77G Obstacle Avoidance Radar

（SR-PA77A）

User Manual

Version：V1.0

NANORADAR

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Disclaimers

Thanks to purchase this product. There is web pages about NRA24 altimeter in our official website (www.nanoradar.cn).You can find the latest product information and user manual on the pages. The user manual is subject to change without notice.

Please read this manual carefully before using this product. Once used, it is deemed to have recognized and accepted the content of this manual. Please strictly follow the manual to install and use the product. Any improper use may cause damage or injury, and Nanoradar would not bear the corresponding loss and liability.

Version History

Date	Version	Description
2019-04-23	1.0	SR-PA77A user manual v1.0

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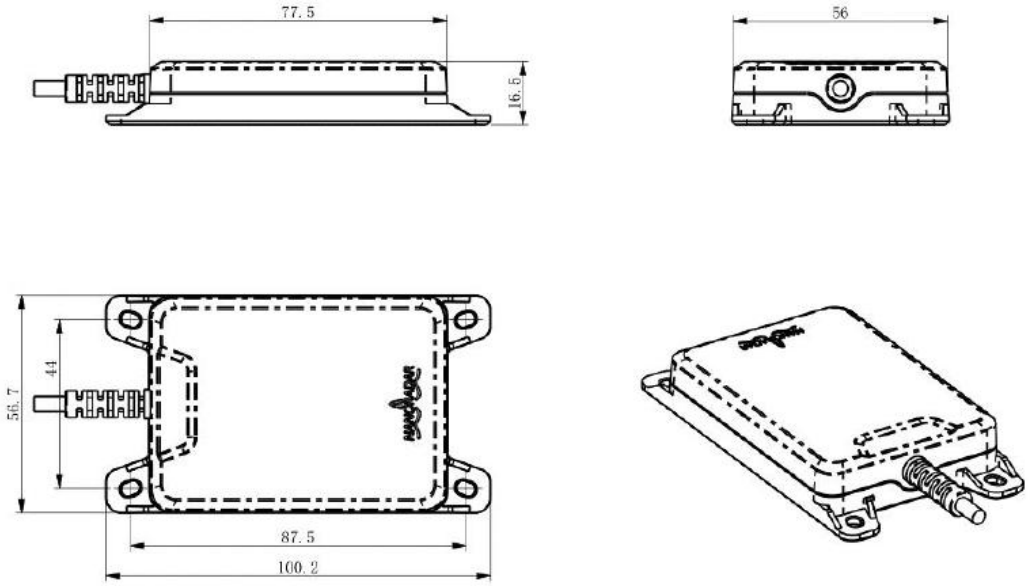
1 SR-PA77A Introduction

SR-PA77A 77G radar millimeter wave radar obstacle avoidance system specially developed for industrial drones. The system can directly connect to the DJI A3/N3 FCU, Pixhawk and other flight platforms . The product is a single-axis PTZ based obstacle avoidance radar system, which can maintain its self-stabilization during flight, and keep detecting the front , free from any flight action. Integrated with a drone ground station APP. the system enable done autonomously hovering in various modes such as manual flight, route flight, return flight when obstacles detected and APP alarm raised. In this case, the system can avoid the done accident as much as possible.



Pic 1 SR-PA77A outline

2 Precautions

(1) The power supply pin needs to be externally connected to a 5V DC regulated power supply;

(2) Keep the antenna interface in the same direction with the drone heading direction and make sure no other cover in front of the radar.

3 Radar Parameter

Table 1 Parameter

Parameter	Specification
Transmitting frequency	76.00-77GHZ
Detection range	≥100m

Measurement accuracy	±0.18m
Beam wave width	Azimuth110°，Elevation 15.6°
Interface	UART
Working voltage	5VDC
Refresh rate	50Hz
Consumption	1.5W(typical value)
Working Temperature	-40~80℃
Weight	90g
Dimension	100×57×16.5mm(LxWxH)

4 Quick use steps

4.1 Pin Definition

SR-PA77A Interface pin definitions, as shown in Table 2:

Table 2 SR-PA77A pin definition

Pin	Definition	Range
1	VCC(red)	5V DC
2	GND(black)	-
3	UART_RX (Yellow)	TTL 3.3V DC
4	UART_TX (Green)	TTL 3.3VDC

4.2 Test

Use USB to serial device to connect the output serial port, connect the USB port to the PC serial port debugging assistant software, the radar output data will be displayed. For details, please refer to the serial data protocol description. The test tools or software is shown in the following table:

Table 3 Product test tool

No	Device	Qty
1	SR-PA77A	1
2	PC	1
3	USB to TTL adapter	1
4	5V power adapter	1

5	Serial port debugging assistant software	1

Note: The TX and RX pins of the USB to TTL adapter and the TX and RX pins of the SR-PA24R Radar need to be cross-connected.

5Data Protocol

The 77 G radar altimeter outputs data through the serial port, 115200bps, 8N1.

5. 1 Radar Uart communication protocol

77Ghz radar uart transmission rate is 50Hz,
Header byte D1 D2 D3 D4 D5 D6 D7 D8 CRC8

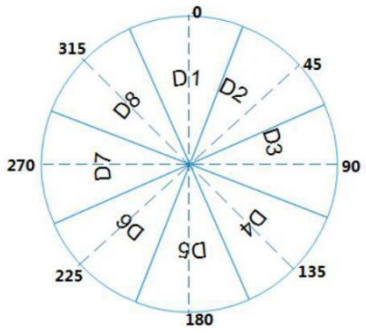
Table 4 Radar output protocol

Byte	Description	Type	Unit	Explanation	remark
byte0	Header byte1	uint8_t		Fixed as‘T’，0x54	
byte1	Header byte2	uint8_t		Fixed as‘H’，0x48	
byte2~3	D1	uint16_t	cm	0 degree sector obstacle	
byte4~5	D2	uint16_t	cm	45 degree sector obstacle	
byte6~7	D3	uint16_t	cm	90 degree sector obstacle	
byte8~9	D4	uint16_t	cm	135 degree sector obstacle	
byte10~11	D5	uint16_t	cm	180 degree sector obstacle	
byte12~13	D6	uint16_t	cm	225 degree sector obstacle	
byte14~15	D7	uint16_t	cm	270 degree sector obstacle	
byte16~17	D8	uint16_t	cm	315 degree sector obstacle	
byte18	CRC8	uint8_t		CRC8 verify	Refer to below description

Obstacle distance: unit: centimeter; high 8 digits in front, lower 8 digits in the back, for example 0 degree sector obstacles distance is 0x07D0, byte 2=0x07, byte 3=0xD0, then the actual distance is 20m.

Note: Command shall be sent no matter with or without radar data. When the data is invalid, DX fills in 0xFFFF. 77G radar obstacle avoidance system

Output D1, D2, D8 sector obstacle distance, other sectors are invalid data, filled with 0xFFFF;



Pic 2 Sector Illustration

5. 2 Radar output CRC8 verify

Crc.cpp：

```
static const uint8_t crc8_table[] = {
0x00, 0x07, 0x0e, 0x09, 0x1c, 0x1b, 0x12, 0x15, 0x38, 0x3f, 0x36, 0x31,
0x24, 0x23, 0x2a, 0x2d, 0x70, 0x77, 0x7e, 0x79, 0x6c, 0x6b, 0x62, 0x65,
0x48, 0x4f, 0x46, 0x41, 0x54, 0x53, 0x5a, 0x5d, 0xe0, 0xe7, 0xee, 0xe9, 0xfc,
0xfb, 0xf2, 0xf5, 0xd8, 0xdf, 0xd6, 0xd1, 0xc4, 0xc3, 0xca, 0xcd, 0x90, 0x97,
0x9e, 0x99, 0x8c, 0x8b, 0x82, 0x85, 0xa8, 0xaf, 0xa6, 0xa1, 0xb4, 0xb3,
0xba, 0xbd, 0xc7, 0xc0, 0xc9, 0xce, 0xdb, 0xdc, 0xd5, 0xd2, 0xff, 0xf8, 0xf1,
0xf6, 0xe3, 0xe4, 0xed, 0xea, 0xb7, 0xb0, 0xb9, 0xbe, 0xab, 0xac, 0xa5, 0xa2,
0x8f, 0x88, 0x81, 0x86, 0x93, 0x94, 0x9d, 0x9a, 0x27, 0x20, 0x29, 0x2e,
0x3b, 0x3c, 0x35, 0x32, 0x1f, 0x18, 0x11, 0x16,
0x03, 0x04, 0x0d, 0x0a, 0x57, 0x50, 0x59, 0x5e, 0x4b, 0x4c, 0x45, 0x42,
0x6f, 0x68, 0x61, 0x66, 0x73, 0x74, 0x7d, 0x7a, 0x89, 0x8e, 0x87, 0x80,
0x95, 0x92, 0x9b, 0x9c, 0xb1, 0xb6, 0xbf, 0xb8, 0xad, 0xaa, 0xa3, 0xa4,
0xf9, 0xfe, 0xf7, 0xf0, 0xe5, 0xe2, 0xeb, 0xec, 0xc1, 0xc6, 0xcf, 0xc8, 0xdd,
0xda, 0xd3, 0xd4, 0x69, 0x6e, 0x67, 0x60, 0x75, 0x72, 0x7b, 0x7c, 0x51,
0x56, 0x5f, 0x58, 0x4d, 0x4a, 0x43, 0x44, 0x19, 0x1e, 0x17, 0x10,
0x05, 0x02, 0x0b, 0x0c, 0x21, 0x26, 0x2f, 0x28, 0x3d, 0x3a, 0x33, 0x34,
0x4e, 0x49, 0x40, 0x47, 0x52, 0x55, 0x5c, 0x5b, 0x76, 0x71, 0x78, 0x7f,
0x6a, 0x6d, 0x64, 0x63, 0x3e, 0x39, 0x30, 0x37, 0x22, 0x25, 0x2c, 0x2b,
0x06, 0x01, 0x08, 0x0f, 0x1a, 0x1d, 0x14, 0x13, 0xae, 0xa9, 0xa0, 0xa7, 0xb2,
0xb5, 0xbc, 0xbb, 0x96, 0x91, 0x98, 0x9f, 0x8a, 0x8d, 0x84, 0x83, 0xde, 0xd9,
```

```
    0xd0, 0xd7, 0xc2, 0xc5, 0xcc, 0xcb, 0xe6, 0xe1, 0xe8, 0xef, 0xfa, 0xfd, 0xf4,
    0xf3
};

uint8_t crc_crc8(const uint8_t *p, uint8_t len)
{
   uint16_t i; uint16_t crc
   = 0x0;

   while (len--)
  {
        i = (crc ^ *p++) & 0xFF;
        crc = (crc8_table[i] ^ (crc << 8)) & 0xFF;
   }

   return crc & 0xFF;
}
```

Call mode: crc8 = crc_crc8 (buffer, 18); / / buffer is the data receive buffer array

6 Open source platform

The SR-PA77A is compatible with the open source flight control altimeter protocol and can be directly connected to the general open source flight control platform. The following is a brief description of the integrated application settings of the SR-PA77A on the APM flight control platform.

Flight Control Hardware: PixhawkV3

Flight Control Software: ArduPilot Copter 3.5.5

Ground station software: MissionPlanner 1.3.62

6. 1 Radar installation and wiring

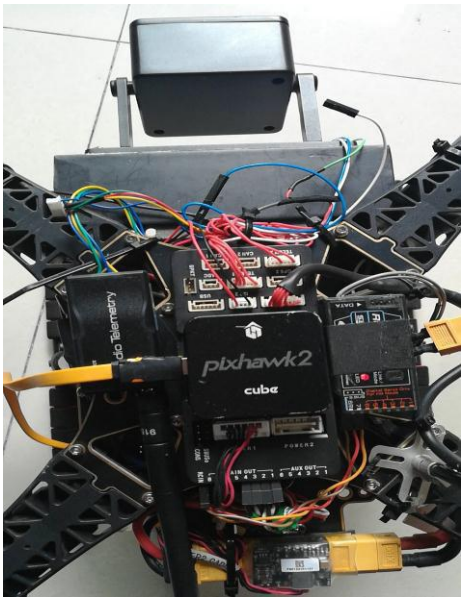
The radar serial port is connected to the pixhawk TELEM2 interface. The radar power supply needs to be powered separately. The interface definition is as follows:

TELEM 1 & 2

Pin #	Name	Dir	Wire Color	Description
1	VCC_5V	out	red / gray	Supply to GPS from AP
2	MCU_TX	out	yellow / black	3.3V-5.0V TTL level, TX of AP
3	MCU_RX	in	green / black	3.3V-5.0V TTL level, RX of AP
4	MCU_CTS (TX)	out	gray / black	3.3V-5.0V TTL level or TX of AP
5	MCU_RTS (RX)	in	gray / black	3.3V-5.0V TTL level or RX of AP
6	GND	-	black	GND connection

Pic 2 pixhawk TELEM2 interface definition

For the installation method, please refer to the following figure (taking the D600 M600 Pro flight control platform as an example):

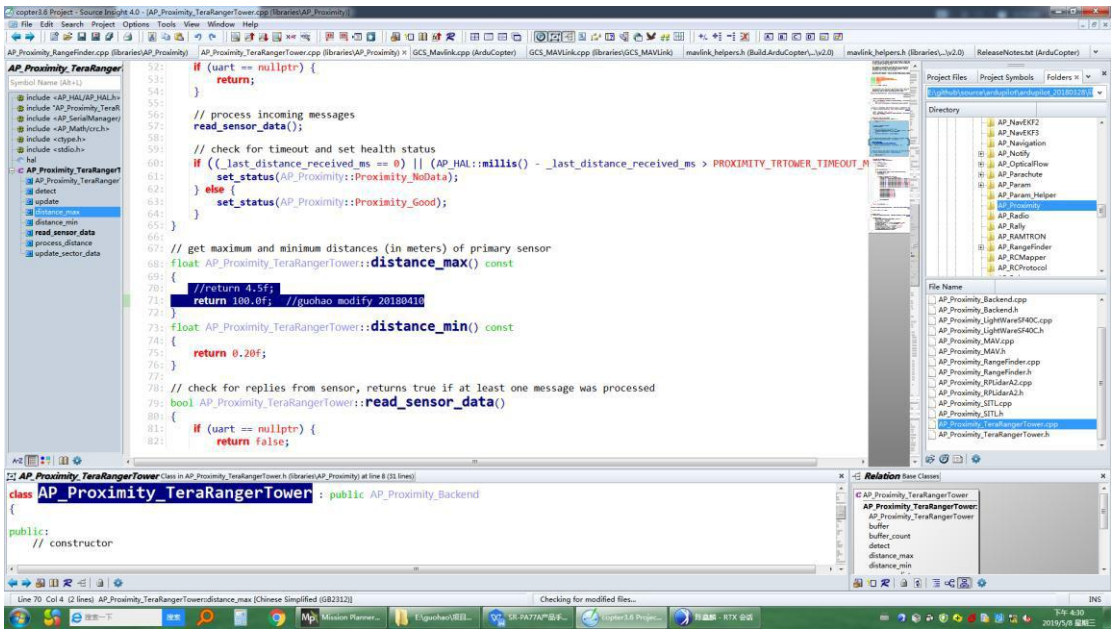


Pic 3 Radar Installation reference

6. 2 MissionPlanner Ground station for flight control parameter setting

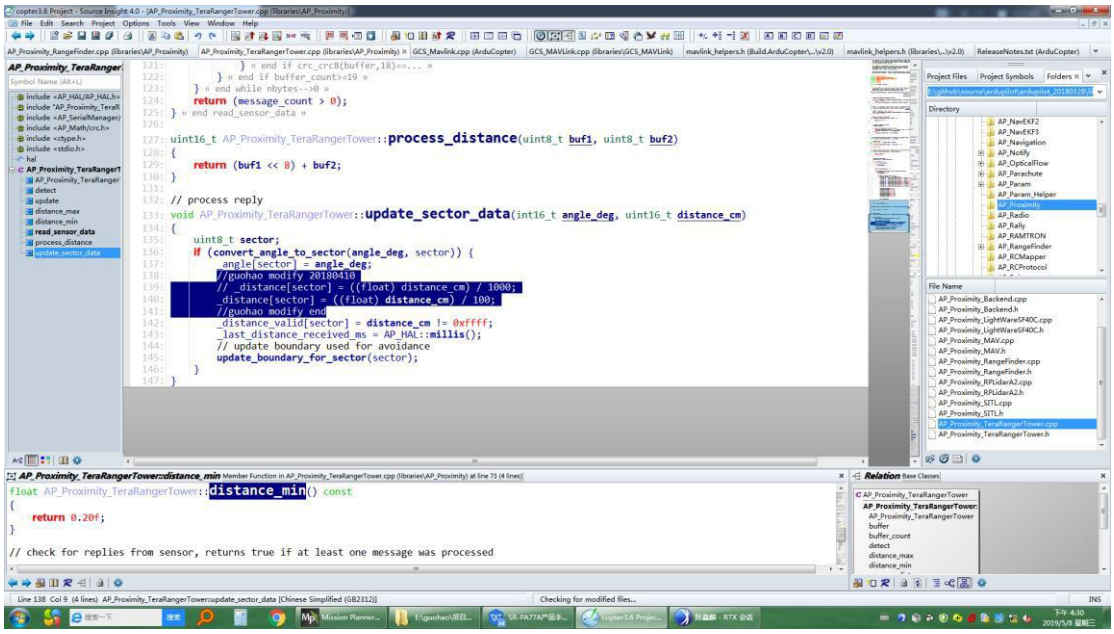
The obstacle avoidance radar uses the Lidar360 protocol. Because the maximum measurement distance is limited, you need to modify the AP_Proximity_TeraRangerTower.cpp file in the AP_Proximity library under the libraries directory, as shown below:

（1）Modify the maximum measurement distance to 100m



Pic 4 Modify the maximum measurement distance

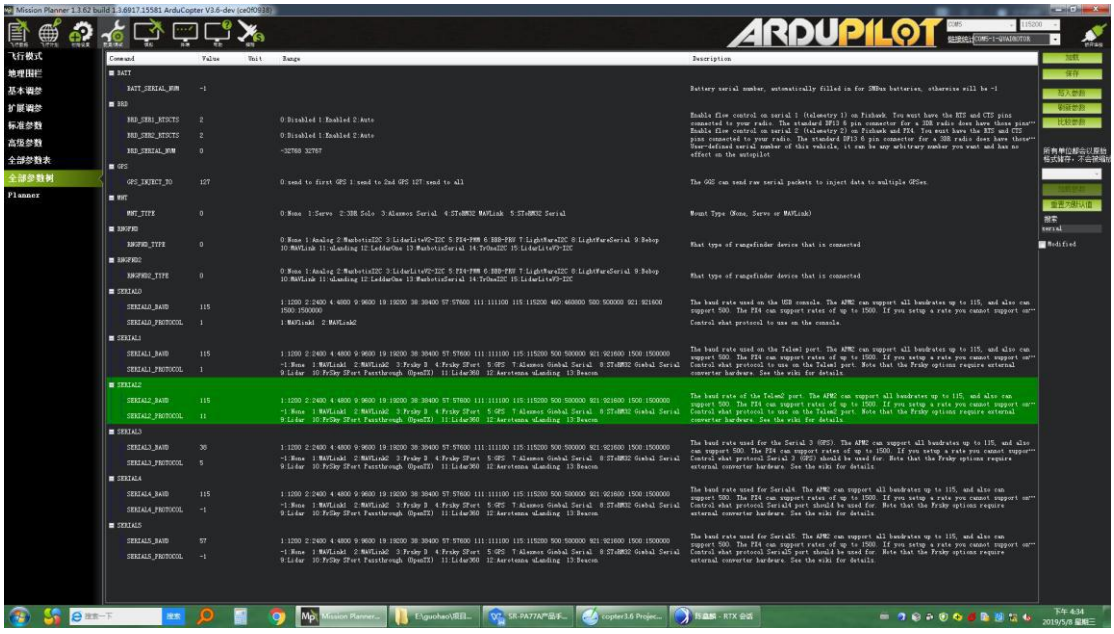
（2）Modify the measured data unit to cm



Pic 5 Modify the measured data unit

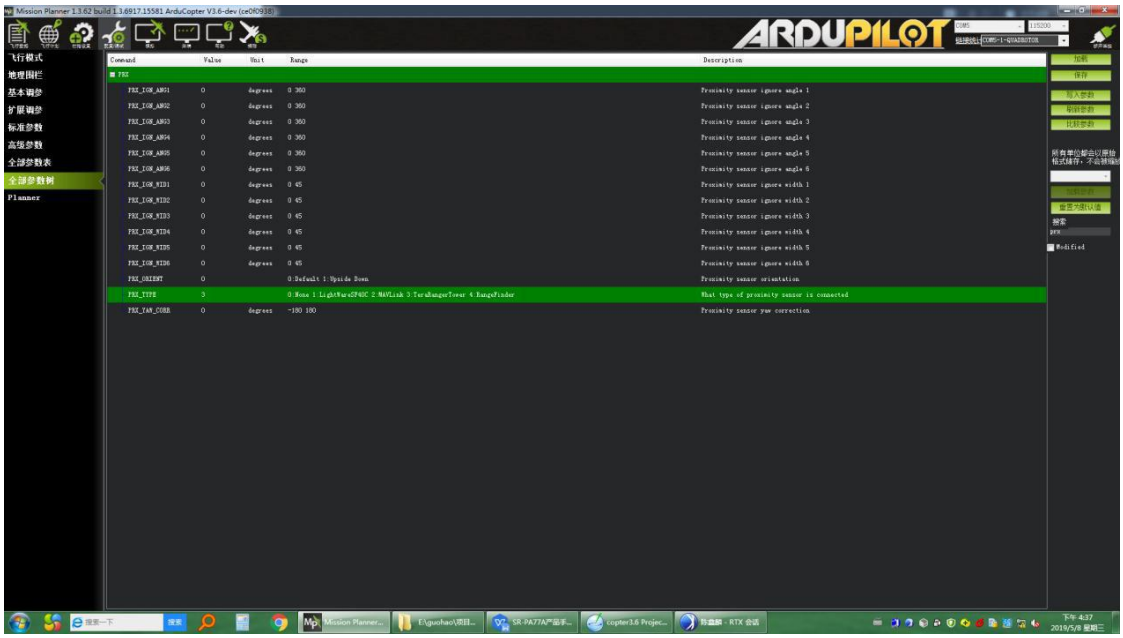
（3）MissionPlanner Ground station flight control parameter setting

Step one : Set the TELEM2 serial port parameter, the SERIAL2 baud rate is set to 115200bit/(SERIAL2_BAUD is set to 115) and the communication protocol is set to Lidar360 (SERIAL2_PROTOCOL Set to 11) as shown below:



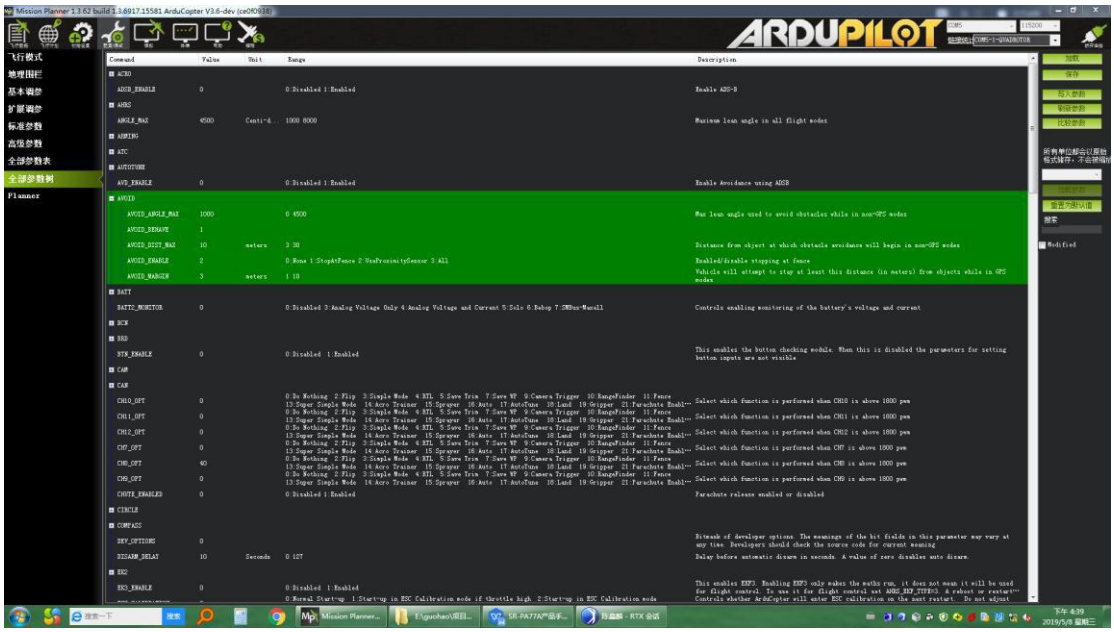
Pic 6 Set TELEM2 serial port parameter

Step two : Set the obstacle avoidance sensor protocol to TeraRangerTower (PRX_TYPE is set to 3) as shown below:



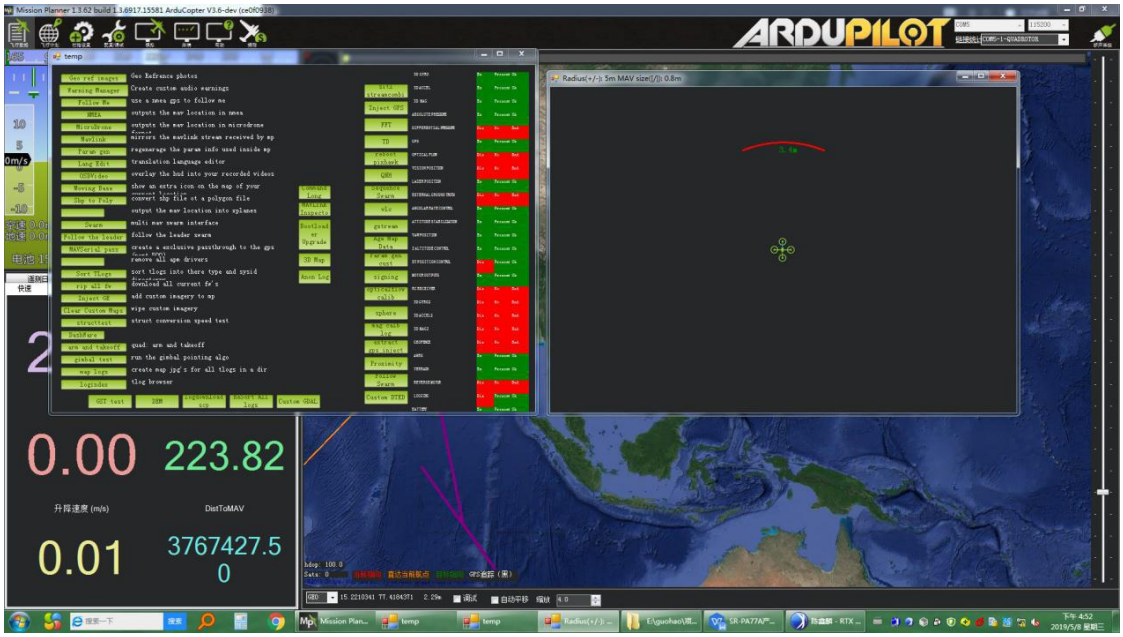
Pic.7 Set the obstacle avoidance sensor protocol

Step three: Set the obstacle avoidance type AVOID_ENABLE to UseProximitySensor, the obstacle avoidance maximum tilt angle is 10 degrees (AVOID_ANGLE_MAX is set to 1000), and the obstacle avoidance action mode is stop(AVOID_BEHAVE is set to 1), the obstacle avoidance distance is 3m(AVOID_MARGIN is set to 3) under gps mode , and the obstacle avoidance distance is 10m in altimeter mode (AVOID_DIST_MAX is set to 10), as shown in the following figure:



Pic 8 Set the obstacle avoidance parameter

Step four: Restart flight control after setting and saving the above parameters, then connect MissionPlanner, CTRL+F to open the debug window to see the obstacle avoidance distance as shown below: (target is 0 sector 3.4m)



Pic 9 Obstacle avoidance distance display

After the above settings are completed, the outdoor test can be performed. When the drone is less than 3m away from the obstacle under gps mode (less than 10m in the altimeter mode), the drone will has a brake action, and the controller cannot the drone to fly any more.