[B122-019] RCR Radar product manual

CubTEK Inc.

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Import：EU local representative: ***／Address: *******

Hereby, CUBTEK INC. declares that the radio equipment type [designation of type of radio equipment] is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: http://xxxxxxxxxx

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Revision History

Version	Change Description	Date	Modified by	Approved by
V0.1	Preliminary draft template	2021/12/10	刘俊显	
V0.2	Fix Section 7.2, Performance Specifications form	2022/01/11	刘俊显	
V0.3	1. Corrected the description field of the abbreviation definition in Section 3.2 2. Corrected the table column width in Section 3	2022/01/13	刘俊显	
V0.4	1. Cancel the base page differently 2. Update the footer settings 3. Correct typos in the Documentation Department 4. Change the file name to [Item Number]XXX Radar Product Manual Template (Chinese Traditional)	2022/01/21	刘俊显	

Table of Contents

1 Purpose

This document is written and published by Shengke Technology Co., Ltd., this document is the product description document of CubTEK 77Ghz Corner Radar, and also serves as a guide document for users to install and debug the product.

2 Scope of Application

The Corner Radar system, which is suitable for M- and N vehicles, detects and warns the driver of pedestrians (adults, children) or cyclists in the near blind zone in front of the vehicle to avoid possible collisions.。

3 Definitions of Terms

3.1 Explanation of terms

noun	illustrate
Relative velocity	The difference between the speed of the vehicle and the speed of the target vehicle. A positive relative velocity indicates that the target vehicle is approaching the vehicle from behind
Pre-collision time	If the target vehicle is in the path towards the vehicle and the current approach speed of the target vehicle remains constant, the estimated time it takes for the target vehicle to collide with the vehicle.

3.2 Abbreviations

abbreviation	full name	illustrate
BSD	Blind Spot Detection	盲点侦测
LCA	Lane Change Assist	换道辅助
RCTA	Rear Cross Traffic Assist	后方横向辅助
DOW	Door Open Warning	开门预警
RCW	Rear Collision Warning	后追尾预警
FCTA	Front Cross Traffic Assist	前方横向辅助
TTC	Time To Collision	预碰撞时间
RCR	Rear Corner Radar	后角雷达
FCR	Front Corner Radar	前角雷达
FCRL	Front Corner Radar Left	左前角雷达
FCRR	Front Corner Radar Right	右前角雷达
RCRL	Rear Corner Radar Left	左后角雷达
RCRR	Rear Corner Radar Right	右后角雷达
GWM	Gateway Module	网关模块

4 Standards and Regulations

Standard number	Standard name	Applicable Vehicles	state
ISO 17387:2008	智能运输系统 换道到决策辅助系统（LCDAS）性能要求与检测方法	M、N	Published
GB/T 37471-2019	智能运输系统换道决策辅助系统性能要求与检测方法	M 、N	Published
GB/T 39265-2020	道路车辆 盲区监视系统（BSD）性能要求及试验方法	M、N	Published
C-NCAP-2021	C-NCAP 管理规则(2021 年版)	M1	Published

M 类：Motor vehicles with at least 4 wheels and used to carry passengers;

M1 类：Passenger cars with no more than 9 seats, including the driver's seat;

M2 类：Including the driver's seat, the number of seats does not exceed 9, and the maximum design total mass does not exceed 5000kg passenger cars;

M3 类：Including the driver's seat, the number of seats does not exceed 9, and the maximum design total mass exceeds 5000kg;

N 类：Motor vehicles with at least 4 wheels and used to carry goods;

N1 类：Cargo vehicles with a maximum design total mass of no more than 3500kg;

N2 类：Cargo vehicles with a maximum design total mass of more than 3500kg but not more than 12000kg;

N3 类：Trucks with a maximum design gross mass of more than 12,000 kg;

O 类(挂车)

O1 类：Trailers with a maximum design total mass of no more than 750kg;

O2 类：Trailers with a maximum design total mass of more than 750kg, but not more than 3500kg;

O3 类：Trailers with a maximum design total mass of no more than 750kg。

O4 类：The maximum design total mass is more than 10000kg

5 Product Overview

Most of the causes of current traffic accidents are caused by failure to maintain driving distance, improper lane change, and failure to pay attention to driving status, resulting in tragedy. Therefore, in order to effectively reduce the incidence of accidents and ensure the safety of drivers and passengers, the front and rear safety warning systems of vehicles have been paid attention to in recent years.

As a corner radar mounted at the four corners of the vehicle, this product can realize BSD/LCA, FCTA, RCTA, DOW, and RCW functions. Radar sensors can be used to monitor whether there are targets approaching in the front and rear lanes and adjacent lanes in real time, especially targets in the blind spot of the rearview mirror. When there is a target approaching or there is a car in the blind spot, the monitoring system will remind the driver with a first-order warning or a second-order warning through sound, lights, etc., and the CubTEK 77Ghz corner radar will actively warn the driver before the vehicle may have an accident, effectively avoiding the accident rate.

Figure 1 CubTEK 77GHz Corner radar

Technical features of the product：

1. Based on 77GHz radar technology, it provides detection and protection of up to 80 meters and 150 degrees
2. Corner radar warning function: BSD/LCA+RCTA+DOW+RCW+FCTA
3. Round-the-clock operation to fully ensure driving safety
4. Take the initiative to warn and remind the driver in time to prevent accidents
5. The anti-interference design of the advanced algorithm is adopted to maintain the stable performance of the radar function
6. Support IP69K waterproof and dustproof

6 Product Introduction

6.1 System architecture

Figure 2 CubTEK 77GHz 4R Angular radar system architecture diagram

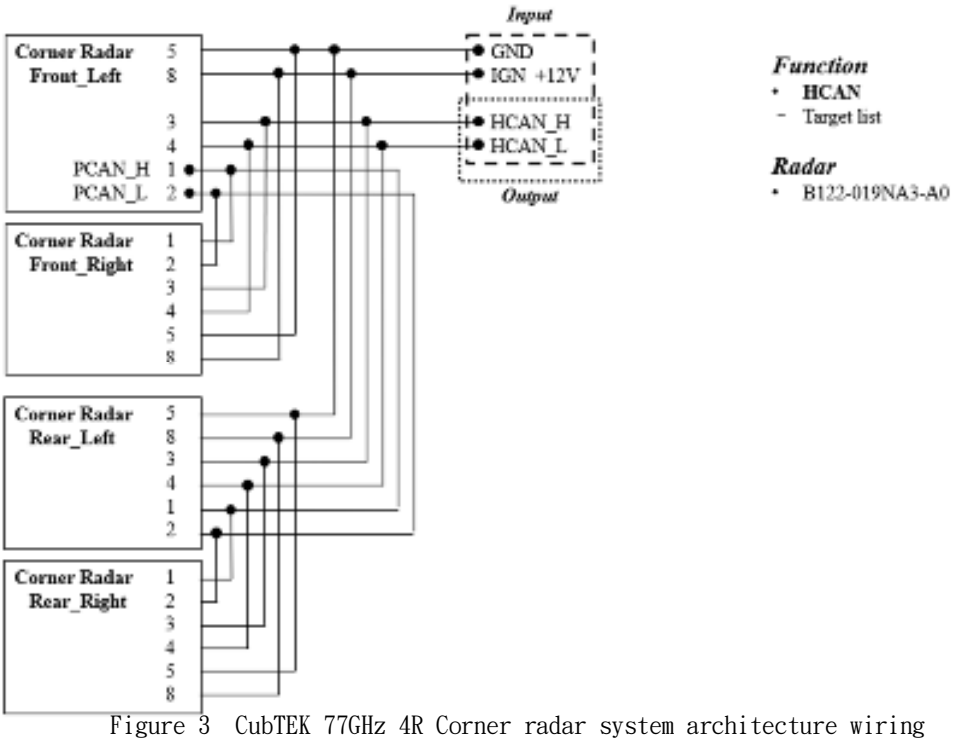


Figure 3 CubTEK 77GHz 4R Corner radar system architecture wiring

6.2 FOV schematic diagram

It can detect 0.4 ~ 80m in front of the vehicle, horizontal FOV ±75°, vertical FOV ±10°

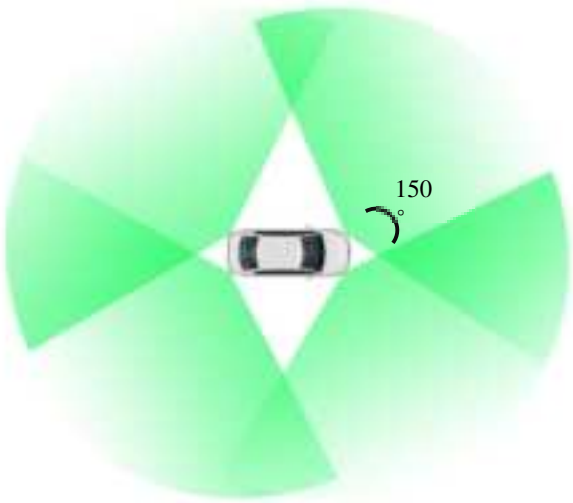


Figure 4 Schematic diagram of the CubTEK 77GHz 4R corner radar FOV

6.3 Function Introduction

6.3.1 BSD/LCA mode

It can detect 70 meters behind the vehicle, 3 meters wide, and the angle covers ± 75 degrees.

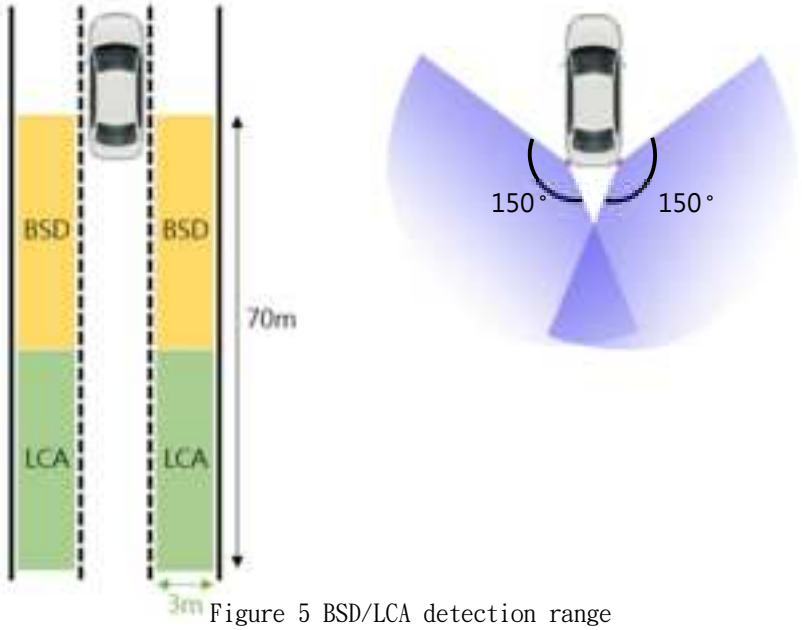


Figure 5 BSD/LCA detection range

The alarm is initiated

BSD：The speed is greater than or equal to 15km/h and less than 190km/h to start,

The car exceeds the target car, and the relative speed > 20km/h without alarm

LCA： The relative speed of the target vehicle is between -70 km/h and 0 km/h.

Monitor the TTC < 3.5 seconds alarm

Alarm mode

Alert phase	Phase 1	Phase 2
Alert scope	The vehicle enters the BSD/LCA range	The vehicle enters the BSD/LCA range And the turn signal has been turned on
Warning method	Flashing light warning	Flashing light warning + buzzer calling

Table 1 BSD/LCA alarm patterns

6.3.2 FCTA mode

It can detect oncoming vehicles in front of the radar 50 meters on the left and right sides and 6.5 meters in width.

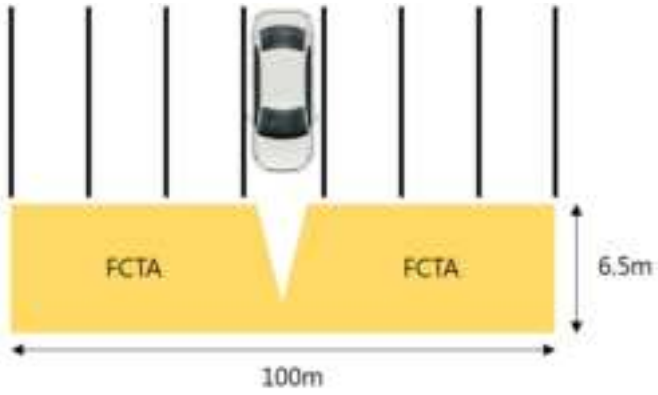


Figure 6 FCTA detection range

The alarm is initiated

- Start function when the vehicle is in the D file
- Starts when the speed is less than or equal to 5km/h
- Monitor the TTC < 2-second alarm for oncoming vehicles from behind

Alarm mode

Alert phase	Phase 1	Phase 2
Alert scope	The vehicle enters the FCTA range	The vehicle enters the FCTA range and meet the conditions for initiation
Warning method	Flashing light warning	Flashing light warning + buzzer calling

Table 2 FCTA alarm patterns

6.3.3 RCTA mode

It can detect oncoming vehicles from the rear with a width of 50 meters to the left and right of the radar and a width of 6.5 meters.

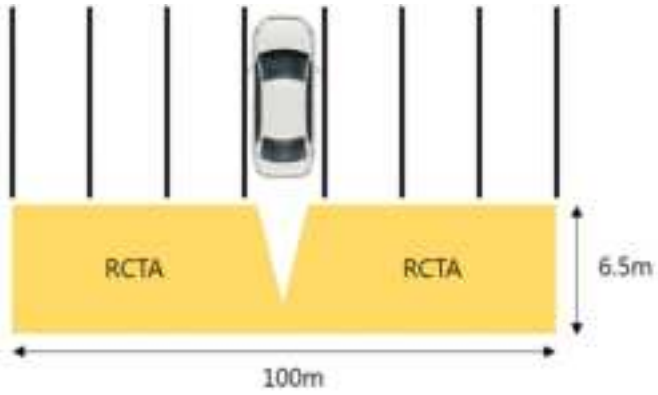


Figure 7 RCTA detection range

The alarm is initiated

- Activate the function when the vehicle is in the R file
- Starts at a speed of 10km/h or less
- Monitor the TTC < 2-second alarm for oncoming vehicles from behind

Alarm mode

Alert phase	Phase 1	Phase 2
Alert scope	The vehicle enters the RCTA range	The vehicle enters the RCTA range and meet the conditions for initiation
Warning method	Flashing light warning	Flashing light warning + buzzer calling

Table 3 RCTA alarm modes

6.3.4 DOW 模式

When stationary, the radar can detect vehicles coming from the left and right with a length of 20 meters on the left and a width of 2 meters.

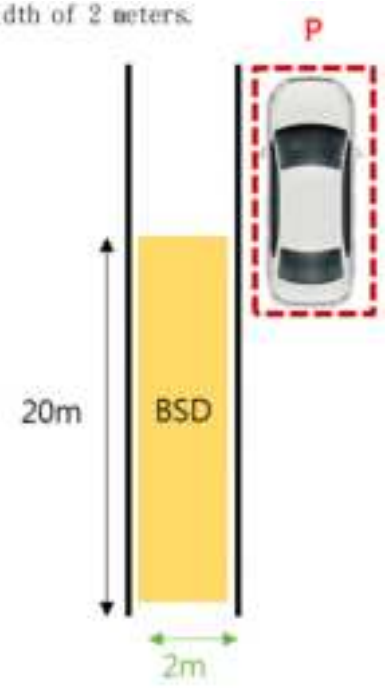


Figure 8 DOW detection range

The alarm is initiated

- Start function when the vehicle is stationary
- Monitor the TTC < 2-second alarm for oncoming vehicles from behind
- Support low-speed walking, bicycles, automobiles... wait

Alarm mode

Alert phase	Phase 1	Phase 2
Alert scope	The vehicle enters the DOW range	The vehicle enters the DOW range and meet the conditions for initiation
Warning method	Flashing light warning	Flashing light warning + buzzer calling

Table 4 DOW alarm patterns

6.3.5 RCW mode

It can detect 70 meters behind the vehicle and warn the vehicle behind when it predicts a high risk of collision.

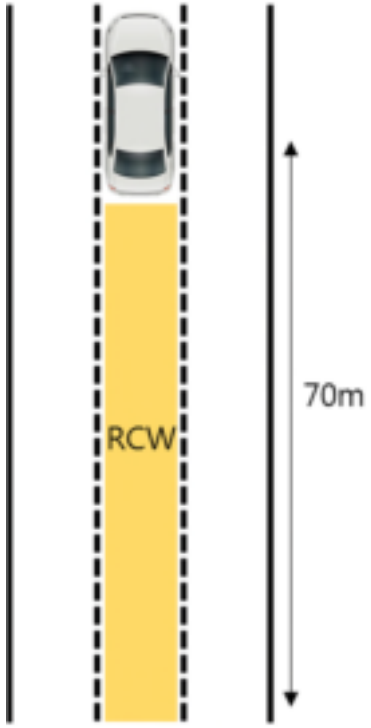


Figure 9 RCW detection range

The alarm is initiated

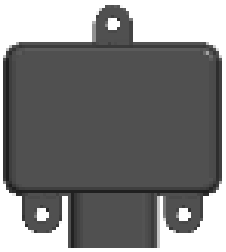
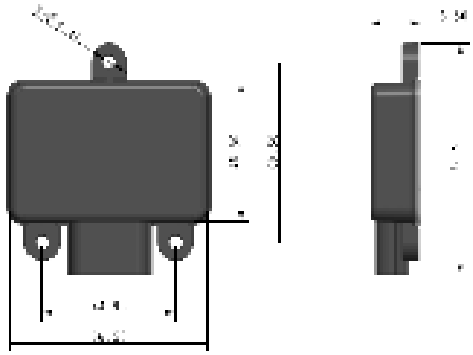
- Start function when the vehicle is moving
- When the vehicle speed is greater than or equal to 15 km/h and less than 190 km/h, the TTC of the oncoming vehicle will be monitored < 1.7 seconds alarm
- The start-up conditions and monitoring scope can be adjusted according to customer needs

Alarm mode

If the vehicle enters the RCW range and meets the TTC alarm conditions, it will take flashing lights and buzzer to warn.

7 Product Specifications

7.1 Product Specifications

雷达产品规格 Specification Introduction	角雷达 Corner Radar
产品图 Product drawing	
应用 Application	BSD、LCA、FCTA、RCTA、DOW、RCW
功耗 Power	< 3W per unit
工作电压 Operating voltage	9V-16V
工作温度/储存温度 Operating temperature / Storage temperature	-40~85°C/-40~90°C
防水等级 Waterproof level	IP69K
材质 Material	Cover :PP+GF30%; Base: PP
外观尺寸 Size	 EX: 66.5 (L) x 77.3 (W) x 16.5 (D) (mm)
接插件型号 Connector	MOLEX 314049110
系统匹配 (公版) Other modules (Public version)	No controller
功能安全等级 ASIL	B

雷达通讯与接口规格 Communication and Interface Specification	角雷达 Corner Radar
CAN 信道 CAN communication channel	2 ways
CAN 数据帧 (对外界面) CAN data frame	Standard frames
CAN 速度 (HMI-CAN 对外界面)	1M/4M
CAN FD (对外界面)	V (Only 8 bytes of packets are supported)
车辆讯号 - 车速 Vehicle signal - Speed	V (necessary)
车辆讯号 - 文件位 Vehicle signal - Gear	V (necessary)
车辆讯号 - 车门 Vehicle signal - Door	V (necessary)
车辆讯号 - 方向灯 Vehicle signal - Turn Indicator	V (necessary)
车辆讯号 - 方向盘转角 Vehicle signal - Steering Angle	V (necessary)
车辆讯号 - 点火讯号 (开/关) Vehicle signal - Ignition (ON/OFF)	X(Not required)
车辆讯号 - 横摆角 Vehicle signal - Yaw Rate	V (必须要)
最大输出目标数 Max target output number	32 pcs
最大输出点云数 Max cluster output number	128 pcs

7.2 Performance Specifications

雷达性能规格 Radar performance Specification		单位 Unit	角雷达 Corner Radar
雷达频率 Radar Frequency		GHz	76-77
数据周期 Data cycle time		ms	50
距离 Distance	范围 / Range	m	0.4-80
	精度 / Accuracy	m	±0.2
	分辨率 / Resolution	m	1
速度 Velocity	范围 / Range	km/h	±200
	精度 / Accuracy	km/h	±0.63
	分辨率 / Resolution	km/h	3.2
水平角度 Horizontal Angular	范围 / Range (FOV)	°	±75
	精度 / Accuracy	°	±0.25
	分辨率 / Resolution	°	13
垂直角度 Vertical Angular	范围 / Range	°	±10
	精度 / Accuracy	°	(Not supported)
	分辨率 / Resolution	°	(Not supported)

7.3 Functional Specifications

雷达功能规格 Function Specification	角雷达 Corner Radar
安装标定方式 Installation and calibration method	下线标定(Offline calibration) 动态标定(Dynamic calibration)
UDS 诊断功能 UDS diagnositc function	V（support）
UDS 更新功能 UDS Firmware update function	V（support）
网络管理功能 Netork management function	V（support）
回滚备份 Rollback and Recovery	V（support）
更新包大小 Image Size	< 1024 KB
更新时长 Update Time	< 2 mins
安装角偏移自侦测 BSD Alignment	V（support）
雷达遮蔽侦测功能 BSD Blockage	V（support）

8 Installation Specifications

8.1 Basic Requirements for Installation

参数 parameter	要求 request
Installation height (radar center from ground) PS: This height is the worst case in no load or full load	suggestion：500mm –700mm
Angle between the radar axis and the vehicle driving axis (Figure 10)	The body angle should be optimally set to 40 degrees, Tolerance ≤ ± 3 degrees
The perpendicular angle to the ground plane	90°，tolerance ≤ ±2°
Bumper thickness	≤ 4mm
The distance between the radar surface and the inside of the bumper	> 5mm
Connector definition for radar mounting	The joint is towards the axle centerline
Radar FOV range limitations	Ensure that there can be no metal parts or metal coating within the FOV range, and the thickness of the bumper face must be consistent, and there should be no stiffeners, height breaks, right angles, and water chestnut angles
Bumper radius radius requirements	Recommended R>400mm (the final result is mainly 3D digital-analog simulation and actual measurement results)
Radar perimeter 50mm box limit (Figure 10)	If there is an interference object, please provide the 3D digital model to CubTEK, and CubTEK will analyze whether there is a risk of interference.

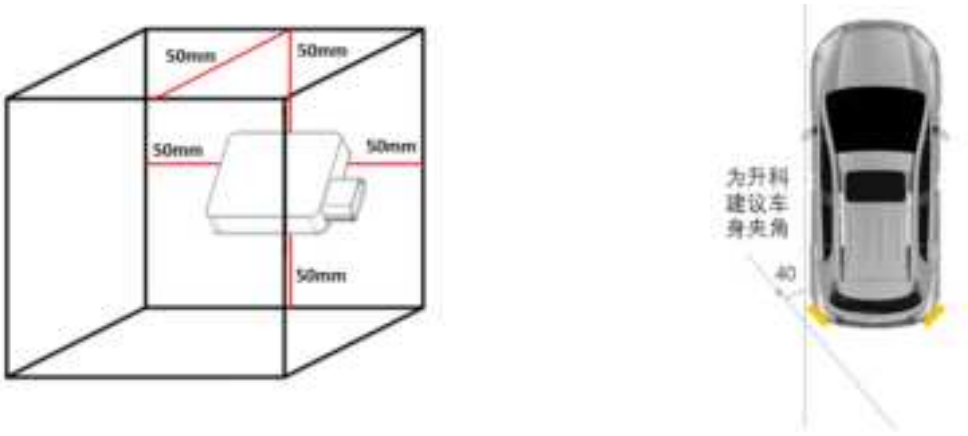


Fig 10 Definition of the 50mm frame around the radar and the 40-degree angle of the body

8.2 Basic requirements for radar front coverage conditions

The material used for the flat shield must avoid metal materials. In addition, metallic coatings must also be avoided for shielding. The following table shows the recommended materials:

Material	The first ideal thickness	The second ideal thickness
Polypropylene	2.55 mm	3.90 mm
ABS	2.39 mm	3.35 mm
Polycarbonate	2.33 mm	3.75 mm

*The tolerance of the cover must be controlled below 5%.

The coating of the cover can also affect the radar signal. The signal of the RF antenna is not only affected by the paint material, but also by the thickness of the paint. If there is a large attenuation factor in the coating, the radar performance will be attenuated with it. The effectiveness of the radar can be controlled by the material and thickness of the cover. Because different materials and thicknesses of the cover will cause different attenuation of the radar signal, the new material and thickness must be approved by CubTEK.

If there is an abnormal situation after installation, please contact CubTEK for detailed discussion and evaluation.

9 Installing the Calibration Function (Offline Calibration)

9.1Purpose of calibration::

The purpose of installation and calibration is to measure the deviation angle between the radar axis and the driving direction axis of the body in the horizontal and vertical directions, and to compensate the software to make the two axes coincide or within a permissible range.

9.2Adjusted configuration:

1. A vehicle equipped with millimeter-wave radar
2. Calibration equipment: metal reflector

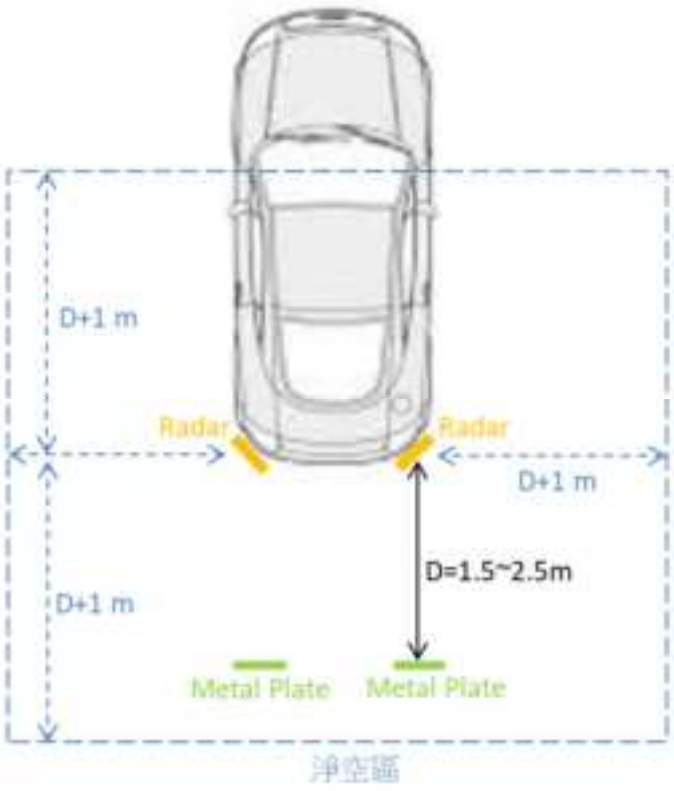


Figure 11 Radar correction configuration

9.3 Comparison of the advantages and disadvantages of metal reflector and metal corner reversal

The following table compares the alignment problem of the calibration platform between the metal reflector and the metal angle reversal, and it can be seen that the elasticity of the metal reflector for the alignment deviation is relatively high.

Calibrate platform alignment issues	Metal reflectors	Metal corner reverse
The vehicle is horizontally offset	The acceptable range of deviations is wide	The range of acceptable deviations is small
Radar installation horizontal offset	The acceptable range of deviations is wide	The range of acceptable deviations is small
Reflector/corner reverse horizontal offset	The acceptable range of deviations is wide	The range of acceptable deviations is small
Horizontal angular rotation deviation of the vehicle's driving axis	The range of acceptable deviations is small	The range of acceptable deviations is small
Reflector/Angle Inverse Normal Horizontal Angle Rotation Deviation	The range of acceptable deviations is small	The acceptable range of deviations is wide

9.4 Calibrate the site layout

9.4.1 Calibrate the reflector position

1. The metal reflector is D=1.5~2.5m behind the radar;
2. The minimum distance is limited by the far-field conditions and hardware conditions of millimeter-wave radar.

9.4.2 Environment settings

Calibrated headroom::

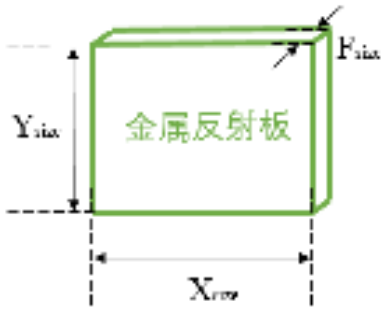
1. In the area between the metal reflector and the front surface of the radar D=1.5~2.5 m & 1 m behind the metal reflector, no metal reflector or any obstacle is allowed.
2. The vertical headroom angle of the radar is ±30ˆ° or 3m.
3. The horizontal clearance angle of the radar is ±75ˆ° or D+1m clearance around the radar.

9.5 Metal reflector requirements

9.5.1 Material and size

1. Metal Reflector Material: Aluminum, Iron, Stainless Steel.
2. Dimensions of metal reflectors, as shown below:

Xsize	Ysize	Fsize
0.8~1 m	0.8~1 m	≥3 mm



Note: Within the size range of the metal reflector, the roughness should be < 0.1mm per 80mm*80mm area

9.5.2 Metal reflector layout requirements

1. The distance between the metal reflector and the radar center is D=1.5~2.5 m.
2. The installation error of the center of the metal reflector is ≤± 5.0 cm relative to the horizontal left and right of the radar center.
3. The vertical up and down installation error of the center of the metal reflector relative to the center of the radar is ≤± 5.0 cm.
4. After fixing the metal reflector, the vertical angle between the horizontal center of the metal reflector and the horizontal center line of the radar is 90°, and the error cannot exceed ±0.5°.

	Aoffset	Xoffset	Yoffset	D	Hsensor
request	90±0.5°	≤±5.0 cm	≤±5.0 cm	1.5~2.5 m	At the same height as the radar installation position

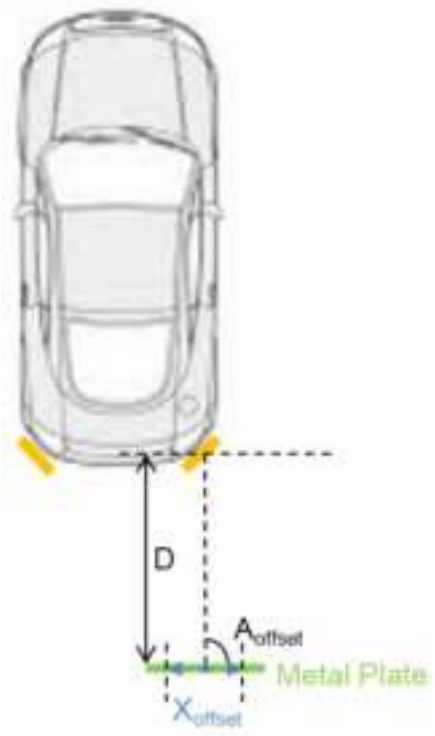


Fig 12. Horizontal layout (unilateral diagram)

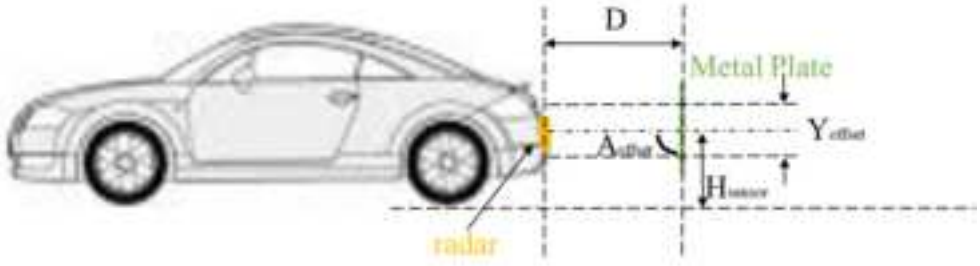


Fig.13 Vertical arrangement (unilateral diagram)

9.6 Calibration process:

Please refer to Figure 14 for the schematic diagram of the installation and calibration process, through the metal reflector target, the deviation angle between the radar axis and the driving direction axis of the body can be measured, and if the deviation angle is within the

installation requirements of CubTEK (the deviation angle ≤ ± 3 degrees), the software will automatically compensate and calibrate the angle and complete the calibration.

However, if the deviation angle exceeds the installation requirements of CubTEK, the OEM needs to send the vehicle back to the maintenance area, readjust the radar bracket, and return it to the calibration platform for installation and calibration.

The calibration time can be measured after the calibration of the production line is established, and the calibration time is subject to the actual measurement (the current internal test calibration time of CubTEK is about 15~30 seconds)

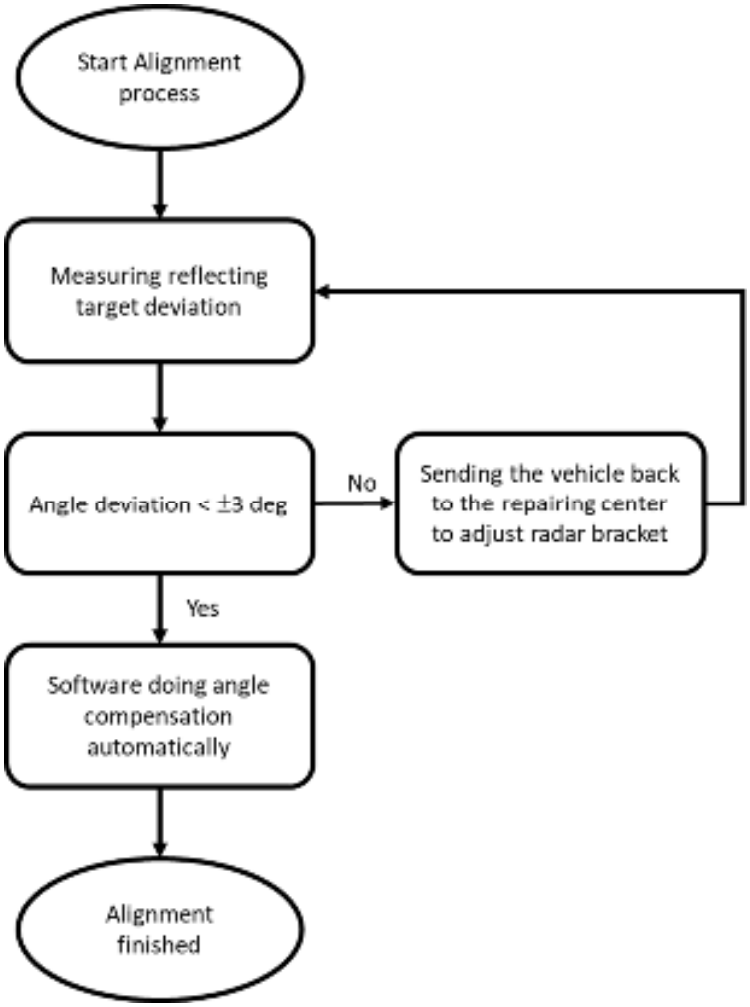


Figure 14 Calibration flow chart

9.7 Vehicle requirements:

The requirements for calibration of vehicles are as follows::

1. Confirm the correct tire pressure.

2. Make sure the vehicle has been aligned before calibration.
3. After confirming that the vehicle is parked and positioned on the calibration platform, the driving axis of the vehicle shall be aligned with the metal reflector, and the maximum deviation shall not exceed ±0.5°.

9.8: Causes of failure of radar calibration :

Radar calibration may fail if:

1. The metal reflector is not in the correct position
2. There is an obstacle in the center of the radar and metal reflector
3. The deviation of the radar installation angle exceeds the specification
4. The horizontal or vertical angle deviation of the metal reflector is too large
5. There are other interfering signals that affect the reflected signal
6. There are other targets in the calibration clearance area that cause stronger reflected signal interference

10 Introduction to connectors and wiring harnesses

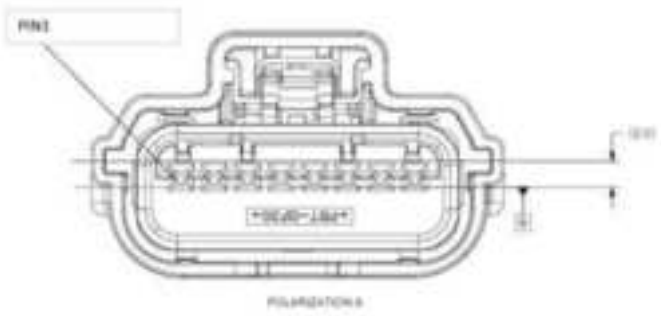


Fig 15 2D drawing of the connector

PIN feet	definition
1	CAN_H
2	CAN_L
3	CAN_H
4	CAN_L
5	VBAT
6	ADD-1
7	ADD-2
8	GND

11 Communication Protocols

Execution is confirmed with the customer.

12 Exclusionary Clauses

Although this product provides blind spot detection and warning function, it may still be affected by the vehicle's driving area, environment, driving behavior, road conditions or climate... Therefore, this product does not guarantee 100% detection and warning accuracy, drivers should abide by traffic rules, stay alert and pay attention to the actual road conditions at any time, drive cautiously, and do not rely too much on this product to avoid accidents.

- Under the following conditions, the radar may give an alarm even if the alarm conditions are not met :
    - o Objects in the vicinity of the vehicle that reflect radar radio waves, such as parked vehicles, guardrails, and walls.
    - o When driving very close to guardrails or concrete walls.
    - o When driving in a tunnel.
    - o When driving a car over a road that lifts water, snow, sand, dirt, etc.
    - o When driving uphill or downhill sections, or on bumpy roads (e.g., slopes).
    - o When driving near curbs, potholes, and tram tracks.
    - o Strongly reflective objects on the ground, such as ditch covers, manhole covers, etc.
- It may be difficult for the radar to detect the target or the radar may not work properly under the following conditions:
    - o When the radar detection area is blocked by a nearby wall or vehicle.
    - o When the radar is obscured by foreign objects such as mud, snow, sand, etc.
    - o Driving in environments with a large reflective area such as too many shrubs and trees.
    - o Affected by similar frequency bands in the vicinity of airports and military sites.
    - o Radio wave interference from radar sensors equipped on nearby vehicles.
    - o Affected by similar frequency bands in the vicinity of airports and military sites.
    - o Bad weather (heavy rain, fog, heavy snowstorms, sandstorms, etc.).
    - o When there is a difference between the driving lane and the adjacent lane.