# MR72-open source CAN protocol UAV obstacle avoidance User's manual



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#### Description of the manual

The purpose of this manual is to let users understand some basic parameters of MR72 UAV obstacle avoidance millimeter wave radar and the application of MR72 CAN protocol obstacle avoidance radar to UAV. It includes the connection between radar and UAV and the precautions for radar use. Users can set some basic parameters for UAV obstacle avoidance according to the steps in the manual, so as to realize the communication and obstacle avoidance between UAV and radar.

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#### I. Introduction

MR72 UAV Obstacle Avoidance 77 GHz millimeter wave radar provides short-range and medium-range dual-beam scanning coverage. It can detect the distance, speed and position information of the target by receiving the radar reflection wave. In this version, it supports the CAN protocol of the ArduPliot platform, and can use a separate port to cascade the radar. Compared with the serial port, the communication rate of the CAN protocol is faster and more convenient. Different from other obstacle avoidance radars, it has strong robustness, high measurement accuracy, all-weather work, and small size, which has great advantages for UAV obstacle avoidance.

#### II. Precautions for product use

1. For initial use, please ensure that the radar is powered separately, with a range of  $+5V \sim 28VDC$ .

2. The firmware of this radar only supports ArduPliot firmware version 4.5.0 and above.

(Ardupilot Firmware Address:https://ardupilot.org/ardupilot/docs/common-downloads\_firmware.html)

3. For the flight controller used, its flash memory needs to be 2Mb or more, and it supports burning ArduPliot firmware.

4. Please keep no other obstructions in front of the radar antenna during the use of the radar.

5. Use and test in an open area without interfering radar signals.

6. When the radar is installed, it is necessary to ensure that the module is vertically forward. The customer can recommend to raise the inclination angle by 5 °  $\sim$  7 ° according to his own flight speed (if the flight speed inclination angle is too large, the recommended range is 5 °  $\sim$  25 °), so as to maintain the accuracy of the data.

7. When the power supply of 5V is used to supply power to the radar, it is recommended to provide a stable current of 0.5A for the radar, otherwise the radar cannot be used normally.

### III. Function Highlights

**Support for Ardupilot:** Perfect compatibility with open source flight control, easy to use, plug and play, no need to calibrate radar.

**High protection level:** radar IP66 protection, high waterproof and dustproof level, shock resistance and fall resistance, to ensure the safety of UAV.

Anti-jamming: low sidelobe synthesis of antenna pattern by Taylor algorithm is adopted for receiving and transmitting antennas, which can make the radar not easily affected by ground clutter.

**Light weight:** The weight with the shell is 90 G, which greatly reduces the load of the UAV and increases the endurance of the UAV.



## IV. List of articles



#### V. Connection between flight controller and radar

The following installation takes UAV and radar as models for example; PIXhawk 2.4.8 flight controller and MR72 radar obstacle avoidance module are taken as examples.

#### 5.1 Installation

1. Use screws to fix MR72 radar and mounting bracket.

2. Forward obstacle avoidance: Install the MR72 radar and mounting bracket on the UAV base with screws.

- 3. The antenna faces forward, and the outgoing line is in the left front of the UAV.
- 4. MR72 radar rises 5  $^{\circ}$  ~ 7  $^{\circ}$  according to the flight inclination of UAV (plant protection).







Figure 2 Installation of radar and base

#### 5.2 Connection

1. Connect the harness of MR72 radar to PIXhawk 2.4.8.

2. Note the RX and TX cross connections in the harness to the RX and TX of the CAN port in PIXhawk 2.4.8.

3. The MR72 radar is powered by an independent power supply of 12V.



Figure 3 Connection between flight control and radar

### VI. Usage

The produced MR72 radar has compiled the open source version firmware (MR72 \_ NR \_ CAN3 \_ 40M \_ V3.0.0). Nanoradar Company provides the supporting upper computer debugging software, which can upgrade and debug the radar and support the remote debugging of technicians. The software adopts Mis sion Planner ground station software to debug obstacle avoidance and CAN protocol parameters. The off icial download address is <a href="https://ardupilot.org/planner/docs/mission-planner-installation.html">https://ardupilot.org/planner/docs/mission-planner-installation.html</a>

#### 6.1 Parameter setting of ground station

1. Open the Misson Planner ground station, and connect the USB cable connected to the flight control to the USB port of the computer.





Figure 4 Port view



3. Click the upper right corner of the ground station, configure the port number and baud rate, and set the baud rate to the 115200.



Figure 5 Connection mode selection

4. Click the "Configuration/Debugging" interface to find all the parameter trees, and find the search on the right side to search for the parameters you need to modify.

া Mission Planner 1.3.80 b	uild 1	.3.8479.20539 ArduCop	oter V4.5.0 (53	ad2c2a)				-		$\times$
	ifig			Aſ	RDU	COM9 115200   Stats COM9-1-QUADRO	ото	 ⊽	DISCO	DNNECT
GeoFence	Com	mand	Value	Unit	Range	Description		Load	from	file
Basic Tuning	E P	RX						Sav	e to f	ile
Extended Tuning		-PRX_ALT_MIN			0 10	Minimum altitude below which proximity should not work.		Wri	te Par	ams
Standard Parans		-PRX_FILT	0.25	Hz	0 20	Cutoff frequency for low pass filter applied to each face in the proximity bou		Refr	esh Pa	rams
dwanced Parame		-PRX_IGN_GND			O:Disab led 1…	Ignore proximity data that is within 1 meter of the ground below the vehicle. Th…		Comp	are Pa	rams
		PRX_LOG_RAW			0:0ff 1:0n	Set this parameter to one if logging unfiltered(raw) distances from sensor sho…				
Unboard USD	P.	RX1						All U	hits a	re in r
<b>MAV</b> Ftp		-PRX1_ADDR			0 127	The bus address of the sensor, where applicable. Used for the I2C and DroneCAN	l	forms	t with	no scal
User Params		-PRX1_IGN_ANG1		deg	0 360	Froximity sensor ignore angle 1		3DK_I	rıs+_AL	
Full Parameter List		-PRX1_IGN_ANG2		deg	0 360	Proximity sensor ignore angle 2		Loa	i Presa	ved
Full Parameter Tree		-PRX1_IGN_ANG3		deg	0 360	Proximity sensor ignore angle 3		Reset	to De:	fault
Planer		-PRX1_IGN_ANG4		deg	0 360	Proximity sensor ignore angle 4		prx		
		-PRX1_IGN_WID1		deg	0 127	Proximity sensor ignore width 1		Modi	fied	
		-PRX1_IGN_WID2		deg	0 127	Proximity sensor ignore width 2				
		-PRX1_IGN_WID3		deg	0 127	Proximity sensor ignore width 3				
		-PRX1_IGN_WID4		deg	0 127	Proximity sensor ignore width 4				
		-PRX1_MAX			0 500	Maximum expected range for Proximity Sensor. Setting this to 0 will set value…				
		-PRX1_MIN			0 500	Minimum expected range for Proximity Sensor. Setting this to 0 will set value				
		-PRX1_ORIENT			0:Defau 1+ 1:	Proximity sensor orientation				
		PRV1 RECV TD	5		0 65535	The receive ID of the CAN frames. A value				

Figure 6 Parameter query



5. According to Table 1 and Table 2 below, we search for keywords, such as "AVOID" and "CAN", find the parameters in the table, and modify them one by one.

Parameter name	Value	Parameter introduction
CAN_D1_PROTOCOL 14		Allows the use of the MR72 CAN communication
		protocol on the CAN1 port
CAN_P1_DRIVER	1	Enable CAN1 bus
CAN_P1_BITRATE	500000	The code rate of CAN1 interface is 500kb/s.

Table 1 Configuration of CAN1 interface parameters

Note: When configuring CAN parameters, you need to modify PROTOCOL and DRIVER first, a nd then write the parameters and refresh them before configuring BITRATE parameters; To use CAN2, change "D1" and "P1" in the above parameters to "D2" and "P2", for example, change "C AN D1 PROTOCOL" "to" CAN D2 PROTOCOL "".

Table 2 Configuration of Obstacle Avoidance Parameters

Parameter name	Value	Parameter introduction
AVOID_ENABLE	2	Enable proximity sensor avoidance
AVOID_ANGLE_MAX	1000	The maximum angle for obstacle avoidance in non-GPS mode is 10 $^\circ$
AVOID_BEHAVE	1	When avoiding obstacles, the action made by the UAV is stop.
AVOID_MARGIN	5	Obstacle avoidance distance of 5 meters in GPS mode
AVOID_DIST_MAX	10	Obstacle avoidance distance of 10 meters in non-GPS mode

Note: We only provide the appropriate recommended parameters for the above parameter values, and the

actual values can be modified according to the customer's requirements.

6. As shown in the figure, we configure the basic parameters in Table 1 and Table 2 to meet the conditions for opening obstacle avoidance.

	-			~			_	_	
DATA PLAN SETUP COM			A	<u>RDL</u>	COM9 115200   Stats COM9-1-QUAD	ROTO	× DR →	DISCO	<b>NNE</b>
eoFence	Comm and	Value	Unit	Range	Description	^	Load	from f	file
asic Tuning	E BRD						Save	to fi	le
rtended Tuning	BRD_SAFETY_DEFLT			O:Disab led 1…	This controls the default state of the safety switch at startup. When set to 1 t		Writ	e Para	ms.
tandard Parans	-BRD_SAFETY_MASK	16383			move while the safety switch has not been	1	Refr	esh Par	ams
dvanced Parans	BRD_SAFETYOPTION				This controls the activation of the safety button. It allows you to control if the s		Comp	are Par	r em s
aboard OSD	-BRD_SD_SLOWDOWN			0 32	This is a scaling factor to slow down microSD operation. It can be used on flig	1			
inter a constant a const	BRD_SERIAL_NUM			83886	User-defined serial number of this vehicle, it can be any arbitrary number you want a <sup></sup>		All Ur	uits ar	
WFtp	E CAN						Lorma	t with	no
ser Params	CAR_D1_PROTOCOL			0:Disab	Enabling this option starts selected		3DR_Ir	154_AC	34
ull Parameter List	-CAN_D1_PROTOCOL2	0		0:Disab	Secondary protocol with 11 bit CAN		Load	Presav	/ed
ull Parameter Tree	CAN_D2_PROTOCOL			0:Disab	Enabling this option starts selected		Reset	to Def	au
anner	CAN_D2_PROTOCOL2	0		0:Disab	Secondary protocol with 11 bit CAN		Search can	1	
	CAN_LOGLEVEL			0 40:Lo…	addressing Loglevel for recording initialisation and debug information from CAN Interface		Modi	fied	
	CAN_P1_BITRATE	500000		10000	Bit rate can be set up to from 10000 to				
	- CAN_P1_DRIVER			0:Disab	Enabling this option enables use of CAN huses				
	-CAN_P2_DRIVER			0:Disab	Enabling this option enables use of CAN				
	-CAN_SLCAN_CPORT			0:Disab led 1…	CAN Interface ID to be routed to SLCAN, O means no routing				
	-CAN_SLCAN_SDELAY			0 127	Duration after which slcan starts after setting SERNUM in seconds				
	- CAN_SLCAN_SERNOM			- 1:Dis	Serial Port ID to be used for temporary SLCAN iface means no temporary serial				
	CAN SLCAN TIMOUT	ń.		0 127	Duration of inactivity after which SLCAN is	~			

Figure 7 CAN1 parameter configuration



Mission Planner 1.3.80 b	uild 1.3.8479.20539	ArduCopter V4.5.0	(53ad2c2a)	)		-		×
		HELP	A	RDU	COM9 - 115200 Stats COM9-1-QUADR	OTOR	→ DISC	CONNECT
GeoFence	Conmand	Value	Uni t	Range	Description	^ I	oad from	file
Basic Tuning	AVD_ENABLE	0		O:Disab led 1…	Enable Avoidance using ADSB		Save to	file
Extended Tuning	AVOID						Vrite Pa	rams
StandardParans	AVOID_ACCEL_	мах з	m/s/s	09	Maximum acceleration with which obstacles will be avoided with. Set zero to disable…	F	lefresh P	arams
tdwanged Parang	AVOID_ALT_M	ס אב		06	Minimum altitude above which proximity based avoidance will start working. This…		ompare P	ar an s
	AVOID_ANGLE_	MAX 1000	cdeg	0 4500	Max lean angle used to avoid obstacles while in non-GPS modes			
Onboard OSD	AVOID_BACKUP	_DZ 0.1		02	Distance beyond AVOID_MARGIN parameter,	Al	l Units	are in r
MAVFtp	AVOID_BACKUE	_SPD 0.75	n/s	02	Maximum speed that will be used to back	fo	ermat wit	h no scai
User Params	AVOID_BEHAVE			0:Slide	Avoidance behaviour (slide or stop)	30	R_Iris+_A	A034 -
Full Parameter List	AVOID_DIST_N	IAX 10		1 30	Distance from object at which obstacle	1	Load Pres	aved
Full Parameter Tree	AVOID ENABLE				avoidance will begin in non-ors modes Enabled/disable avoidance input sources	Re	set to D	efault
Planner	AVOID_MARGIN				Vehicle will attempt to stay at least this distance (in meters) from objects while i…	Se avo	arch òid	
	FENCE						lodi fi ed	
	FENCE_MARGIN	1 2		1 10	Distance that autopilot's should maintain from the fence to avoid a breach	1		
	FLTMDDE1			0:Stabi liza	Flight mode when pwm of Flightmode channel			
	-FLTMDDE2			0:Stabi	Flight mode when pwm of Flightmode channel			
	FLTMDDE3			0:Stabi	Flight mode when pwm of Flightmode channel			
	FLTMDDE4			0:Stabi	Flight mode when pum of Flightmode channel			
	FLTMDDE5	0		0:Stabi	flight mode when per of flightmode channel			
	FLITMODRG			0:Stabi	(FLIMUDE_CH) is >1620, <= 1/49 Flight mode when pwm of Flightmode channel			

Figure 8 Obstacle avoidance parameter configuration

#### 6.2 Sensor parameters

Table 3 Configuration of One-way Obstacle Avoidance Sensor 1

Parameter name	Value	Parameter introduction		
PRX1_TYPE	17	Connect MR72 Proximity Sensor		
PRX1_RECV_ID	0	The ID of radar allowed to receive is 0		
PRX1_YAW_CORR	0	Radar shows the sector position is straight ahead.		

Note: When configuring PRX parameters in the default parameters, you need to set PRX1 \_ TYPE first, write the parameters and refresh the parameters.

Configure the subsequent parameters. When modifying the PRX \_ RECV \_ ID, the flight control needs to be powered off once before the modification of this parameter will be displayed.

1. Configure sensor 1 according to the above table, as shown in the figure:

Mission Planner 1.3.80 b	uild 1	.3.8479.20539 ArduCoj	oter V4.5.0 (53	ad2c2a)				-		×
DATA PLAN SETUP COM	iFIG			A	RDU	COM9 115200 Stats COM9-1-QUADF	ROTO	v DR <del>v</del>	DISCO	NNECT
GeoFence	Con	mand	Value	Unit	Range	Description	^	Load	from f	ile
Basic Tuning		PRN_IGN_GND	0		0:Disab led 1…	Ignore proximity data that is within 1 meter of the ground below the vehicle. Th…		Sav	e to fi	le
Extended Tuning		PRX_LOG_RAW			0:0ff 1:0n	Set this parameter to one if logging unfiltered(raw) distances from sensor sho…	I	Wri	te Para	ms
Standard Parans	∎ P	RX1						Refr	esh Par	ans
Advanced Parane		-PRX1_ADDR			0 127	The bus address of the sensor, where applicable. Used for the I2C and DroneCAN	I	Conp	are Par	ams
		PRN1_IGN_ANG1		deg	0 360	Proximity sensor ignore angle 1	I			
Unboard USD		PRE1_IGN_ANG2		deg	0 360	Proximity sensor ignore angle 2		A11 U	nits ar	e in r
<b>MAVF</b> tp		PRE1_IGN_ANG3		deg	0 360	Proximity sensor ignore angle 3		torns	t with	no scal
User Params		-PRX1_IGN_ANG4		deg	0 360	Proximity sensor ignore angle 4	I	3UK_I	ris+_AU	511 <b>-</b>
Full Parameter List		-PRX1_IGN_WID1		deg	0 127	Proximity sensor ignore width 1		Load	l Presa	red
Full Parameter Tree		-PRX1_IGN_WID2		deg	0 127	Proximity sensor ignore width 2		Reset	to Def	ault
Planner		PRX1_IGN_WID3		deg	0 127	Proximity sensor ignore width 3	ł	prx	<u> </u>	
		-PRX1_IGN_WID4		deg	0 127	Proximity sensor ignore width 4		Modi	fied	
		-PRX1_MAX			0 500	Maximum expected range for Proximity Sensor Setting this to 0 will set value				
		-PRX1_MIN			0 500	Minimum expected range for Proximity Sensor Setting this to 0 will set value				
		-PRX1_ORIENT			0:Defau 1+ 1	Proximity sensor orientation				
		PRN1_RECV_ID			0 65535	The receive ID of the CAN frames. A value				
		PRX1_TVPE			0:None	What type of proximity sensor is connected				
		PRX1_YAW_CORR		deg	-180	Proximity sensor yaw correction				
	= P	RX2					~			

Figure 9 PRX parameter configuration



2. After configuring the sensor parameters, click "Flight Data" to return to the main interface, and open the interface "Temp" through "Ctrl + F".

🔛 temp								×
Geo ref images	moved to dataflash tab	hez Maylink decode				Prese	at Ok	1
Warning Manager	Create custom audio warnings	driver clean	remove installed drivers		2n			
Follow Me	use a nmea gps to follow me	Toggle Saftey Switch	virtual press the satey button	3D MAG	En	Press	at Ok	
NMEA	outputs the may location in nmea	Message Interval	set custom message interval's for					
MicroDrone	outputs the mav location in microdrone	MAVLink Inspector	Inspect all mavlink packets being		- <b>1</b>			
Mavlink	mirrors the mavlink stream received by mp	Bootloader Upgrade	update the bootloader	DIFFERENTIAL PRESSURE	01.9			
Param gen	regenerate the param info used inside mp	3D Map	3d map testing		Dis			
Lang Edit	translation language editor	decode HWID's	display info about a hardware id typed		Dis			
OSDVi deo	overlay the hud into your recorded videos	parse packet bytes	debug a hex string mavlink packet	VISION POSITION	01.			
Moving Base	show an extra icon on the map of your	adjust aircraft baro he	modify baro alt reference alt	LASERROSTING	D1=			
Shp to Poly	convert shp file ot a polygon file	Lockup MAV	cause the autopilot to lockup					
Anon Log	-	DEM	display information about the	EXTERNAL GROUND TRUTH	019		Bad	
Swarm	multi mav swarm interface	logdownload scp	logdownload via sop - ssh (apsyno)	ANGULAR RATE CONTROL	ān.			
Follow the leader	follow the leader swarm	ReSort All logs	resort all the logs in the MP logging	ATTITUDE STABILIZATION	za –			
MAVSerial pass	create a exclusive passthrough to the gps	Custom GDAL	load a custom map tile source via GDAL		En			
Start Remote df Lo	8	sitl streamcombiner		ZALTITUDE CONTROL		Press	at Red	
Sort TLogs	sort tlogs into there type and sysid	Param Restore						
rip all fw	download all current fw's	FFT		XY POSITION CONTROL	019	Press	a Bad	
Inject GE	add custom imagery to mp	grab threads.txt		MOTOR OUTPUTS	01.			
Clear Custom Maps	wipe custom imagery	reboot pixhawk	reboot the autopilot	RCRECEIVER	Dis			
structtest	struct conversion speed test	QNH	adjust the qnh		01.9			
DashWare	Create dashware date input file	Sequence Swarm	label49	3D ACCEL2	D1=		Red	
arm and takeoff	quad: arm and takeoff	vlc	display video stream via vlo - USE					
gimbal test	run the gimbal pointing algo	Age Map Data	remove image tiles older than 30 days	30 12402	019		Bad	
map logs	create map jpg's for all tlogs in a dir	Param gen cust	generate aged param data	GEOFENCE	Dis			
logindex	tlog browser	signing	mavlink2 signing configuration		En .			
opticalflow calib	display the image data from the px4	extract gps_inject	extract rtcm data from tlog	TERRAIN	En			
APJ Tool		Proximity	display the proximity ui	REVERSENOTOR	Dia		Bad	
mag calb log	get mag offisets from a log	Follow Swarm	swarm style					
CoT	Uutputs Cursor-on-Target	Manage Command List	Manage Flanner s Command List	2000200	01.5			
Force Accel Cal	Mark accel as cal d after param restore	DFU Mode	DFU Mode		019			
Force Compass Cal	Mark mag as cal d after param restore			PROXIMITY				

Figure 10 "Temp" interface

3. In the range of 315 ° to 45 ° in the figure, red lines will be displayed. Each red line represents a target obstacle. A maximum of three targets will be displayed in one range.



Figure 11 Real-time display of radar interface



# 七、 Radar parameters

Modulation mode		FMCW
Test distance		0.2~40m/80m
Angular range		$\pm 56^{\circ}@6dB$
Speed range		-100km/h + 100km/H (-means far from the target, + means close to the target)
Elevation beam		14°
Azimuth beam		112°
Radar transmitting frequency	Follow ETSI & FCC	7677GHz
Power source		+5V28VDC
Interface type		UART, CAN (high speed 500Kbit/s)
Power consumption		2.5W
Operating temperature		-40°C+70°C
Storage temperature		-40°C+90°C
Weight		90g
Size	W*L*H	100×57×16.5mm
Degree of protection		IP66



# VIII. Appendix

### 8.1 Definition of radar harness

Pin	Color	Interface description	Remarks
1	Red	DC12V	Power supply positive
2	-	-	-
3	Black	GND	Negative pole of power supply
4	-	-	-
5	White	CAN_L	Low level CAN port
6	Yellow	CAN_H	High level CAN port
7	-	-	-
8	-	-	-





## 8.2 Definition of flight controller harness

Color	Interface description	Remarks				
Red	DC5V	5V power supply (not used temporarily)				
Yellow	CAN_H	High level CAN port				
White	CAN_L	Low level CAN port				
Black	GND	Ground wire (not used temporarily)				



#### 8.3 FAQ

- Q: In which modes can the obstacle avoidance of MR72CAN protocol be used?
- A: Radar obstacle avoidance is divided into simple obstacle avoidance and algorithm obstacle avoidance. MR72 adopts simple obstacle avoidance, so it only supports LOITER mode and ALT \_ HOLD mode at present. If you want to use obstacle avoidance in AUTO or RTL mode, please modify the parameters OA \_ TYPE = 1 (BendyRuler obstacle avoidance algorithm), OA \_ MARGIN \_ MAX = 5 (obstacle avoidance distance is 5 meters).
- Q: Can the radar ID number be modified arbitrarily to match the CAN protocol of flight control?
- A: The PRX \_ RECV \_ ID of the parameters at the flight control end changes with the ID of the radar itself. For example, if the ID of the radar I got is 5, then the parameters at the flight control end are changed to PRX \_ RECV \_ ID = 5; If the parameter PRX \_ RECV \_ ID of the flight control end is set as 9, the ID of the radar itself needs to be changed to 9 before it can be used according to the CAN protocol.



Q: How does Mission Planner divide the range of radar display interface?

A: As shown in the above figure, the radar display interface is composed of 360 ° circular interface, and the circular interface is divided into a sector by 45 °, and the two sectors are divided into an interval, that is, the first interval is from 315 ° to 45 °, the second interval is from 45 ° to 135 °, the third interval is from 135 ° to 225 °, and the fourth interval is from 225 ° to 315 °. That is, the first section is the front, the second section is the right, the third section is the rear, and the fourth section is the left.

Q: Can the open source MR72CAN protocol connect multiple radars to achieve multidirectional obstacle avoidance?

- A: Yes, we support up to three MR72 radars cascading for obstacle avoidance in three directions. If necessary, you can go to the user manual for multi-radar cascading of the open source CAN protocol.
- Q: MR72 obstacle avoidance distance and installation issues?
- A: MR72 obstacle avoidance distance can be modified at the ground station. The installation of radar needs to consider the angle change caused by navigation obstacle avoidance and hovering obstacle avoidance of UAV. Considering the characteristics of radar visual angle range, and due to the delay of UAV braking in radar data transmission, it is necessary to control the extension of braking distance caused by flight speed and delay in order to ensure UAV flight installation.
- Q: Standard test data flow?
- A: After the configuration parameters are completed, the radar and flight control need to be powered on again to ensure that the data is valid. At the same time, the radar test is affected by the indoor multipath of millimeter wave, and the indoor data is inaccurate. When the hardware connection and parameter configuration are verified to be normal, the radar test needs to be carried out in the outdoor open field.

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