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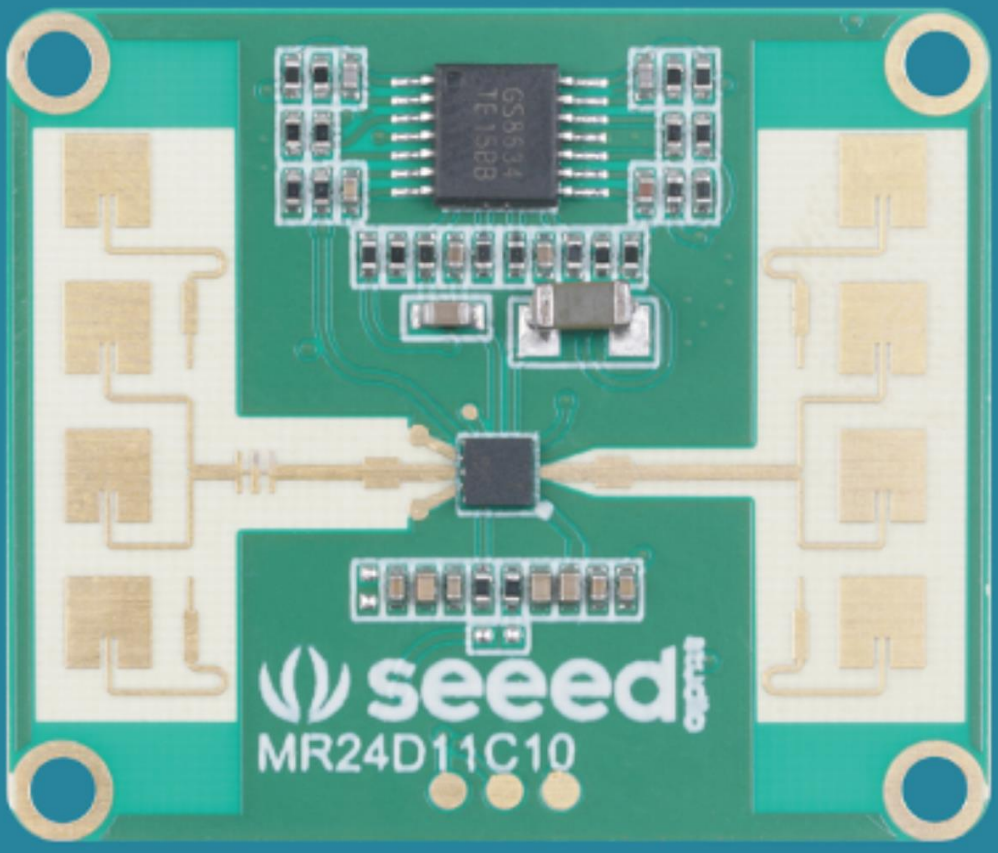
MR24HPB1

Human Presence Radar User Manual

V1.7



Catalog

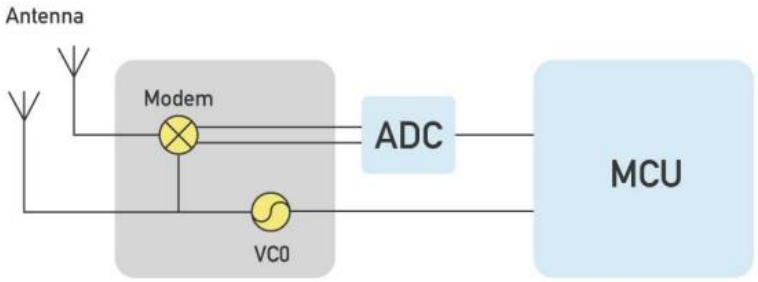
Overview

This document focuses on the use of the radar, the issues that need to be paid attention to in each phase, to minimize the design cost and increase the stability of the product, and to improve the efficiency of the project completion. This document focuses on the issues that need to be taken into account in each phase, in order to minimize the design cost and increase the stability of the product, and to improve the efficiency of the project completion.

From hardware circuit reference design, radar antenna and housing layout requirements, how to distinguish interference and multi-functional standard UART protocol output. The radar is a self-contained system.

This radar is a self-contained space sensing sensor, which consists of RF antenna, radar chip and high speed MCU. The radar is a self-contained sensor with a combination of RF antenna, radar chip and high-speed main frequency MCU. It can be equipped with a host computer or host computer to flexibly output detection status and data, and meet the needs of several groups of GPIOs. It can be equipped with a host computer or a host computer to flexibly output detection status and data, and meet several groups of GPIOs for user customization and development.

1. Working Principle



The radar transmits a 24G band millimeter wave signal, and the target reflects the electromagnetic wave signal, and demodulates it from the transmitted signal. The signal is demodulated, then amplified, filtered, ADC and other processing to obtain the echo demodulation signal data. In the MCU unit, the amplitude, frequency and phase of the echo signal are decoded, and the target signal is finally decoded. The target parameters (sleep quality, respiration, tossing, body movement, etc.) are measured and evaluated in the MCU.

2. Hardware Design Considerations

The rated supply voltage of the radar needs to meet 4.9 - 6V, and the rated current needs to be 200mA or more input is required. The power supply is designed to have a ripple of ⩽ 100mv.

2.1 Power supply can refer to the following circuit design

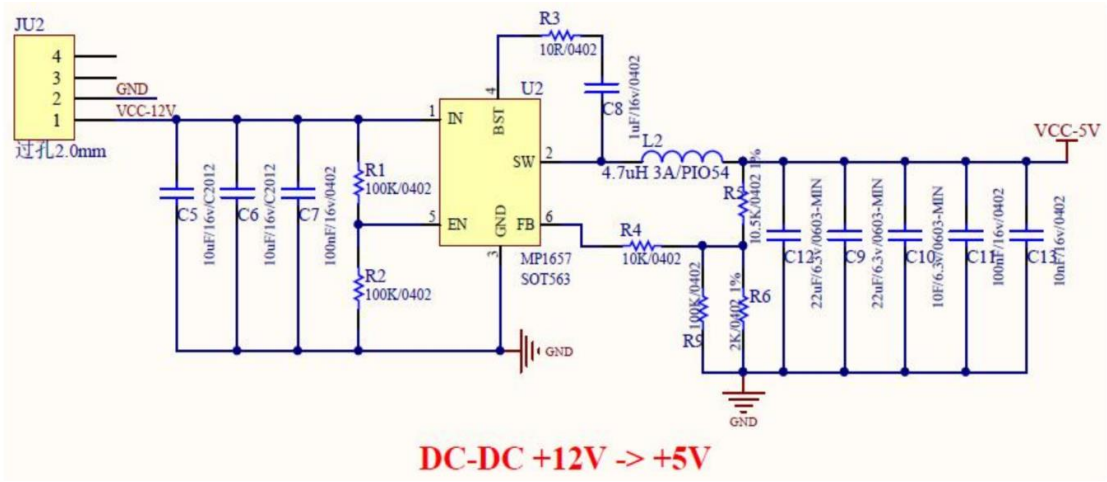


Figure 1

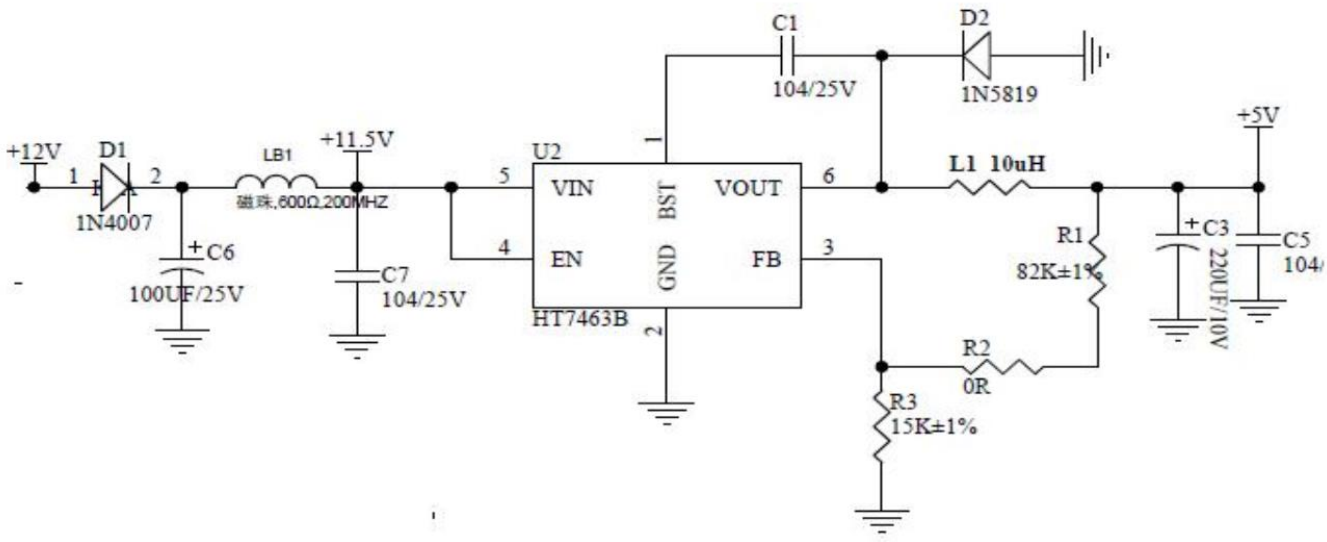


Figure 2

2.2 Wiring Diagram

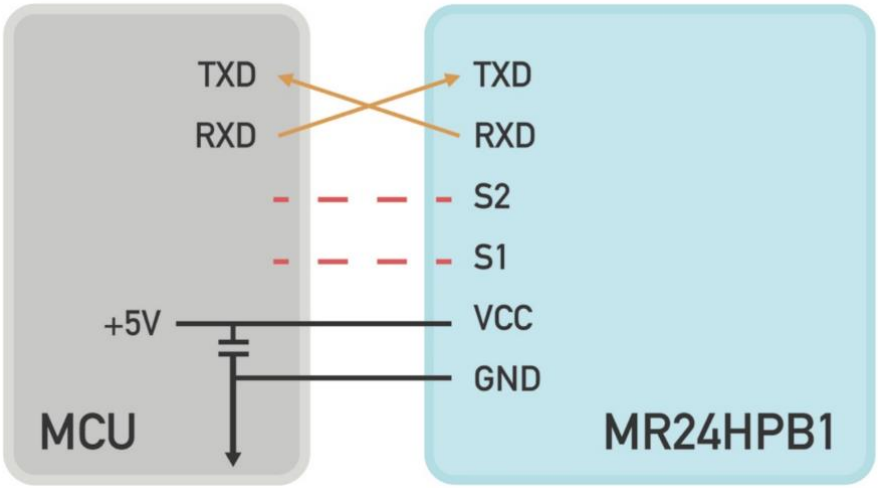


Figure 3 Module and peripheral wiring diagram

3. Antenna and housing layout requirements

PCBA: Need to keep the radar patch height ⩾ 1mm higher than other devices

Housing structure: need to keep the radar antenna surface and the housing surface have 2 - 5mm distance

Housing detection surface: non-metallic housing, need to be straight to avoid bending surface, affect the performance of the whole sweep surface area Performance

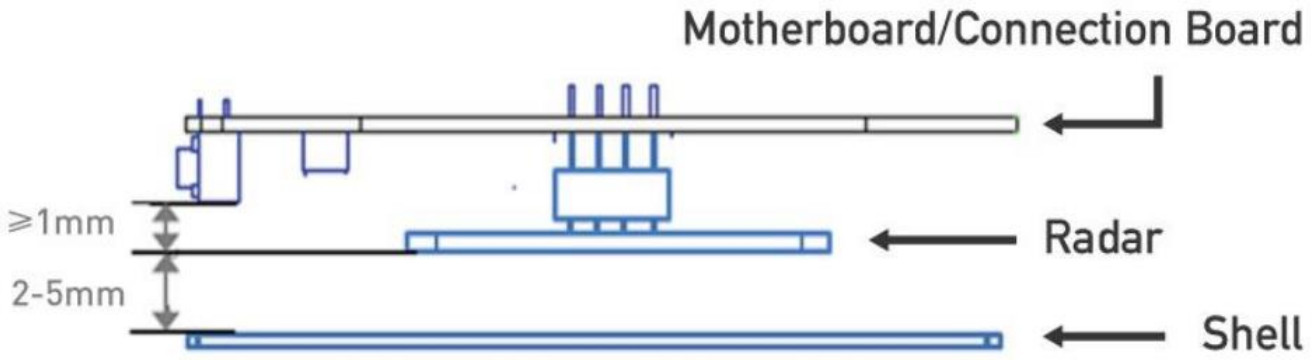


Figure 4

4. Electrostatic protection

Radar products with electrostatic sensitive circuitry inside, vulnerable to electrostatic hazards, so need to be in transport, storage, work and handling process to do a good job of electrostatic protection, do not touch the grasp of the radar hands. Therefore, it is necessary to do a good job in the transportation, storage, work and picking up process of static protection, do not touch and grab the radar module antenna surface and connector pins, only touch the corners. Do not touch the surface of the radar module antenna and connector pins with your hands, only touch the corners.

When handling the radar sensor, please wear anti-static gloves as much as possible.

5. Interference terms

5.1 Reported information is misidentified as occupied while unoccupied

Under normal circumstances, the sensor will accurately determine the body's sedentary state and movement state, and output the corresponding vital signs and other information. The influencing factors leading to such errors may be the following possibilities.

A. Strong penetration ability of the sensor, the movement behind the doorway or boarded wall is detected.

Adjustment: Reduce the radar sensitivity and set the radar scene according to the range and environment.

B. The lower side of the sensor is facing the running air conditioner, fan and other motion equipment.

Adjustment method: adjust the radar position, do not directly face the air conditioner, fan and other equipment.

C. Air conditioning wind caused by the shaking of objects.

Adjustment method: cotton, non-metal objects will not cause false alarms, metal objects need to be fixed.

D. Radar is not fixed, its own vibration caused by false alarms.

Adjustment method: avoid supporting shaking, vibration.

E. Pets, flying birds and other occasional movement of living organisms in the detection environment.

Adjustment method: As the sensor measures the value of spatial fluctuations, the sensitivity is very high, it is impossible to exclude this interference, try not to have in the environment in addition to the object of detection of living organisms.

F. Power interference, resulting in occasional misjudgment.

Adjustment method: try to keep the supply current stable and reduce ripple.

5.2 The current environment is occupied, but the sensor anomaly is reported as unoccupied.

The sensor sends and receives signals through electromagnetic waves to determine the presence of the human body. The closer the distance to the radar, the higher the accuracy.

A. The human body is outside the detection range of the sensor.

Adjustment method: adjust the installation angle of the sensor. The measurement range of the sensor in different environments, the electromagnetic wave reflection area is different, the scanning area will have a small difference.

B. Metal obscuring the sensor causes false output.

Excessively thick desks and chairs, metal seats. Will block the electromagnetic wave penetration, resulting in misjudgment.

6. Detailed explanation of functions

6.1 Function Description

Function	Status change time/function explanation
DP1: occupied/unoccupied	From unoccupied to occupied, report within 0.5s From occupied to unoccupied, report within 50 s
DP2: Someone is stationary/someone is active	Reported within 0.5 seconds
DP3: Someone close to the device/ Someone moving away from the device / Someone moving without direction	Reported within 0.5s Continuous 3s close/away will report continuous close/continuous away status
DP4: Body movement parameter	Reported within 1 seconds
DP5: Sensitivity setting 1 - 3 gears	Default is sensitivity 3 Support 3 gears Adjustment, the higher the sensitivity, the larger the stationary detection area
DP7: Scene mode (default, regional detection, bathroom, hotel, bedroom, office)	According to the size of the area, adapted to different scenes

6.2 Description of Body Movement Parameters

Body Movement Parameters		
0%	Unoccupied	Environmental Unmanned
1%	Resting (sleeping)	Only breathing without body movements
2%-30%	Micromovement	Only minor head or limb movements
31%-60%	Walking/rapid body movements	Slower body movements
61%-100%	Running/proximity large movements	Rapid body movements

7. Protocol Description

This protocol is applied to the communication between the 24G millimeter wave Human Stationary Presence Module and the host computer.

This protocol outlines the radar workflow, briefly introduces the interface protocol composition architecture, and The interface protocol structure is briefly introduced, and the related radar work requires control commands and data.

Interface level: TTL

Baud rate: 9600bps

Stop bit: 1

Data bits: 8

Parity check: None

8. Communication command and parameter definition

8.1 Frame structure definition and description

8.1.1Definition of frame structure

Frame Header	Data Length		Function Code	Address_1	Address_2	Data	Checksum	
0x55	Length_L	Length_H	Command	Address_1	Address_2	Data	Crc16_L	Crc16_H
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	n Byte	1 Byte	1 Byte

8.1.2 Description of the frame structure

a. Start code: 1Byte, fixed to 0x55.

b. Data length: 2 Byte, low byte before, high byte after.

Length = Data Length + Function Code + Address Code 1 + Address Code 2 + Data + Checksum.

c. Function code: 1 Byte

Read command: 0x01

Write command: 0x02

Passive report command: 0x03

Active report command: 0x04

d. Address code: Address code 1 indicates the function classification, and address code 2 indicates the specific function.

See the description of address assignment and data information.

e. Data: n Byte

f. Checksum: 2 Byte, low byte in front, high byte at the end.

Use CRC16 checksum, see Appendix 1 for reference code

7.2 Description of address assignment and data information

Function Code	Address_1	Address_2	Data	Note
Read command 0x01	Identification Inquiry 0x01	Device ID 0x01	None	
		Software Version 0x02	None	
		Hardware Version 0x03	None	
		Protocol Version 0x04	None	
	Sensor Information Inquiry 0x03	Environmental Status 0x05	None	
		Body movement parameters 0x06	None	
	System parameter inquiry 0x04	Threshold gears 0x0C	None	
		Scene setup 0x10	None	
		Forced access to unoccupied stalls query 0x12	None	
Write command 0x02	System parameter inquiry 0x04	Threshold gears 0x0C	Enumeration Scope 1~3	Corresponding to 1, 2, 3 gears respectively (default 3 gears) the greater the gear, the more sensitive.
		Scene Setup 0x10	Default Mode 0x00	
			Area detection (top-mounted) 0x01	
			Bathroom (top-mounted) 0x02	
			Bedroom (top-mounted) 0x03	
			Living room (top loading) 0x04	
			Office (top loading) 0x05	
			Hotel (top loading) 0x06	

Function Code	Address_1	Address_2	Data	Note
Write command 0x02	System parameter inquiry 0x04	Forced into unoccupied gears 0x12	Do not use the forced entry unoccupied function. 0x00	
			10s 0x01	
			30s 0x02	
			1min 0x03	
			2min 0x04	
			5min 0x05	
			10min 0x06	
			30min 0x07	
			60min 0x08	
	Other functions 0x05	Reboot 0x04	None	
		Start OTA upgrade 0x08	4Byte integer data (firmware package size) + 15Byte firmware information	
		Upgrade package transfer 0x09	Packet offset (4Byte) + Packet (1024Byte)	
		End of upgrade information 0x0A	Fixed characters 0x0F	
Passive report command 0x03	Report module identification 0x01	Device ID 0x01	12 Byte Data	
		Software Version 0x02	15 Byte Data	
		Hardware Version 0x03	8 Byte Data	
		Protocol Version 0x04	8 Byte Data	
	Report sensor information 0x03	Environmental Status 0x05	unoccupied 0x00 0xFF 0xFF occupied & static 0x01 0x00 0xFF occupied & moving 0x01 0x01 0x01	
		Body movement parameters 0x06	4 Byte Float Data (See Appendix 2)	
	Report system parameter 0x04	Threshold gears 0x0C	Current gear value 0x01~0x02	
		Scene setup 0x10	Default Mode 0x00	
			Area detection (top-mounted) 0x01	
			Bathroom (top-mounted) 0x02	
			Bedroom (top-mounted) 0x03	
			Living room (top loading) 0x04	
			Office (top loading) 0x05	
			Hotel (top loading) 0x06	

Function Code	Address_1	Address_2	Data	Note
Passive report command 0x03	Report system parameter 0x04	Forced into unoccupied gears 0x12	Do not use the forced entry unoccupied function. 0x00	
			10s 0x01	
			30s 0x02	
			1min 0x03	
			2min 0x04	
			5min 0x05	
			10min 0x06	
			30min 0x07	
			60min 0x08	
	Report other information 0x05	Feedback OTA upgrade begins 0x08	Failure 0x00 Success 0x01	
		Feedback OTA transmission 0x09	Fixed characters 0x0F	
Proactive report command 0x04	Report module identification 0x01	Software Version 0x02	15 Byte Data	
	Report sensor information 0x03	Environmental Status 0x05	unoccupied 0x00 0xFF 0xFF occupied & static 0x01 0x00 0xFF occupied & moving 0x01 0x01 0x01	
		Body movement parameters 0x06	4 Byte Float Data (See Appendix 2)	
		Approach/away status 0x07	None 0x01 0x01 0x01 Approach 0x01 0x01 0x02 Away 0x01 0x01 0x03 Sustained Approach 0x01 0x01 0x04 Sustained Away 0x01 0x01 0x05	
	Report other information 0x05	Heartbeat Package 0x01	unoccupied 0x00 0xFF 0xFF occupied & static 0x01 0x00 0xFF occupied & moving 0x01 0x01 0x01	
		Abnormal Reset 0x02	0x0F	When the radar is restarted or re-powered, an abnormal reset command will be reported first, and then the initialization process will start. Finally, the initialization success command is reported, which means the radar initialization is successful and starts normal operation.
		Initialization successful 0x0A	0x0F	

Description:

1) The read/write commands are sent from the host computer to the sensor.
2) The report command is a message sent from the radar to the host computer.
3) Sensitivity is 1-3 gears, default 3 gears, the greater the gear, the more sensitive.

Appendix 1: About the calculation of check digit

```
const unsigned char cuc_CRCHi[256]=
{
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40
};

const unsigned char cuc_CRCLo[256]=
{
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7,
0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E,
0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9,
0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,
0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32,
0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D,
0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,
0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF,
0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
```

```
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1,
0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,
0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB,
0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA,
0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,
0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97,
0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E,
0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89,
0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83,
0x41, 0x81, 0x80, 0x40
};


static unsigned short int us_CalculateCrc16(unsigned char *lpuc_Frame, unsigned short int lus_Len)
{
unsigned char luc_CRCHi = 0xFF;
unsigned char luc_CRCLo = 0xFF;
int li_Index=0;

while(lus_Len--)
{
li_Index = luc_CRCLo ^ *( lpuc_Frame++);
luc_CRCLo = (unsigned char)( luc_CRCHi ^ cuc_CRCHi[li_Index]);
luc_CRCHi = cuc_CRCLo[li_Index];
}
return (unsigned short int )(luc_CRCLo << 8 | luc_CRCHi);
}
```

Appendix 2: Analysis codes for motor sign parameters

```
1. typedef union
2. {
3. unsigned char Byte[4];
4. float Float;
5. }Float_Byte;
6.
7. void main()
8. {
9. Float_Byte fb;
10. fb.Byte[0] = 0x9A;
11. fb.Byte[1] = 0xFB;
12. fb.Byte[2] = 0xE7;
13. fb.Byte[3] = 0x3F;
14. printf("%f\ r\ n",fb.Float);
15. }
```