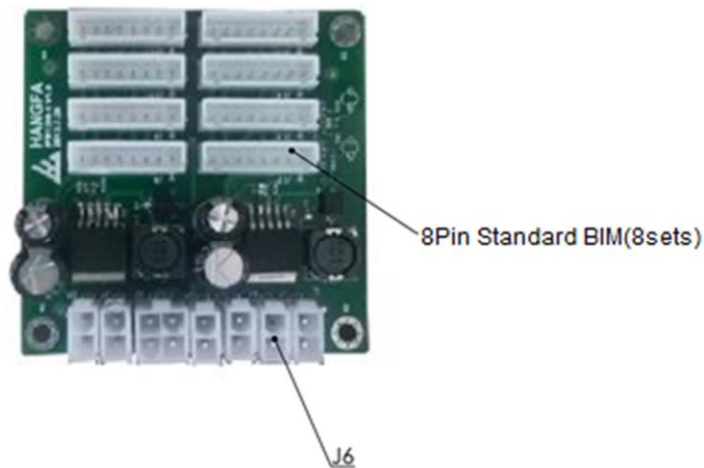
IFB1205 Power Source and BIM
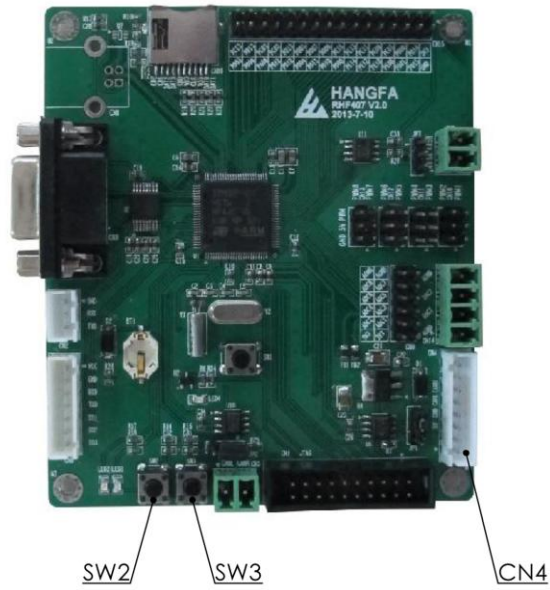
RHF407 Development Board

4.1 Position Parallel Movement DEMO

Click the RHF407 SW2 button，the robot will make a parallel movement according to the route of the below rectangle. The rectangle width is 0.8m, length is 1.6m.

4.2 Self-movement in Place DEMO

Click the RHF407 SW3 button，the robot will make self-movement in place for 20 seconds.
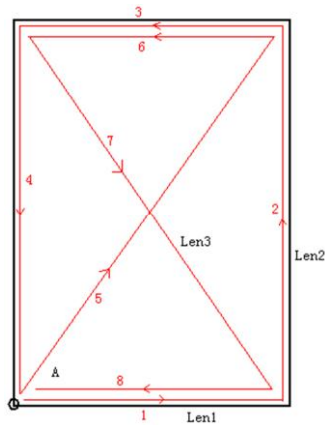
5 System Brief Introduction

5.1 Typical Research and Application Area

|	
Research on pattern recognition technology	Electronic Engineering Experiment
Research on Path Planning Technology	Mechanical engineering experiment
Research on automatic driving technology	Embedded system development and experiment
Research on sensor technology	Research on image processing technology
Research on artificial intelligence technology	Research on multi robot cooperation technology
Handling and storage applications	Map rendering application
Monitoring and investigation application	Application of flexible manufacturing system
Robot competition	

5.2 Specification Parameters

Table 1.Discovery Q2 Specification Parameters

Body Form	Sheet forming
Overall Size	374×320×114mm
Driven wheel	101.6 diameter Mecanum wheel
Driven mode	Four-wheel independent drive
Suspension form	coaxial pendulous suspension
Minimum space to the floor	23mm
Whole Weight	7kg
Rated load capacity	20kg
Minimum turning radius	0m
Maximum parallel movement speed	0.5m/s
Maximum self-movement speed	90°/s
Application floor	Flat floor
Typical endurance time	>10h（Loading 3kg，moving speed 0.5m/s, moving rate 70%）
Stand-by time	>30h
Recharging time	4h
User electrical energy output supporting	5V @ 5A（2.5A×2）
Voltage	Battery Voltage(9.6~12.6V) @ >5A
Battery rated voltage	12V
Battery volume	10.4Ah
Battery type	Lithium batteries
Batter fast replacing	Supporting
Battery charger Voltage	AC100V~240V
Battery charger	DIP
Rated charging current	2A
Power supply fuse set size	5×20/10A

DEMO development board model	STM32F407

6　Mechanical systems

6.1　Dimensions
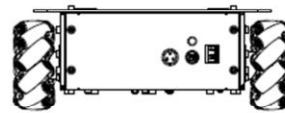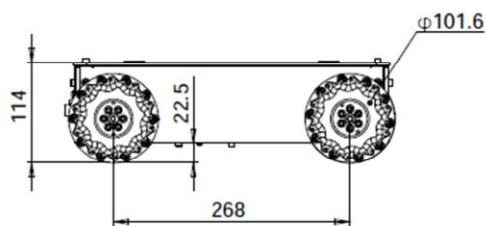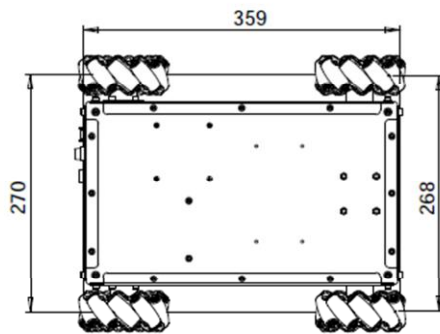
6.2　Motor

Discovery Q2 uses Faulhaber 2342 motor. Test parameters:

Rated voltage: 12V

Rated current: 1.1A

Rated output power: 11W

No load rotating speed: 6800rpm

Rated rotating speed: 5800rpm

Reduction ratio: 64:1

Encoder :12 line/rev, A、B phase output

Encoder rated voltage: 5V

6.3 Omni wheel

Table 2. The main parameter of QMA-10 Omni wheel

Hangfa Industrial QMA-10 Omni wheel	
Diameter	101.6mm
Wide	45.7mm
Roller number	10
Bearing number	20
Hub Material	steel
Load Capacity	45kg

6.4 Bearing block

 After Faulhaber 2342 motor equipping with reducer, gear reducer output shaft bearing is sliding copper bearing and the output shaft diameter is small, which is not suitable for direct bear radial and axial load but suitable for main transmission torque of the occasion.

The Discovery series robot adopts the design of the outer body bearing block, the shaft of bearing block bears the wheel in axial and radial load and the motor shaft is only used to transfer torque. This greatly improves the load capacity of robot, the motor working condition, and the motor characteristics and extends the motor service life.

6.5 Coaxial pendulum suspension

With the coaxial pendulum suspension as shown in figure 1, the robot four driving wheels can still touch the ground and output power on uneven ground.

6.6 Support column

The robot uses the steel pressure molding support column. The support column, top and bottom plate form a high stability of rigid frame structure.

6.7 User extension platform

The top plate is user extension plane. Users can install other equipment or structures in the plane according to your own application requirements.

# 7 Electrical systems

7.1 Electrical principle drawing
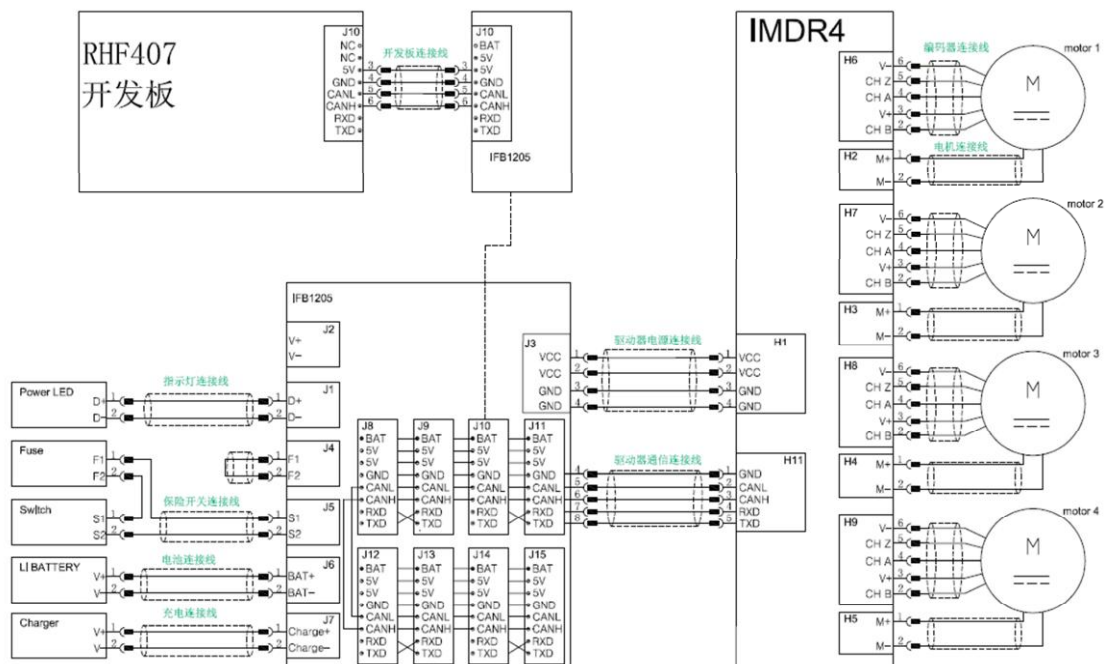
7.2 IMDR4 four shaft driver

7.2.1 The module overview

This module is used to drive the four dc servo motors and provide accurate speed closed-loop control. It also integrates motion control algorithm of the four omnidirectional wheels. Users can realize the overall chassis motion control or directly for each motor motion control through the communications via CAN bus and RS232 interface.

For more details，please check "discovery_Q2_communication_protocol_V1.0".
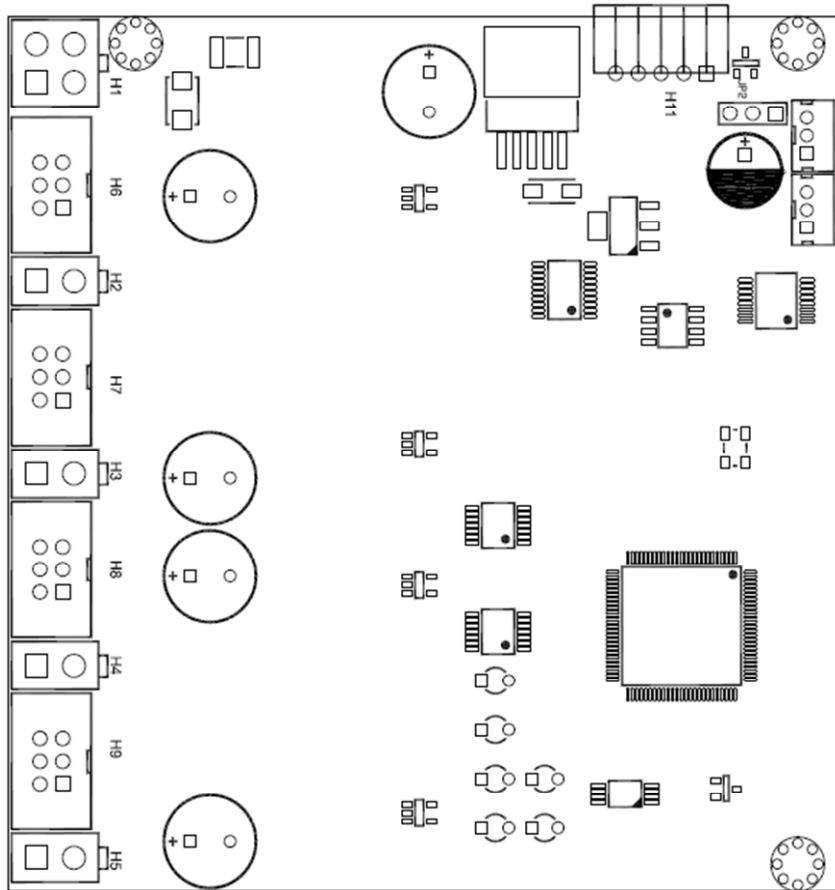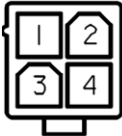
7.2.2 Interface Description

7.2.2.1 Interface summary

Table 3. IMDR4 Interface summary

Interface serial number	Description	Note
H1	Power input	
H2	Motor 1 power interface	
H3	Motor 2 power interface	
H4	Motor 3 power interface	
H5	Motor 4 power interface	
H6	Motor 1 encoder interface	
H7	Motor 2 encoder interface	
H8	Motor 3 encoder interface	
H9	Motor 4 encoder interface	
H11	RS232、CAN bus interface	
JP2	CAN bus 120Ωresistance jump line	

7.2.2.2 H1, main power input

Table 4. IMDR4 main power input port

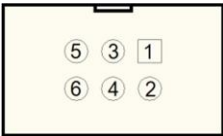| Pin No	Description	Note
1	GND	
2	GND	
3	VCC	
4	VCC	

7.2.2.3 H2、H3、H4、H5, Motor 1、Motor 2、 Motor 3 、Motor 4 power input

Table 5. IMDR4 Motor 1、Motor 2、 Motor 3 、Motor 4 power input port

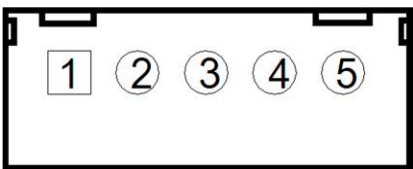| Pin No	Description	Note
1	Motor+	
2	Motor-	

7.2.2.4 H6、H7、H8、H9, Motor 1、Motor 2、 Motor 3 、Motor 4 encoder interface

Table 6. IMDR4 Motor 1、Motor 2、 Motor 3 、Motor 4 encoder port

Pin No	Description	Note
1	NC	
2	B	
3	5V	
4	A	
5	Z	
6	GND	

7.2.2.5 H11, RS232, CAN communication port

Table 7. IMDR4 RS232, CAN communication port

PIN number	description	remark
1	GND	
2	CANL	
3	CANH	
4	RXD	
5	TXD	

7.3   IFB1205 power and bus port module

7.3.1   Module summary

These modules are used for power supply and line-concentrating of component and equipment.
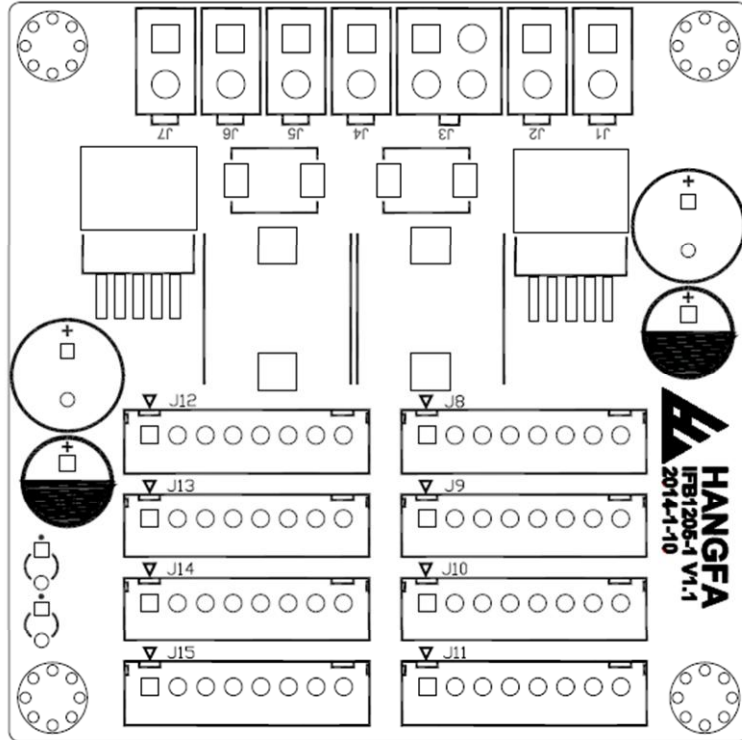
7.3.2 Port description

7.3.2.1 Port summary

Table 8. IFB1205 port summary

Port number	description	remark
J1	Indicator light access port	
J2	user charge port	
J3	IFB1205 power output port	Used for connect IMDR4 drive
J4	power main switch port	
J5	Fuse access port	
J6	battery access port	
J7	Charger access port	
J8	Standard power and bus port	J8、J9 port's 7、8 pin cross connect
J9	Standard power and bus port	
J10	Standard power and bus port	J10、J11 port's 7、8 pin cross connect
J11	Standard power and bus port	
J12	Standard power and bus port	J12、J13 port's 7、8 pin cross connect
J13	Standard power and bus port	
J14	Standard power and bus port	J14、J15 port's 7、8 pin cross connect
J15	Standard power and bus port	

7.3.2.2 J1, Indicator light access port

Table 9. IFB1205 Indicator light access port

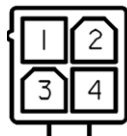| PIN number	description	remark
1	VCC	
2	GND	

7.3.2.3 J2, user charge port

Table 10. IFB1205 user charge port

PIN number	description	remark
1	VCC	
2	GND	

7.3.2.4 J3, power output

Table 11. IFB1205 power output port

PIN number	description	remark
1	GND	
2	GND	
3	VCC	
4	VCC	

7.3.2.5 J4, power main switch port

Table 12. IFB1205 power main switch port

PIN number	description	remark
1	Switch PIN1	
2	Switch PIN2	

7.3.2.6 J5, fuse port

Table 13. IFB1205 Fuse access port

PIN number	description	remark
1	Fuse PIN1	
2	Fuse PIN2	

7.3.2.7 J6, battery access port

Table 14. IFB 1205 battery access port

PIN number	description	remark
1	VCC	
2	GND	

7.3.2.8 J7, charger access port

Table 15. IFB1205 charger access port

| PIN number	description	remark
1	P+	
2	P-	

7.3.2.9 J8~J15, standard bus port

Standard port connector have A and B types, the different between them is serial thread order.

Standard port connector A(J8,J10,J12,J14)		Standard port connector B(J9,J11,J13,J15)	
Pin1	24V	Pin1	24V
Pin2	12V	Pin2	12V
Pin3	5V	Pin3	5V
Pin4	GND	Pin4	GND
Pin5	CANL	Pin5	CANL
Pin6	CANH	Pin6	CANH
Pin7	RXD	Pin7	TXD
Pin8	TXD	Pin8	RXD

Standard port connector use XH-254-8 white terminal. Please check following image.
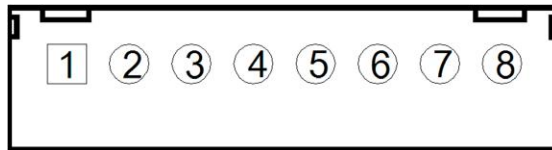
7.4   RHF 407 development board

Please check "RHF 407 user manual".

8   User extend

Hardware in the robot can be extending through many ways:

8.1   Bus extend

The equipment which have CAN bus port can access bus through 8 PIN standard ports on the IFB1205 board, and realize equipment connection. Meanwhile, it can realize connect two each other which have RS232 port through 8 PIN standard ports on the IFB1205 board.

8.2　RHF407 extend

The RHF407 development board has lots of source, it can access various equipment. Following source: CAN×2, RS232×2, TTL*1, RS485×1，SPI×1，I2C×1，ADC×8，DAC×2，PWM×8，LED×2，button×2, independence I/O×24, repeat use I/O×29, TF card port×1, RTC spare battery, Repeat use TFT LCD port×1.

8.3　Design your own main control unit

The users can design their own main control unite according to application requirement.

8.4　Accessories can be choose

Remote controller and receiver	motion sensor	electronic compass
Line sensor module	vision camera	speaker and microphone
Ultrasonic ranging sensor	GPS locator	WIFI to serial module
IR sensor module	accelerometer	WAN to serial module
Laser radar	gyroscope	Bluetooth to serial module
panoramic cameras	inclinometer	

9　Packing list:

1. robot platform(robot platform×1, QMA-10L Mecanum wheel×2, QMA-10R Mecanum wheel ×2, motor×4, Four-Axes Servo×1, Lithium battery×1, IFB1205×1)
2. Lithium battery charger
3. RHF407 development board
4. CD
5. Certificate
6. Packing list paper

10　Technical support and quality guarantee

Hangfa offers free lifetime technical support for Discovery Q2 in working days. And offers free warranty service for a year from delivering day.

HANGFA

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