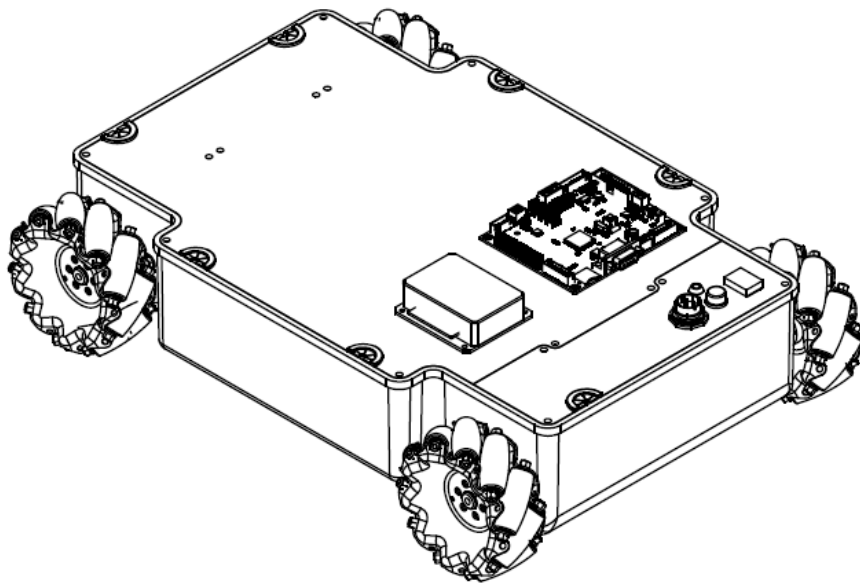# Compass Q2
# Four-wheel Omni-directional Robot Platform

### User Manual V1.2

Chengdu Hangfa Hydraulic Engineering Co., Ltd

Robot Division

Feb 3rd, 2017

## 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.

## Copyright Statement

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# CATALOGUE

# 1   Description

As economical small robot platform, the Compass series are aimed at offering a complete, multi-interfaced and highly reliable moving robot system at the best cost-performance. Compass Q2 is such a platform with four QMA-10 Mecanum wheels which are made by Hangfa itself. Compared to the traditional ones, the wheels are able to move laterally, rotate, or rotate when move laterally. The robot platform chassis is made by mold. Compass Q2 is driven by 4 high power 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

- 360 degree free movement
With 4 Mecanum wheels, the robot platform is able to move in all directions horizontally, and rotate in the same time.
- Suspension system
Rocker suspension structure enables the 4 wheels to touch the ground and be driven evenly. This suspension system can help reducing vibration when passing the rough ground.

- Wholly casted chassis
 This robot chassis is made by mold with strong structure. Our processing center keeps the high precise four-wheel relative position。 This chassis is much stronger than the welded chassis which is with big error and low precision.

- Precise Mecanum wheel
 The classic series QMA-10 Mecanum wheel is made by Hangfa with industrial grade quality. Each wheel roller is with two bearing which moves smoothly and steadily.

- Coreless DC servo motor
 The 4 coreless DC servo motors realize the high power density, high torque and quick speed response. The motor is with precise plant gearbox and 500RMP encoder.

- 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
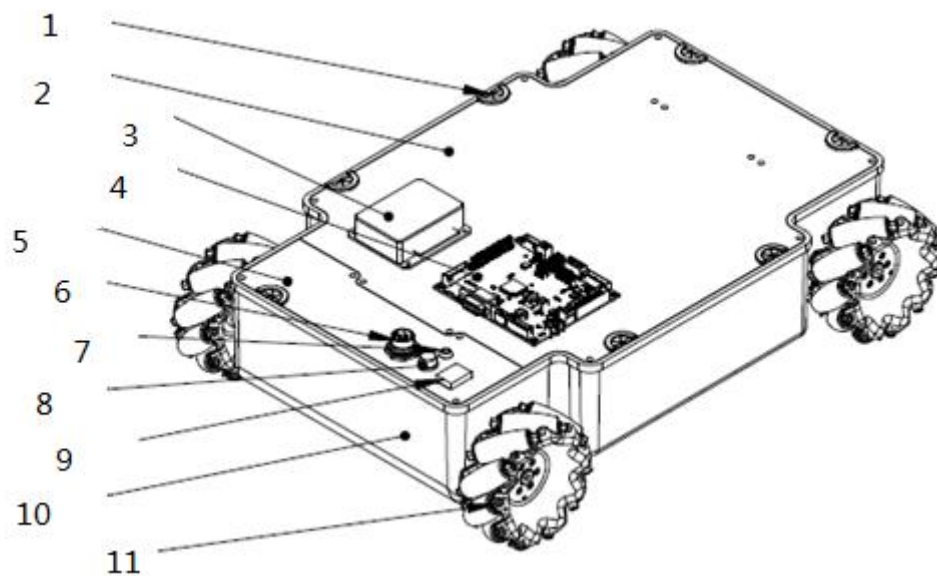


1、 wire hole

Wire from inside of the robot to outside.

2、 Big cover plate

3、 Wireless receiver module

4、 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.

5、 Small cover plate

6、 recharger socket

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

7、 power light

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

8、 power fuse

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

9、 power fuse

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

10、    Chassis body

11、    QMA-10 Mecanum wheel

## 3.2 Interior structure
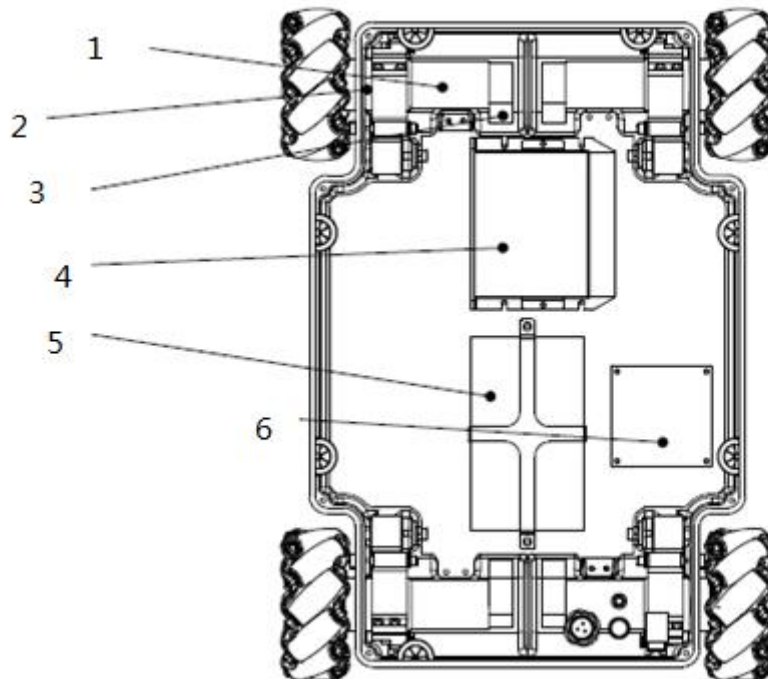


1、 Plant Gearbox

2、 Motor

3、 Encoder

4、 Driver

5、 Lithium Battery

6、 Power source and bus ports modular

# 4    Let your Compass 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：Assemble the fuse and turn on the power source 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.
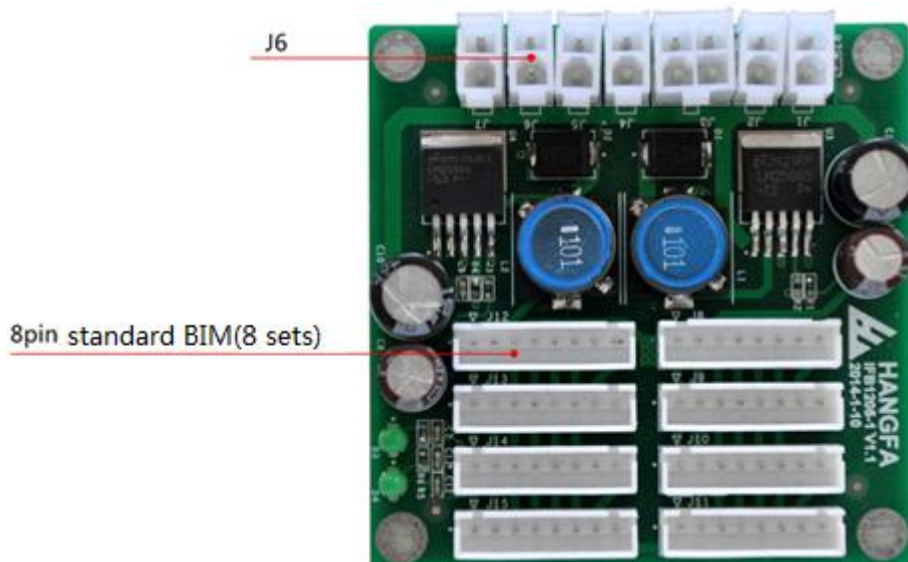


IFB1205 Power Source and BIM
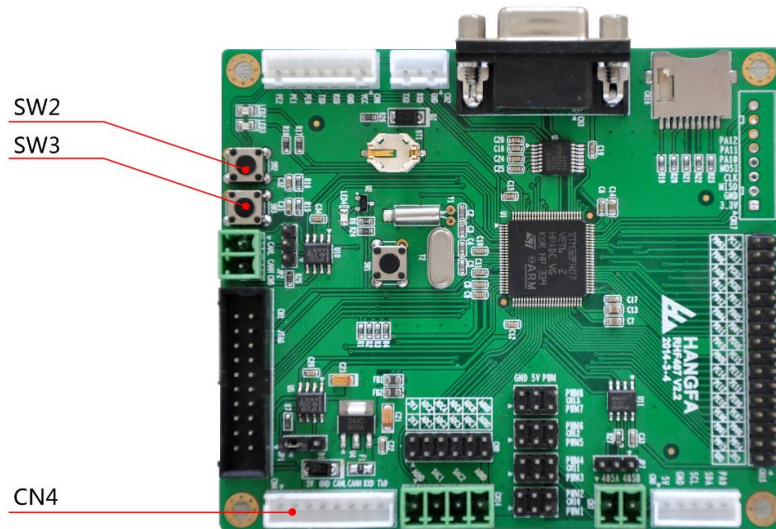
RHF407 Development Board

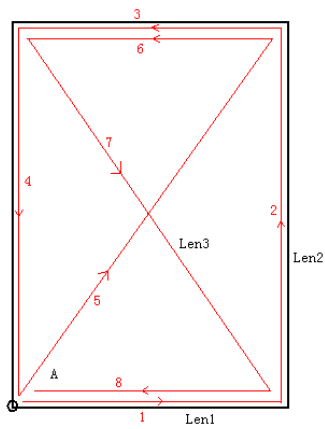## 4.1 Position Parallel Movement DEMO

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.Compass Q2 Specification Parameters

| | |
|---|---|
| Body structure: | Aluminum Alloy Molding Whole Shape |
| Dimension: | 450×330×115mm |
| Driven wheel: | QMA-10 Omni wheel |
| Diameter of driving wheel: | 101.6mm |
| Driven mode: | four-wheel independent drive |
| Suspend kind | rocker arm suspension |
| Minimum space between robot to ground: | 22.5mm |
| Rated load capacity: | 20kg |
| Maximum translational speed: | 0.75m/s |
| Maximum rotation speed: | 215°/s |
| Adaptive ground | indoor, bituminous ground ,concrete ground with little depression |
| Typical duration time | 10h(load capacity 10KG,moving speed |
| Standby time | >30h |
| Charging time | 4h |
| Support electricity output | 5V @ 2.5A |
| | 12V @ 2.5A |
| | (22~29.2V) @ >5A |
| Battery output | 24V |
| Battery capacity | 7.8Ah |
| Battery | lithium-ion battery |
| Battery fast change: | Support |
| Charger input voltage | AC100V~240V |
| Interface | direct plug-in |
| Charging current: | 3A |
| The default specification of The power of | 5×20/10A |

| insurance tube: | |
|---|---|
| DEMO development board model | STM32F407 |

# 6     Mechanical systems

## 6.1   Dimensions
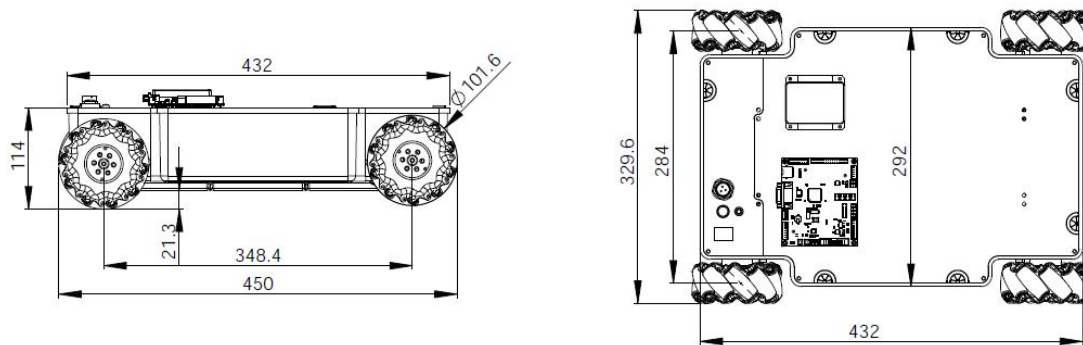


## 6.2   Main structure

     Compass Q2 is made by aluminum alloy casting process, the bottom and the inside with a protruding ribs, support ear, which will reduce the connection of platform, so it will make     full use of the material properties. The main structure is one-time producing which makes it with high strength and high rigidity; it avoids the shortcomings such as poor precision, poor integration error and poor rigidity of the assembly of the steel plate.

## 6.3   Motor

     Compass Q2 uses HFmotor-3230 motor. Test parameters:
Rated voltage: 24V
Rated current: 1.45A
Rated output power: 31W
No load rotating speed: 6450rpm
Rated rotating speed: 5230rpm
Reduction ratio: 24:1
Encoder :500 line/rev, A、B phase output
Encoder rated voltage: 5V

## 6.4 Omni wheel



Table2  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 materials | steel |
| Load capacity | 30kg |

## 6.5 Rocker suspension

Rocker suspension structure enables the 4 wheels to touch the ground and be driven evenly. This suspension system can help reducing vibration when passing the rough ground. The Polyurethane shock absorber helps reducing vibration when the platform is moving. In this way, the working environment of the added equipment would be improved.

## 6.6 Users extension platform

The plate on the robot is made of one big board and one small board. There is power source switch on the small board, please do not disassemble it. The big board is for user to extend. Users can add other equipment and structure to this board as required.

## 6.7 The thread hole

There are many thread holes on the plate with rubber ring. The hole is for connection of thread outside of the robot and inside of the robot. The half-opened thread ring only requires the thread to be pushed to the thread ring, no need to cross the plate.

# 7    Electric system

## 7.1    Electrical principle drawing
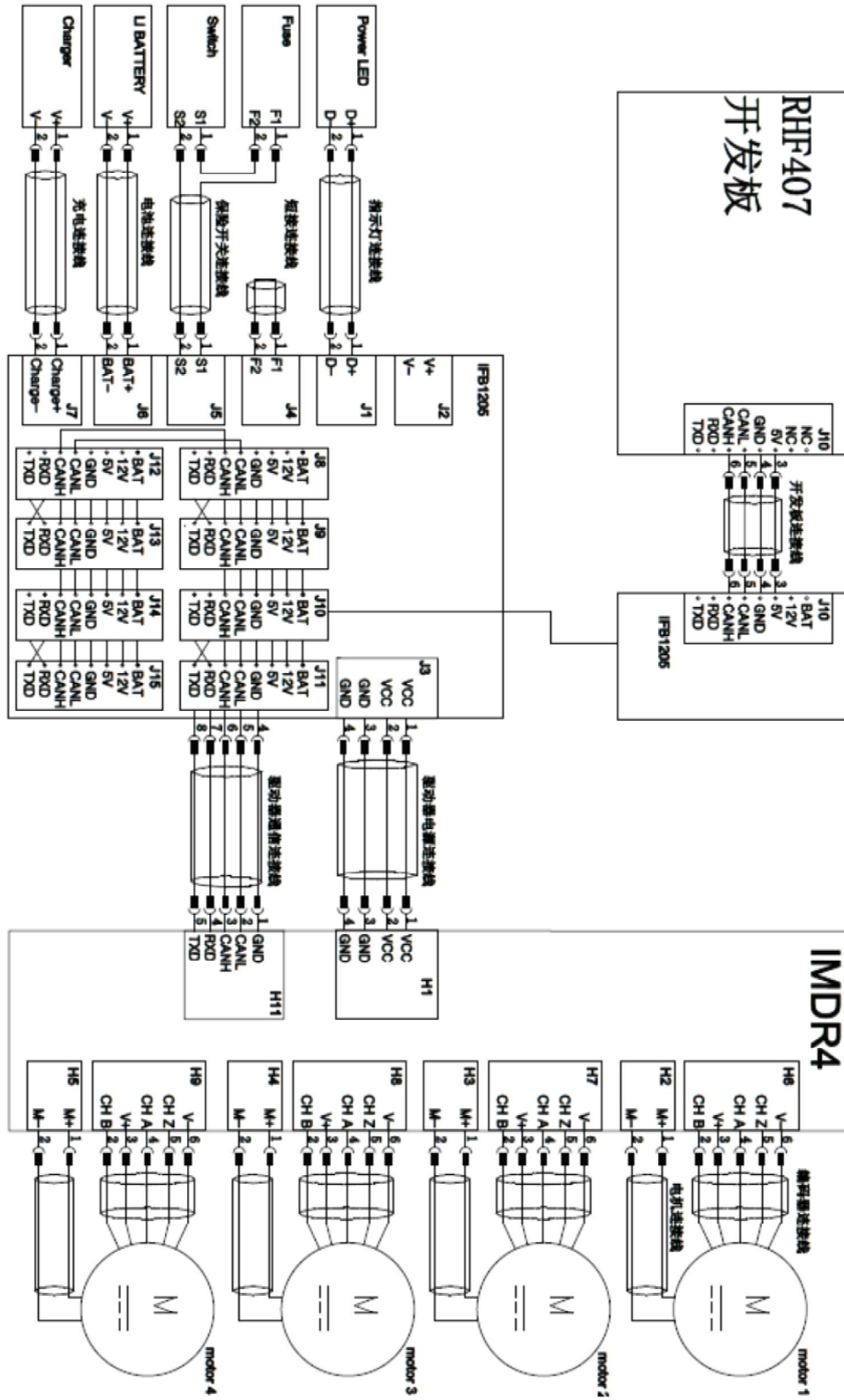
## 7.2 IMDR4 Four shaft driver

### 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 IMDR4 four shaft driver Can communication protocol , and MDR4 four shaft drive UART communication protocol .
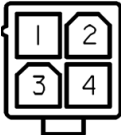
### 7.2.2 Interface description

#### 7.2.2.1 Interface summary

Table3 IMDR4 Interface summary

| Interface serial number | Description | Remark |
|---|---|---|
| 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 port.

Table4 IMDR4 main power input port

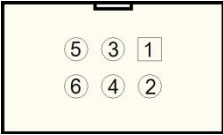| Pin No. | Description | note |
|---------|-------------|------|
| 1 | GND | |
| 2 | GND | |
| 3 | VCC | |
| 4 | VCC | |

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

Table 5 IMDR4 motor 1,2,3,4 Power interface

| Pin No. | Description | note |
|---------|-------------|------|
| 1 | M+，    Motor+ | |
| 2 | M-，    Motor+ | |

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

Table6 IMDR4 motor 1、2、3、4 encoder port

| PIN number | description | remark |
|------------|-------------|--------|
| 1 | NC | |
| 2 | CH B | |
| 3 | 5V | |
| 4 | CH A | |
| 5 | NC | |
| 6 | GND | |

### 7.2.2.5    H11, communication port

Table 7IMDR4 motor  1、2、3、4 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

This module is used for power supply and line-concentrating of component and equipment. Supply battery power and two way step-down powers to users' equipment. The module output eight way power port and bus port, the users' can use electricity and communication network easily for the equipment through these port.
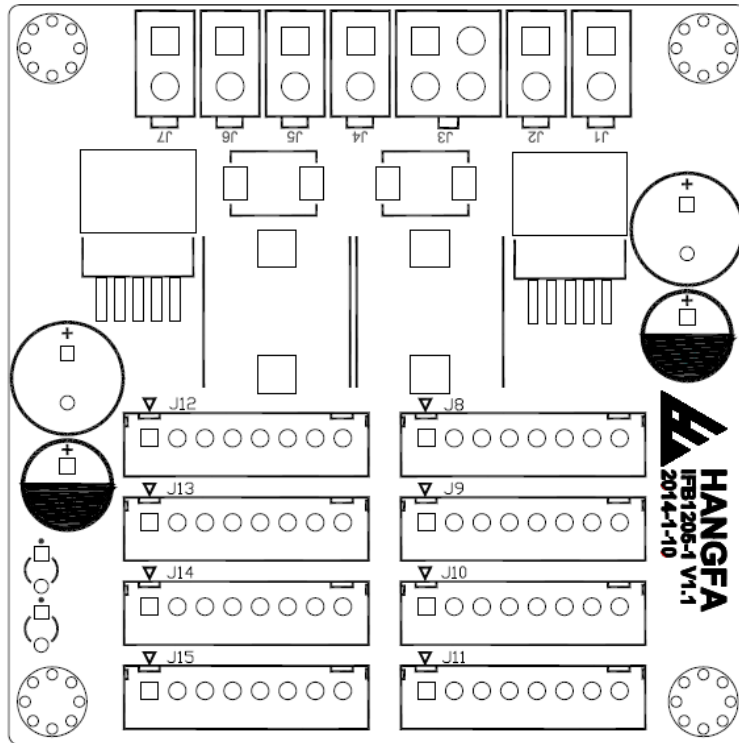


### **7.3.2** Port description

### 7.3.2.1   Port summary

Table8 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 | Fuse access port | |
| J5 | power main switch port | |
| J6 | battery access port | |
| J7 | Charger access port | |
| J8 | Standard power and bus port | J8、J9 port's 5、6 pin cross connect |
| J9 | Standard power and bus port | |

| J10 | Standard power and bus port | J10、J11 port's 5、6 pin cross connect |
|-----|------------------------------|----------------------------------------|
| J11 | Standard power and bus port | |
| J12 | Standard power and bus port | J12、J13 port's 5、6 pin cross connect |
| J13 | Standard power and bus port | |
| J14 | Standard power and bus port | J14、J15 port's 5、6 pin cross connect |
| J15 | Standard power and bus port | |

## 7.3.2.2 J1, Indicator light access port

Table 9IFB1205 Indicator light access port
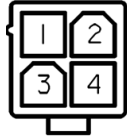
| PIN number | Description | Remark |
|------------|-------------|--------|
| 1 | D+ | |
| 2 | GND | |

## 7.3.2.3 J2, user charge port

Table 10IFB1205 user charge port

| PIN number | Description | Remark |
|------------|-------------|--------|
| 1 | 24V/BAT, voltage changed along with battery anode | |
| 2 | GND | |

## 7.3.2.4 J3, battery power output

Table 11 IFB1205 battery power output port

| PIN number | Description | Remark |
|------------|-------------|--------|
| 1 | GND | |
| 2 | GND | |
| 3 | 24V/BAT | |
| 4 | 24V/BAT | |

### 7.3.2.5 J4，Fuse Port

Table 12.Ifb1205 Fuse Access Port

| PIN number | Description | Remark |
|---|---|---|
| 1 | F1，Fuse PIN1 | |
| 2 | F2，Fuse PIN2 | |

### 7.3.2.6 J5，Power Main Switch Port

Table 13. Ifb1205 Power Main Switch Port

| Pin number | Description | Remark |
|---|---|---|
| 1 | S1，Switch PIN1 | |
| 2 | S2，Switch PIN2 | |

### 7.3.2.7 J6，Battery Access Port

Table 14. Ifb 1205 Battery Access Port

| Pin number | Description | Remark |
|---|---|---|
| 1 | BAT+ | |
| 2 | BAT- | |

### 7.3.2.8 J7，Charger Access Port
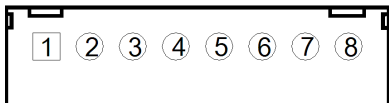
Table 15. Ifb1205 Charger Access Port

| Pin | Description | Remark |
|---|---|---|

| number | | |
|---|---|---|
| 1 | Charge+ | |
| 2 | Charge- | |

### 7.3.2.9  J8~J15，Standard Bus Port

Table 16.Ifb1205 Standard Power Bus Port

| Pin number | Description | Remark |
|---|---|---|
| 1 | 24V/BAT | |
| 2 | 12V | |
| 3 | 5V | |
| 4 | GND | |
| 5 | CANL | |
| 6 | CANH | |
| 7 | RXD | |
| 8 | TXD | |

## 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 Compass Q2 in working days. And offers free warranty service for a year from delivering day.

# HANGFA

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