



## **[A001-029] RCR Radar product manual**

**CubTEK Inc.**

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## Disclaimer

Thank you for purchasing this product, please read this manual carefully before using this product. Once used, it is deemed to have recognized and accepted the contents of this manual, please install and use this product in strict accordance with the manual. SinoTech shall not be liable for any direct or indirect, consequential or specific damages, wear and tear, costs or expenses arising out of or in connection with the use of this document or the products described herein.

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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>**

**Peak Power: 29.02 dBm**

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.

**This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.**

**This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and a human body.**

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### Revision History

Version	Change Description	Date	Modified by	Approved by
V0.1	Initial draft	2022/07/14	刘俊显	
V0.2	Modify the technical content	2022/07/23	刘俊显	
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## 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**

It is used in passenger cars to realize BSD, DOW, RCTA, RCW, LCA and other functions.

## 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
<b>BSD</b>	Blind Spot Detection	盲点侦测
<b>LCA</b>	Lane Change Assist	换道辅助
<b>RCTA</b>	Rear Cross Traffic Assist	后方横向辅助
<b>DOW</b>	Door Open Warning	开门预警
<b>RCW</b>	Rear Collision Warning	后追尾预警
<b>TTC</b>	Time To Collision	预碰撞时间
<b>RCR</b>	Rear Corner Radar	后角雷达
<b>RCRL</b>	Rear Corner Radar Left	左后角雷达
<b>RCRR</b>	Rear Corner Radar Right	右后角雷达



## 4 Standards and Regulations

Standard number	Standard name	Applicable Vehicles	State
ISO 17387:2008	Intelligent Transportation System Lane Change to Decision Aid System (LCDAS) Performance Requirements and Inspection Methods	M、N	Published
GB/T 37471-2019	Performance requirements and detection methods of lane change decision-making assistance system for intelligent transportation system	M 、 N	Published
GB/T 39265-2020	Performance requirements and test methods for road vehicle blind spot monitoring system (BSD).	M、N	Published
C-NCAP-2021	C-NCAP Administrative Rules (2021 Edition)	M1	Published

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

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

Category M2: 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;

Category M3: Passenger cars with no more than 9 seats, including the driver's seat, and a maximum design total mass of more than 5,000 kg;

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

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

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

Category N3: Cargo vehicles with a maximum design total mass of more than 12,000kg;

Category O (trailer)

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

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

Category O3: Trailers with a maximum design total mass of more than 3500kg, but not more than 10000kg;

Category O4: 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, 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
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 2R Angular radar system architecture diagram

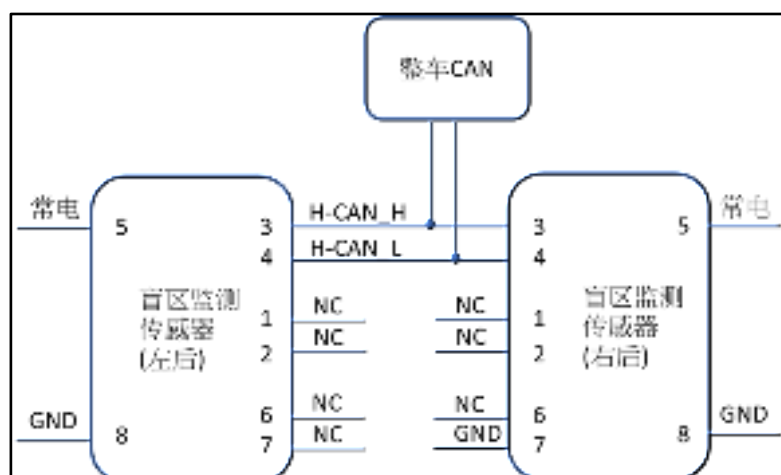
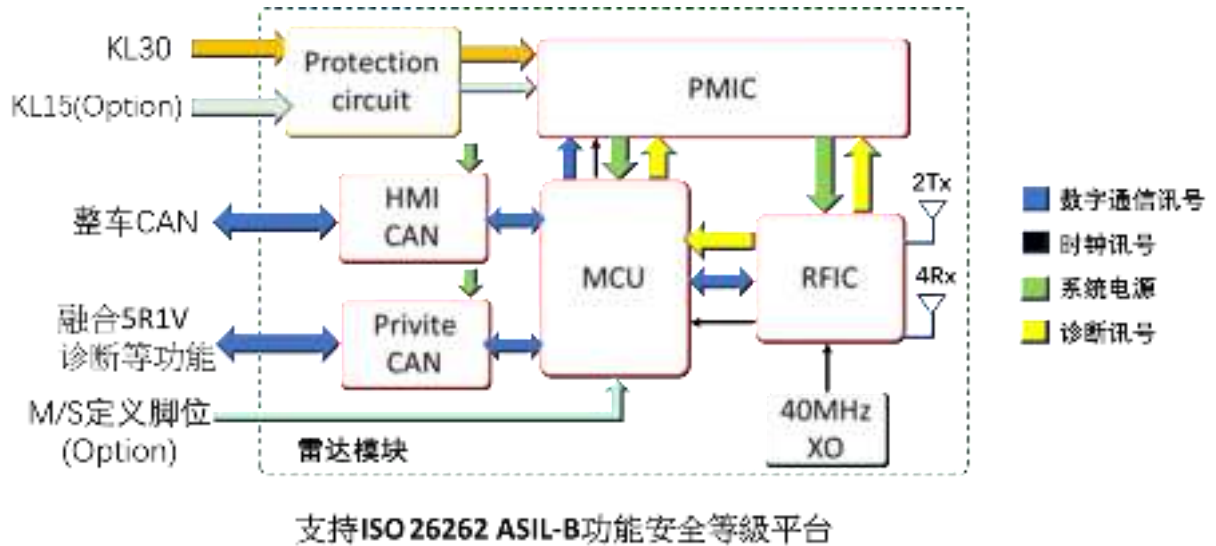
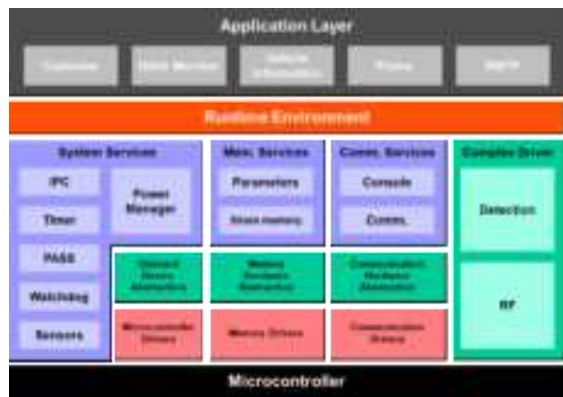


Figure 3 CubTEK 77GHz 2R Corner radar system architecture wiring

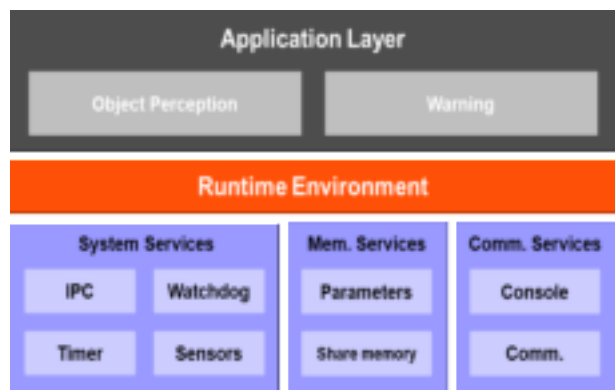
## 6.2 Hardware Block Diagram



## 6.3 Software architecture diagram



Z70



Z71

## 6.4 Schematic diagram of FOV

It can detect 0.4 ~ 80m in front of the vehicle, horizontal FOV  $\pm 75^\circ$ , vertical FOV  $\pm 10^\circ$ .

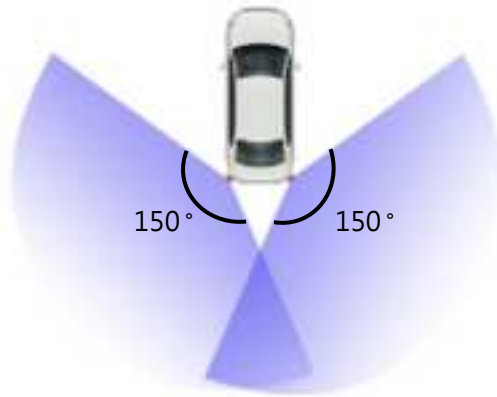


Figure 4      CubTEK 77GHz 2R      Schematic diagram of corner radar FOV

## 7 Functional requirements/功能要求

### 7.1 Blind spot detection (BSD) and Lane change assist (LCA)/盲点检测与换道辅助

BSD is used for monitoring vehicles at the potential blind spots on either side of the vehicle. The LCA function is primarily to warn the driver of from behind oncoming vehicles in the adjacent lane. LCA alerts will active when a quickly closing vehicle is detected and may cause a threat during a lane-change maneuver.

BSD 功能用于监视车辆两侧潜在盲区的车辆。LCA 功能主要是警告驾驶员在相邻车道上从后面驶来的车辆。当检测到快速接近车辆并可能在换道操作期间造成威胁时，LCA 警报将激活。

#### 7.1.1 State diagram/状态图

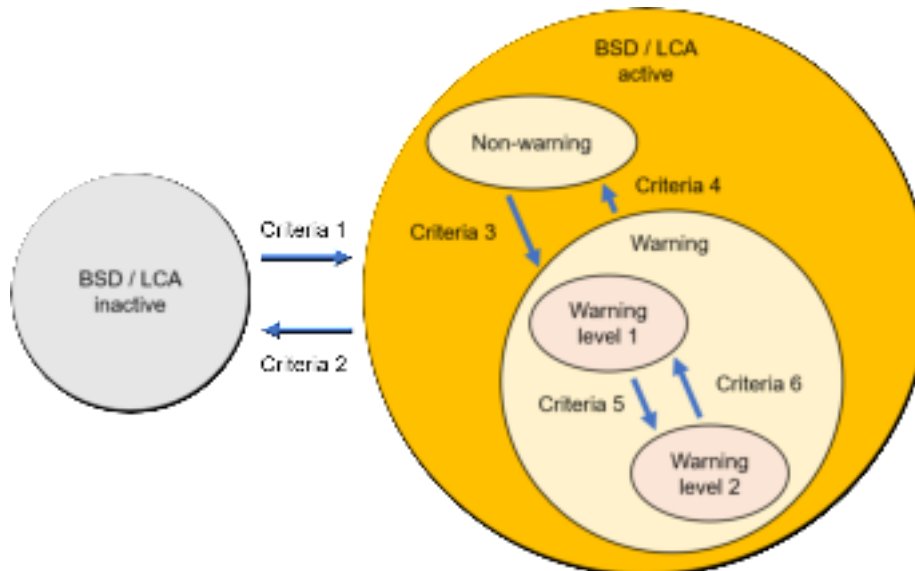


Figure 1 – BSD / LCA state diagram

Table 1 – BSD / LCA operating state and criteria BSD / LCA 的操作状态和条件

Term 术语	Description 定义
BSD / LCA inactive state  BSD / LCA 未激活状态	In this state, the system will detect target vehicles but give no warnings to the driver.  在这种状态下，系统将检测目标车辆，但不向驾驶员发出警告。
BSD / LCA active state  BSD / LCA 激活状态	In the BSD / LCA active state the system will detect target vehicles.  在 BSD / LCA 处于激活状态时，系统将检测目标车辆。

Non-warning state  非警告状态	In the non-warning state the system is active, but the warning requirements are not fulfilled.  在非警告状态下，系统处于激活状态，但未满足警告要求。
Warning state  警告状态	In the warning state the system is active and the warning requirements in Criteria 3 are fulfilled.  在警告状态下，系统处于激活状态，并且满足条件 3 中的警告要求。
Warning level 1 state  1 阶警告状态	The warning given to driver in this state will trigger a LED alert.  在此状态下向驾驶员发出的警告将触发 LED 警报。
Warning level 2 state  2 阶警告状态	The warning given to driver in this state will trigger a LED alert and a buzzer alert.  在此状态下向驾驶员发出的警告将触发 LED 警报和蜂鸣器警报。
Criteria 1  条件 1	The system will transition to BSD / LCA active state if the following conditions are fulfilled: 1. Power ON. 2. The subject vehicle is not in reverse gear. 3. The subject vehicle speed is greater than or equal to 15,0 km/h and less than 190,0 km/h. 4. The curve radius is greater than or equal to 125,0 m.  如果满足以下条件，系统将转换为 BSD / LCA 激活状态： 1. 电源为 ON 档。 2. 本车辆未处于倒档。 3. 本车车速大于或等于时速 15 公里且小于时速 190 公里。 4. 曲率半径大于或等于 125m。
Criteria 2  条件 2	The system will transition to the BSD / LCA inactive state if the corresponding conditions in Criteria 1 are not met.  如果不符合条件 1 中的相应条件，则系统将转换为 BSD / LCA 非激活状态。
Criteria 3  条件 3	The system will transition to the warning state if the warning requirements are fulfilled (See 7.1.2.2).  如果满足警告要求，则系统将转换为警告状态（请参阅 7.1.2.2）。

Criteria 4  条件 4	The system will transition to the warning state if the warning requirements are not fulfilled (See 7.1.2.2).  如果未满足警告要求，则系统将转换为警告状态（请参阅 7.1.2.2）。
Criteria 5  条件 5	The turn signal is on.  转向灯打开。
Criteria 6  条件 6	The turn signal is off.  转向灯关闭。

## 7.1.2 System performance/系统性能

### 7.1.2.1 General/概述

The following lines, illustrated in Figure 2, are needed for the description of the BSD and LCA warning requirements. The designations right, left and behind refer to the driving direction of the subject vehicle. The lane markings in Figure 2 are shown for reference only. All dimensions are given with respect to the subject vehicle.

- Line A shall be parallel to the trailing edge of the subject vehicle and a distance up to 70,0 meters behind it.
- Line B shall be parallel to the trailing edge of the subject vehicle and a distance is 3,0 meters .
- Line C shall be the extension in both directions of the trailing edge of the subject vehicle.
- Line D shall be parallel to the leading edge of the subject vehicle and located at the centre of the 95th percentile eyellipse.
- Line E shall be parallel to the centreline of the subject vehicle and located at the left outermost edge of the subject vehicle's body excluding the exterior mirror.
- Line F shall be parallel to the centreline of the subject vehicle and a distance of 0,5 meter to the left of the left outermost edge of the subject vehicle's body.
- Line G shall be parallel to the centreline of the subject vehicle and a distance of 3,0 meters to the left of the left outermost edge of the subject vehicle's body.
- Line H shall be parallel to the centreline of the subject vehicle and located at the right outermost edge of the subject vehicle's body excluding the exterior mirror.
- Line I shall be parallel to the centreline of the subject vehicle and a distance of 0,5 meter to the left of the right outermost edge of the subject vehicle's body.
- Line J shall be parallel to the centreline of the subject vehicle and a distance of 3,0 meters to the left of the right outermost edge of the subject vehicle's body.

描述 BSD 和 LCA 警告需要符合图 2 中所示。图中线条旨在更准确说明盲区监测警告要求，右侧、左侧和后部等描述参考试验车的行驶方向，图中所有给出的尺寸均相对试验车而言，道标记仅供参考。

- 直线 A 与本车尾边缘平行，距离为 70.0m。



- 直线 B 与本车尾边缘平行，距离为 3.0 米。
- 直线 C 应是本车尾边缘在两个方向上的延伸。
- 直线 D 应平行于车头前边缘，并未于第九十五百分位眼椭圆的中心。
- 直线 E 与本车中心线平行，和本车左边缘线重合（外后视镜除外）。
- 直线 F 与本车中心线平行，距离本车左边缘线 0.5m。
- 直线 G 与本车中心线平行，距离本车左边缘线 3.0m。
- 直线 H 与本车中心线平行，和本车右边缘线重合（外后视镜除外）。
- 直线 I 与本车中心线平行，距离本车右边缘线 0.5m。
- 直线 J 与本车中心线平行，距离本车右边缘线 3.0m。

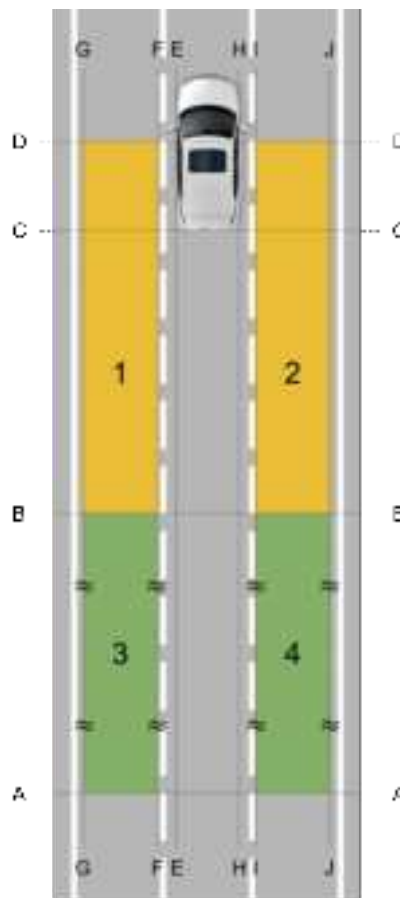


Figure 2 – BSD / LCA warning requirements diagram

#### 7.1.2.2 BSD warning requirements/ BSD 警告要求

The BSD function shall provide coverage of the left and right adjacent zones. As shown in Figure 2, the yellow areas 1 and 2 are the active areas of the BSD function.

BSD 功能应提供左右相邻区域的覆盖范围。如图 2 所示，黄色区域 1 和 2 是 BSD 功能的激活区域。

- **Left side blind spot warning requirements/左侧盲点警告要求**

Referring to Figure 2, a left side blind spot warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line B.
- The target vehicle is entirely behind line D when it overtakes the subject vehicle from the rear.
- Any part of the target vehicle is behind line C when the subject vehicle overtakes the target vehicle.
- The target vehicle is entirely to the left of line F.
- Any part of the target vehicle is to the right of line G.
- The relative speed of the target vehicle between -70,0 km/h and 15,0 km/h.

参照图 2，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出左侧盲区警告：

- 目标车辆的任何一部分在直线 B 的前方。
- 当目标车辆从后方超越目标车辆时，它完全位于直线 D 的后面。
- 当本车辆超越目标车辆时，目标车辆的任何一部分位于直线 C 之后。
- 目标车辆完全在直线 F 的左侧。
- 目标车辆的任何一部分在直线 G 的右侧。
- 目标车辆的相对速度在-70 km/h 和 15 km/h 之间。

- **Right side blind spot warning requirements/右侧盲点警告要求**

Referring to Figure 2, a right side blind spot warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line B.
- The target vehicle is entirely behind line D when it overtakes the subject vehicle from the rear.
- Any part of the target vehicle is behind line C when the subject vehicle overtakes the target vehicle.
- The target vehicle is entirely to the right of line I.
- Any part of the target vehicle is to the left of line J.
- The relative speed of the target vehicle between -70,0 km/h and 15,0 km/h.

参照图 2，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出右侧盲区警告：

- 目标车辆的任何一部分在直线 B 的前方。
  - 当目标车辆从后方超越目标车辆时，且完全位于直线 D 的后面。
  - 当本车辆超越目标车辆时，目标车辆的任何一部分位于直线 C 之后。
  - 目标车辆完全在直线 I 的右侧。
-

- 目标车辆的任何一部分在直线 J 的左侧。
- 目标车辆的相对速度在 -70 km/h 和 15 km/h 之间。

### 7.1.2.3 LCA warning requirements/LCA 警告要求

The LCA function shall provide coverage of the left and right rear zones. As shown in Figure 2, the green areas 3 and 4 are the active areas of the LCA function. The side borders of the active areas (line G, F, I, J) shall be adjusted according to the roadway radius of curvature.

LCA 应覆盖左右侧后方区域，如图二所示，绿色区域 3 和 4 为 LCA 的作用区域。其中，作用区域的侧边界（直线 G, F, I, J）需要根据道路的弯道半径进行调整。

#### • Left side lane change warning requirements/左侧换道警告需求

Referring to Figure 2, a left side lane change warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line A.
- Any part of the target vehicle is behind of line B.
- The target vehicle is entirely to the left of line F.
- Any part of the target vehicle is to the right of line G.
- The relative speed of the target vehicle between -70,0 km/h and 0,0 km/h.
- The target vehicle's TTC is less than or equal to 3,5 seconds.

参照图 2，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出左侧车道变更警告：

- 目标车辆的任何一部分位于直线 A 的前方。
- 目标车辆的任何一部分在直线 B 后面。
- 目标车辆完全在直线 F 的左侧。
- 目标车辆的任何一部分在直线 G 的右侧。
- 目标车辆的相对速度在 -70 km/h 和 0 km/h 之间。
- 目标车辆的 TTC 小于或等于 3.5 秒。

#### • Right side lane change warning requirements/右侧换道警告需求

Referring to Figure 2, a right side lane change warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line A.
  - Any part of the target vehicle is behind of line B.
  - The target vehicle is entirely to the right of line I.
-

- Any part of the target vehicle is to the left of line J.
- The relative speed of the target vehicle between -70,0 km/h and 0,0 km/h.
- The target vehicle's TTC is less than or equal to 3,5 seconds.

参照图 2，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出右侧车道变更警告：

- 目标车辆的任何一部分位于直线 A 的前方。
- 目标车辆的任何一部分在直线 B 后面。
- 目标车辆完全在直线 I 的右侧。
- 目标车辆的任何一部分在直线 J 的左侧。
- 目标车辆的相对速度在 -70 km/h 和 0 km/h 之间。
- 目标车辆的 TTC 小于或等于 3.5 秒。

## 7.2 Rear Cross Traffic Assist (RCTA)/倒车横向辅助

The RTCA system provides information to the driver in the event of a vehicle approaching from the left-hand-side or right-hand-side rear of the vehicle during reversing maneuvers. In this mode, the omni-directional tracking algorithm is used to detect targets in the radar FOV, and the warning zone is adjusted by the attack angle of each target vehicle individually.

如果在倒车操作期间目标车辆从本车辆的左侧或右侧后方驶近，则 RTCA 系统会向驾驶员提供警告。在这种模式下，使用全方位跟踪算法检测雷达视场中的目标，并根据每个目标车辆的行径角度分别调整警告区域。

### 7.2.1 State diagram/状态图

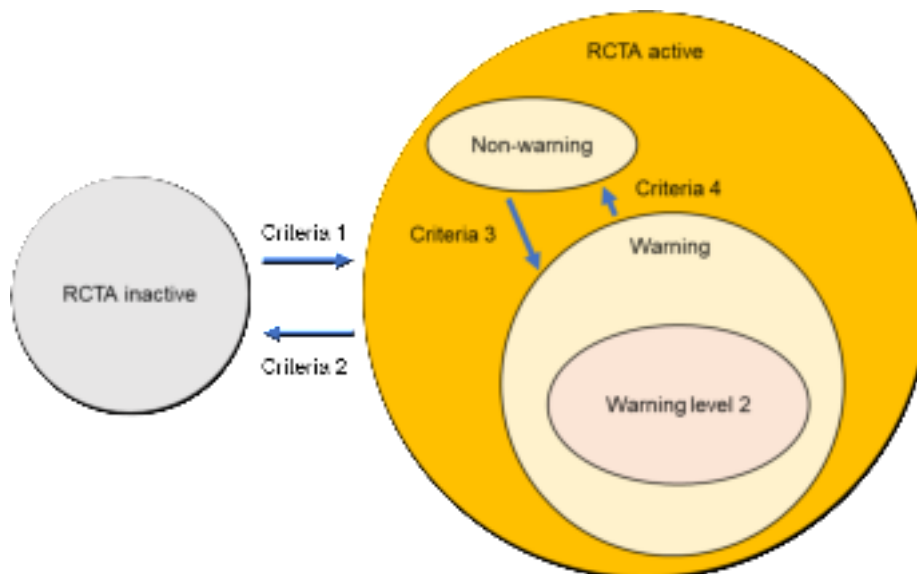


Figure 3 – RCTA state diagram

**Table 2 – RCTA operating state and criteria/ RCTA 的操作状态和条件**

Term 术语	Description 定义
RCTA inactive state  RCTA 未激活状态	In this state, the system will detect target vehicles but give no warnings to the driver.  在这种状态下，系统将检测目标车辆，但不向驾驶员发出警告。
RCTA active state  RCTA 激活状态	In the RCTA active state the system will detect target vehicles.  在 RCTA 处于激活状态时，系统将检测目标车辆。
Non-warning state  非警告状态	In the non-warning state the system is active, but the warning requirements are not fulfilled.  在非警告状态下，系统处于激活状态，但未满足警告要求。
Warning state  警告状态	In the warning state the system is active and the warning requirements in Criteria 3 are fulfilled.  在警告状态下，系统处于激活状态，并且满足条件 3 中的警告要求。
Warning level 2 state  2 阶警告状态	The warning given to driver in this state will trigger a LED alert and a buzzer alert.  在此状态下向驾驶员发出的警告将触发 LED 警报和蜂鸣器警报。
Criteria 1  条件 1	The system will transition to the RCTA active state if all of the following conditions are fulfilled:  1. Power ON. 2. The subject vehicle is in reverse gear. 3. The subject vehicle speed is less than or equal to 10,0 km/h.  如果以下条件全部满足，系统将转换为 RCTA 激活状态： 1. 电源为 ON 档 2. 本车辆处于倒档。 3. 本车车速小于或等于时速 10 公里。
Criteria 2  条件 2	The system will transition to the RCTA inactive state if any condition in Criteria 1 is not met.  如果条件 1 中的任一条件不满足，系统将转换为 RCTA 未激活状态。
Criteria 3	The system will transition to the warning state if the warning requirements are fulfilled (See 7.2.2.2).

条件 3	如果满足警告要求（请参阅 7.2.2.2），系统将转换为警告状态。
Criteria 4	The system will transition to the warning state if the warning requirements are not fulfilled (See 7.2.2.2).
条件 4	如果满足警告要求（请参阅 7.2.2.2），系统将转换为警告状态。

## 7.2.2 System performance/系统性能

### 7.2.2.1 General/概述

The following lines, illustrated in Figure 4, are needed for the description of the RCTA warning requirements. The lane markings in Figure 4 are shown for reference only. All dimensions are given with respect to the subject vehicle.

- Line A shall be parallel to the target vehicle's heading direction and adjusted by each target vehicle accordingly and a distance of 6,5 meters behind the trailing edge of the subject vehicle.
- Line B shall be crossed the intersection of Line D and Line I and parallel to the target vehicle's heading direction and adjusted by each target vehicle accordingly.
- Line C shall be crossed the intersection of Line D and Line G and parallel to the target vehicle's heading direction and adjusted by each target vehicle accordingly.
- Line D shall be the extension in both directions of the trailing edge of the subject vehicle.
- Line E shall be parallel to the leading edge of the subject vehicle and located at the centre of the 95th percentile eyellipse.
- Line F shall be the extension in both directions of the centreline of the subject vehicle.
- Line G shall be parallel to the centreline of the subject vehicle and located at the left outermost edge of the subject vehicle's body excluding the exterior mirror.
- Line H shall be parallel to the centreline of the subject vehicle and a distance of 50,0 meters to the left of the left outermost edge of the subject vehicle's body.
- Line I shall be parallel to the centreline of the subject vehicle and located at the right outermost edge of the subject vehicle's body excluding the exterior mirror.
- Line J shall be parallel to the centreline of the subject vehicle and a distance of 50,0 meters to the right of the right outermost edge of the subject vehicle's body.
- Line K shall be crossed the intersection of Line C and Line G and an angle of 10 degrees with Line G.
- Line L shall be crossed the intersection of Line B and Line I and an angle of 10 degrees with Line I.

描述 RCTA 警告需要符合图 4 中所示。图中所有给出的尺寸均相对试验车而言，道标记仅供参考。

- 直线 A 与本车尾边缘平行，距离为 6.5m
- 直线 B 应与直线 D 与直线 I 相交，并与目标车辆的前进方向平行，并应由每个目标车辆进行相应调整。
- 直线 C 应与直线 D 和直线 G 的交叉点相交，并平行于目标车辆的前进方向，并由每个目标车辆相应地进行调整。
- 直线 D 应是本车辆后缘在两个方向上的延伸。

- 直线 E 应平行于本车辆的前缘，并未于第九十五百分位眼椭圆的中心。
- 直线 F 应是本车辆中心线在两个方向上的延长线。
- 直线 G 与本车中心线平行，和本车左边缘线重合（外后视镜除外）。
- 直线 H 与本车中心线平行，距离本车左边缘线 50.0m。
- 直线 I 与本车中心线平行，和本车右边缘线重合（外后视镜除外）。
- 直线 J 与本车中心线平行，距离本车右边缘线 50.0m。
- 直线 K 线应与直线 C 和直线 G 相交，并与直线 G 成 10 度角。
- 直线 L 线应与直线 B 和直线 I 相交，并与直线 I 成 10 度角。

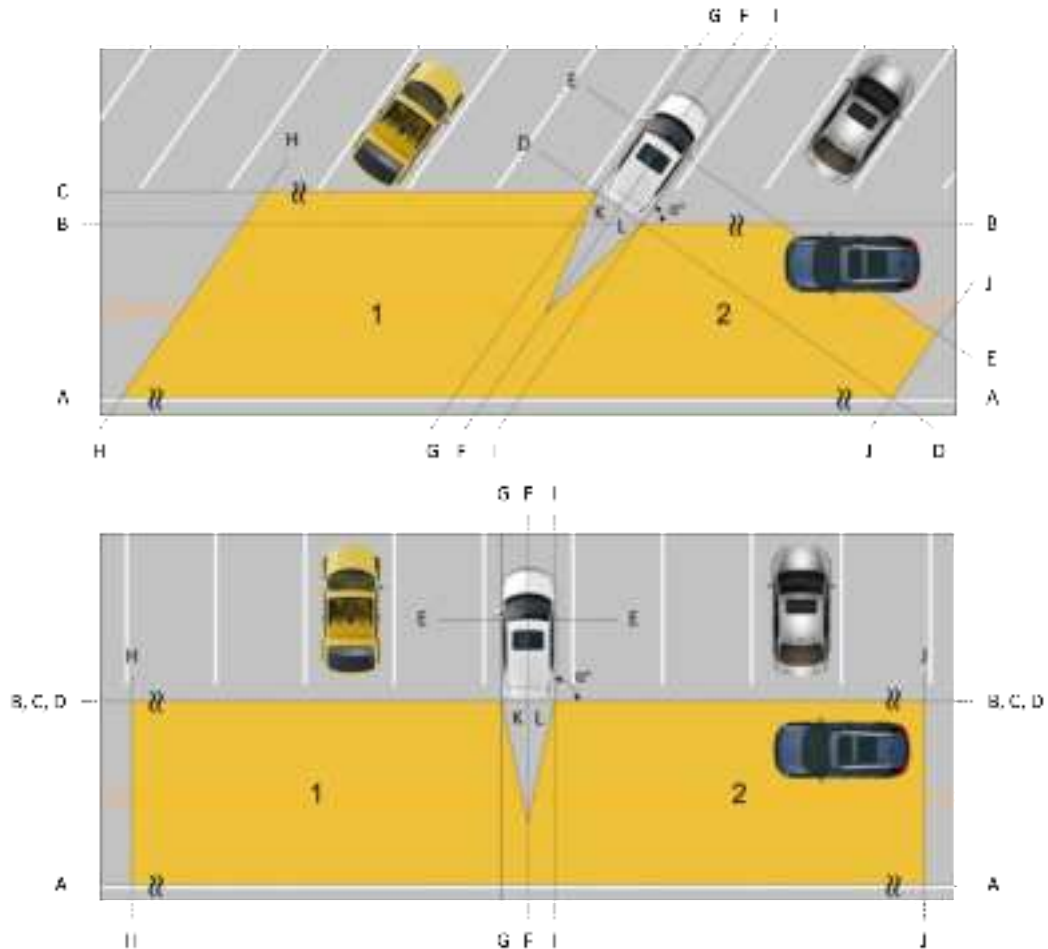


Figure 4 – RCTA warning requirements diagram

#### 7.2.2.2 RCTA warning requirements/ RCTA 警告要求

Referring to **Figure 4**, when the angle  $\alpha$  between the target vehicle's heading direction and centreline of the subject vehicle is  $45^\circ \leq \alpha \leq 135^\circ$ , the yellow areas 1 and 2 are the RCTA active areas, they shall be adjusted according to the angle  $\alpha$  and the side borders. Figure 4 shows the scenes where the angle  $\alpha$  is  $55^\circ$  and  $90^\circ$  respectively.

参照图 4，当目标车辆的前进方向与本车辆的中心线之间的角度  $\alpha$  为  $45^\circ \leq \alpha \leq 135^\circ$  时，黄色区域 1 和 2 为 RCTA 激活区域，应根据该角度进行调整  $\alpha$  和侧面边界。图 4 出示了角度  $\alpha$  分别为  $55^\circ$  和  $90^\circ$  的场景。

• **Left side closing vehicle warning requirements/左侧接近车辆警告需求**

Referring to Figure 4, a left side closing vehicle warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line A.
- Any part of the target vehicle is behind of line C.
- Any part of the target vehicle is behind of line E.
- Any part of the target vehicle is to the left of line F.
- Any part of the target vehicle is to the left of line K.
- Any part of the target vehicle is to the right of line H.
- The target vehicle is moving.
- The relative speed of the target vehicle between -50,0 km/h and 0,0 km/h.
- The target vehicle's TTC is less than or equal to 2,0 seconds.

参照图 4，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出左侧接近车辆警告：

- 目标车辆的任何一部分位于直线 A 的前方。
- 目标车辆的任何一部分都在直线 C 的后面。
- 目标车辆的任何一部分都在直线 E 的后面。
- 目标车辆的任何一部分在直线 F 的左侧。
- 目标车辆的任何一部分在直线 K 的左侧。
- 目标车辆的任何一部分在直线 H 的右侧。
- 目标车辆正在移动。
- 目标车辆的相对速度在 -50 km/h 和 0 km/h 之间。
- 目标车辆的 TTC 小于或等于 2.0 秒。

• **Right side closing vehicle warning requirements/右侧接近车辆警告需求**

Referring to Figure 4, a right side closing vehicle warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line A.
  - Any part of the target vehicle is behind of line B.
  - Any part of the target vehicle is behind of line E.
  - Any part of the target vehicle is to the right of line F.
-



- Any part of the target vehicle is to the right of line L.
- Any part of the target vehicle is to the left of line J.
- The target vehicle is moving.
- The relative speed of the target vehicle between -50,0 km/h and 0,0 km/h.
- The target vehicle's TTC is less than or equal to 2,0 seconds.

参照图 4，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出右侧接近车辆警告：

- 目标车辆的任何一部分位于直线 A 的前方。
- 目标车辆的任何一部分都在直线 B 的后面。
- 目标车辆的任何一部分都在直线 E 的后面。
- 目标车辆的任何一部分在直线 F 的右侧。
- 目标车辆的任何一部分在直线 L 的右侧。
- 目标车辆的任何一部分在直线 J 的左侧。
- 目标车辆正在移动。
- 目标车辆的相对速度在 -50 km/h 和 0 km/h 之间。
- 目标车辆的 TTC 小于或等于 2.0 秒。

### 7.3 Door Open Warning (DOW)/开门预警

This feature is intended to assist passengers when exiting the SV when parked alongside busy roads. The radar modules continuously scan the side-rear of the SV to detect approaching vehicles. If the approaching vehicle satisfies the TTC criteria and also has a direction vector that intersects a defined activation area, then a warning will be triggered.

当停在繁忙道路旁开启车门时此功能为乘客提供帮助。雷达模块连续扫描本车的后部，以检测接近的车辆。如果接近的车辆满足 TTC 条件，并且还具与定义的激活区域相交的方向矢量，则会触发警告。

### 7.3.1 State diagram/状态图

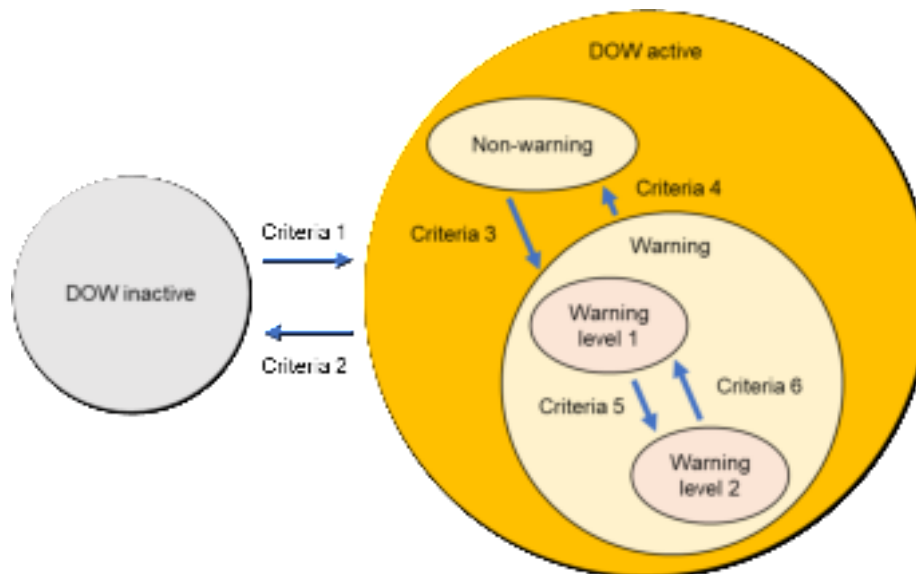


Figure 5 – DOW state diagram

Table 3 – DOW operating state and criteria/DOW 的操作状态和条件

Term	Description
DOW inactive state DOW 未激活状态	In this state, the system will detect target vehicles but give no warnings to the driver. 在这种状态下，系统将检测到目标车辆，但不向驾驶员发出警告。
DOW active state DOW 激活状态	In the DOW active state the system will detect target vehicles. 在 DOW 处于激活状态时，系统将检测目标车辆。
Non-warning state 非警告状态	In the non-warning state the system is active, but the warning requirements are not fulfilled. 在非警告状态下，系统处于激活状态，但未满足警告要求。
Warning state 警告状态	In the warning state the system is active and the warning requirements in Criteria 3 are fulfilled. 在警告状态下，系统处于激活状态，并且满足条件 3 中的警告要求。
Warning level 1 state 1 阶警告状态	The warning given to driver in this state will trigger a LED alert. 在此状态下向驾驶员发出的警告将触发 LED 警报。

Warning level 2 state  2 阶警告状态	The warning given to driver in this state will trigger a LED alert and a buzzer alert.  在此状态下向驾驶员发出的警告将触发 LED 警报和蜂鸣器警报。
Criteria 1  条件 1	The system will transition to the DOW active state if all of the following conditions are fulfilled:  1. Power ON. 2. The subject vehicle is in parking gear. 3. The subject vehicle speed is equal to 0 km/h.  如果全部满足以下条件，系统将转换为 DOW 激活状态：  1. 电源为 ON 档。 2. 本车辆处于停车档。 3. 本车车速等于时速 0 公里。
Criteria 2  条件 2	The system will transition to the DOW inactive state if any condition in Criteria 1 is not met.  如果条件 1 中的任一条件不满足，系统将转换为 DOW 未激活状态。
Criteria 3  条件 3	The system will transition to the warning state if the warning requirements are fulfilled (See 7.3.2.2).  如果满足警告要求（请参阅 7.3.2.2），系统将转换为警告状态。
Criteria 4  条件 4	The system will transition to the warning state if the warning requirements are not fulfilled (See 7.3.2.2).  如果满足警告要求（请参阅 7.3.2.2），系统将转换为警告状态。
Criteria 5  条件 5	The door is open.  车门开启。
Criteria 6  条件 6	The door is close.  车门关闭。

## 7.3.2 System performance/系统性能

### 7.3.2.1 General/概述

The following lines, illustrated in Figure 6, are needed for the description of the DOW warning requirements. The designations right, left and behind refer to the driving direction of the subject vehicle. The lane markings in Figure 6 are shown for reference only. All dimensions are given with respect to the subject vehicle.

- Line A shall be parallel to the trailing edge of the subject vehicle and a distance up to 50,0 meters behind it.
- Line B shall be the extension in both directions of the trailing edge of the subject vehicle.
- Line C shall be parallel to the leading edge of the subject vehicle and located at the centre of the 95th percentile eyellipse.
- Line D shall be parallel to the centreline of the subject vehicle and located at the left outermost edge of the subject vehicle's body excluding the exterior mirror.
- Line E shall be parallel to the centreline of the subject vehicle and a distance of 0,5 meter to the left of the left outermost edge of the subject vehicle's body.
- Line F shall be parallel to the centreline of the subject vehicle and a distance of 3,0 meters to the left of the left outermost edge of the subject vehicle's body.
- Line G shall be parallel to the centreline of the subject vehicle and located at the right outermost edge of the subject vehicle's body excluding the exterior mirror.
- Line H shall be parallel to the centreline of the subject vehicle and a distance of 0,5 meter to the left of the right outermost edge of the subject vehicle's body.
- Line I shall be parallel to the centreline of the subject vehicle and a distance of 3,0 meters to the left of the right outermost edge of the subject vehicle's body.

描述 DOW 警告需要符合图 6 中所示。右侧、左侧和后部等描述参考试验车的行驶方向，图中所有给出的尺寸均相对试验车而言，道标记仅供参考。

- 直线 A 与本车尾边缘平行，距离为 50.0m。
- 直线 B 应是本车尾边缘在两个方向上的延伸。
- 直线 C 应平行于车头前边缘，并未于第九十五百分位眼椭圆的中心。
- 直线 D 与本车中心线平行，和本车左边缘线重合（外后视镜除外）。
- 直线 E 与本车中心线平行，距离本车左边缘线 0.5m。
- 直线 F 与本车中心线平行，距离本车左边缘线 3.0m。
- 直线 G 与本车中心线平行，和本车右边缘线重合（外后视镜除外）。
- 直线 H 与本车中心线平行，距离本车右边缘线 0.5m。
- 直线 I 与本车中心线平行，距离本车右边缘线 3.0m。

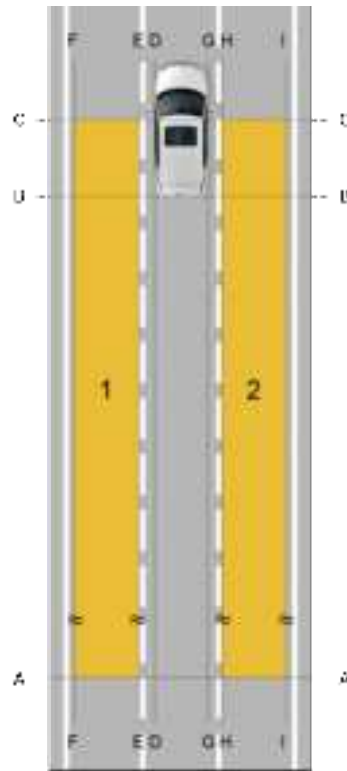


Figure 6 – DOW warning requirements diagram

### 7.3.2.2 DOW warning requirements/DOW 警告需求

- Left side vehicle warning requirement/左侧接近车辆警告需求

Referring to Figure 6, a left side closing vehicle warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line A.
- Any part of the target vehicle is behind of line B.
- Any part of the target vehicle is to the left of line E.
- Any part of the target vehicle is to the right of line F.
- The relative speed of the target vehicle between -70,0 km/h and 0,0 km/h.
- TTC less than or equal to 2,0 seconds.

参照图 6，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出左侧接近车辆警告：

- 目标车辆的任何一部分在直线 A 的前方。
- 目标车辆的任何一部分在直线 B 的后方。。
- 目标车辆完全在直线 E 的左侧。
- 目标车辆的任何一部分在直线 F 的右侧。
- 目标车辆的相对速度在-70 km/h 和 0 km/h 之间。

- 目标车辆的 TTC 小于或等于 2.0 秒。

- **Right side vehicle warning requirements/右侧接近车辆警告需求**

Referring to Figure 6, a right side closing vehicle warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:

- Any part of the target vehicle is forward of line A.
- Any part of the target vehicle is behind of line B.
- Any part of the target vehicle is to the right of line H.
- Any part of the target vehicle is to the left of line I.
- The relative speed of the target vehicle between -70,0 km/h and 0,0 km/h.
- The target vehicle's TTC is less than or equal to 2,0 seconds.

参照图 6，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出右侧接近车辆警告：

- 目标车辆的任何一部分在直线 A 的前方。
- 目标车辆的任何一部分在直线 B 的后方。。
- 目标车辆完全在直线 H 的右侧。
- 目标车辆的任何一部分在直线 I 的左侧。
- 目标车辆的相对速度在-70 km/h 和 0 km/h 之间。
- 目标车辆的 TTC 小于或等于 2.0 秒。

## 7.4 Rear Collision Warning (RCW)/后追尾预警

This feature is intended to reduce the occurrence of such accidents by providing a warning to the following vehicle when there is a high risk of collision . Each type of warning becomes active when the TTC drops below a defined threshold value.

此功能透过在发生高碰撞风险时向后方车辆发出警告，以此来减少此类事故的发生。当 TTC 降至定义的阈值以下时，每种类型的警告都会激活。

### 7.4.1 State diagram/状态图

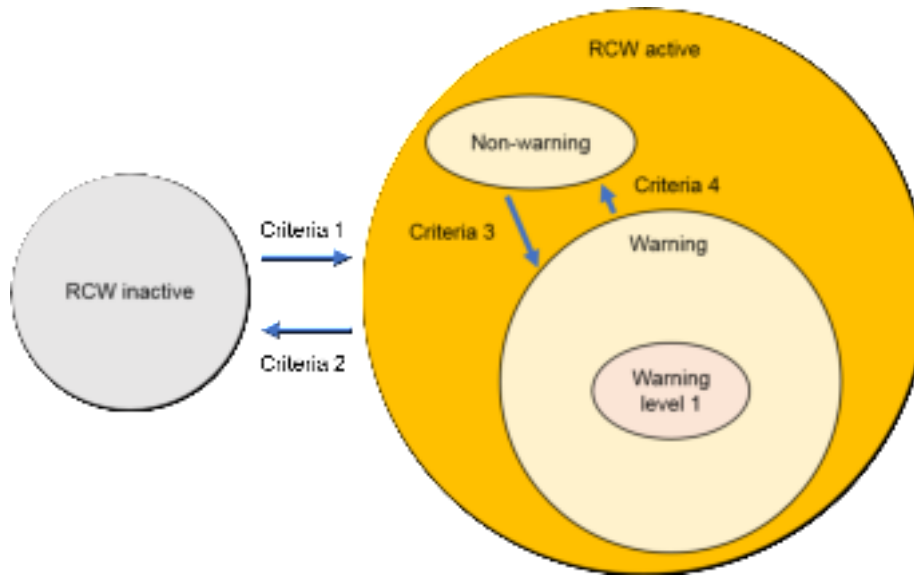


Figure 7 – RCW state diagram

Table 4 – RCW operating state and criteria/ RCW 的操作状态和条件

Term	Description
RCW inactive state RCW 未激活状态	In this state, the system will detect target vehicles but give no warnings to the driver. 在这种状态下，系统将检测到目标车辆，但不向驾驶员发出警告。
RCW active state RCW 激活状态	In the RCW active state the system will detect target vehicles. 在 RCW 处于激活状态时，系统将检测目标车辆。
Non-warning state 非警告状态	In the non-warning state the system is active, but the warning requirements are not fulfilled. 在非警告状态下，系统处于激活状态，但未满足警告要求。
Warning state 警告状态	In the warning state the system is active and the warning requirements in Criteria 3 are fulfilled. 在警告状态下，系统处于激活状态，并且满足条件 3 中的警告要求。
Warning level 1 state 1 阶警告状态	The warning given to driver in this state will trigger a LED alert. 在此状态下向驾驶员发出的警告将触发 LED 警报。

Criteria 1  条件 1	<p>The system will transition to the RCW active state if all of the following conditions are fulfilled:</p> <ol style="list-style-type: none"> <li>1. Power ON.</li> <li>2. The subject vehicle is in driving gear.</li> <li>3. The subject vehicle speed is greater than or equal to 15,0 km/h and less than 190,0 km/h.</li> <li>4. The curve radius is greater than or equal to 125,0 m.</li> </ol> <p>•</p> <p>如果以下条件完全满足，系统将转换为 RCW 激活状态：</p> <ol style="list-style-type: none"> <li>1. 电源为 ON 档</li> <li>2. 本车辆处于开车档</li> <li>3. 本车车速大于或等于时速 15 公里且小于时速 190 公里</li> <li>4. 曲率半径大于或等于 125 m</li> </ol>
Criteria 2  条件 2	<p>The system will transition to the RCW inactive state if any condition in Criteria 1 is not met.</p> <p>如果条件 1 中的任一条件不满足，系统将转换为 DOW 未激活状态。</p>
Criteria 3  条件 3	<p>The system will transition to the warning state if the warning requirements are fulfilled (See 7.4.2.2).</p> <p>如果满足警告要求（请参阅 7.4.2.2），系统将转换为警告状态。</p>
Criteria 4  条件 4	<p>The system will transition to the warning state if the warning requirements are not fulfilled (See 7.4.2.2 ).</p> <p>如果满足警告要求（请参阅 7.4.2.2），系统将转换为警告状态。</p>

## 7.4.2 System performance/系统性能

### 7.4.2.1 General/概述

The following lines, illustrated in Figure 8, are needed for the description of the RCW warning requirements. The designations right, left and behind refer to the driving direction of the subject vehicle. The lane markings in Figure 8 are shown for reference only. All dimensions are given with respect to the subject vehicle.

- Line A shall be parallel to the trailing edge of the subject vehicle and a distance up to 70,0 meters behind it.
- Line B shall be the extension in both directions of the trailing edge of the subject vehicle.
- Line C shall be parallel to the leading edge of the subject vehicle and located at the centre of the 95th percentile eyellipse.
- Line D shall be parallel to the centreline of the subject vehicle and located at the left outermost edge of the subject vehicle's body excluding the exterior mirror.



- Line E shall be parallel to the centreline of the subject vehicle and located at the right outermost edge of the subject vehicle's body excluding the exterior mirror.

描述 RCW 警告需要符合图 8 中所示。右侧、左侧和后部等描述参考试验车的行驶方向，图中所有给出的尺寸均相对试验车而言，道标记仅供参考。

- 直线 A 与本车尾边缘平行，距离为 70.0m
- 直线 B 应是本车尾边缘在两个方向上的延伸。
- 直线 C 应平行于车头前边缘，并未于第九十五百分位眼椭圆的中心。
- 直线 D 与本车中心线平行，和本车左边缘线重合（外后视镜除外）。
- 直线 E 与本车中心线平行，和本车右边缘线重合（外后视镜除外）。

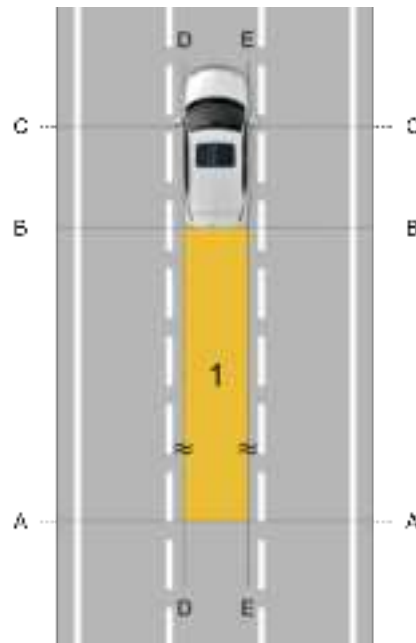


Figure 8 – RCW warning requirements diagram

#### 7.4.2.2 RCW warning requirements/ RCW 警告需求

The RCW function shall provide coverage of the rear zones. As shown in Figure 8, the yellow area 1 is the active area of the RCW function. The side borders of the active areas (line D, E) shall be adjusted according to the roadway radius of curvature.

RCW 功能应覆盖后方区域。如图 8 所示，黄色区域 1 是 RCW 功能的激活区域。激活区域（D，E 线）的侧边界应根据曲率半径进行调整。

#### Closing vehicle warning requirements

Referring to Figure 8, a closing vehicle warning shall be issued to the subject vehicle driver if a target vehicle satisfies all of the following conditions:


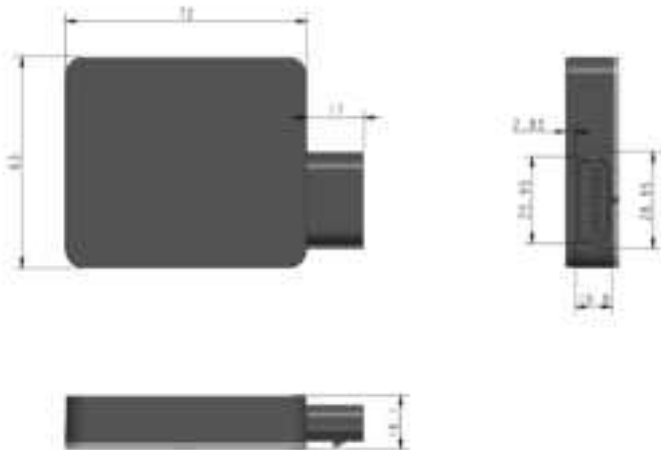
- Any part of the target vehicle is forward of line A.
- Any part of the target vehicle is behind of line B.
- Any part of the target vehicle is to the left of line E.
- Any part of the target vehicle is to the right of line D.
- The relative speed of the target vehicle between -70,0 km/h and 0,0 km/h.
- The target vehicle's TTC is less than or equal to 1,5 seconds.

参照图 8，如果目标车辆满足以下所有条件，则应向本车辆驾驶员发出接近车辆警告：

- 目标车辆的任何一部分在直线 A 的前方。
- 目标车辆的任何一部分在直线 B 的后方。。
- 目标车辆完全在直线 E 的左侧。
- 目标车辆的任何一部分在直线 D 的右侧。
- 目标车辆的相对速度在-70 km/h 和 0 km/h 之间。
- 目标车辆的 TTC 小于或等于 1.5 秒。

## 8 Specification Introduction

### 8.1 8 Specification Introduction

雷达产品规格 Specification Introduction	角雷达 Corner Radar
产品图 Product drawing	
应用 Application	BSD、LCA、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	 <p>EX: 63 (L) x 72 (W) x 16.1 (D) (mm)</p>
接插件型号 Connector	MOLEX 314049110
系统匹配 (公版) Other modules (Public version)	无控制器
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 路
CAN 数据帧 (对外界面) CAN data frame	标准帧
CAN 速度 (HMI-CAN 对外界面)	2M/4M
CAN FD (对外界面)	V (仅支援 8 bytes 封包)
车辆讯号 - 车速 Vehicle signal - Speed	V (必须要)
车辆讯号 - 文件位 Vehicle signal - Gear	V (必须要)
车辆讯号 - 车门 Vehicle signal - Door	V (必须要)
车辆讯号 - 方向灯 Vehicle signal - Turn Indicator	V (必须要)
车辆讯号 - 方向盘转角 Vehicle signal - Steering Angle	V (必须要)
车辆讯号 - 点火讯号 (开/关) Vehicle signal - Ignition (ON/OFF)	V (必须要)
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 个
最大输出点云数 Max cluster output number	128 个

## 8.2 性能规格

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	°	(不支援)
	分辨率 / Resolution	°	(不支援)

### 8.3 Function Specification

雷达功能规格 Function Specification	角雷达 Corner Radar
安装标定方式	下线标定 动态标定
UDS 诊断功能 UDS diagnositic function	V (支援)
UDS 更新功能 UDS Firmware update function	V (支援)
网络管理功能 Netork management function	V (支援)
回滚备份 Rollback and Recovery	V (支援)
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 (支援)
雷达遮蔽侦测功能 BSD Blockage	V (支援)

## 9 Installation Specifications

### 9.1 Basic requirements for installation

Parameter	Request
Installation height (radar center from ground)/安装高度 (雷达中心距离地面)  PS: This height is the worst case in an empty or full load  PS: 此高度为空载或满载中的 worst case	suggestion: 500mm–700mm
The angle between the radar axis and the vehicle driving axis/雷达轴线与车辆行驶轴线夹角	The body angle should be optimally set to 40 degrees,  Tolerance $\leq \pm 3$ degrees 车身夹角应最佳设定为 40 度, 公差 $\leq \pm 3$ 度
The perpendicular angle to the ground plane/与地平面的垂直夹角	90 degrees, tolerance $\leq \pm 2$ degrees 90 度, 公差 $\leq \pm 2$ 度
Bumper thickness/保杆厚度	$\leq 4$ mm
The distance between the radar surface and the inside of the bumper/雷达面与保杆内侧距离	$> 5$ mm
Radar FOV range limitations/雷达 FOV 范围内限制	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  保证在 FOV 范围内不能有任何金属部件、金属镀膜, 保杆面厚度需一致, 且不可有加强筋、高度断差、直角、菱角
Bumper radius radius requirements/保杆曲率半径要求	suggestion: $R > 200$ mm (the final result is mainly 3D digital simulation and actual measurement results)  建议 $R > 200$ mm (最终以 3D 数模模拟与实测结果为主)
Radar perimeter 50mm box limit (Figure 10)/雷达周边 50mm 方框限制 (如图十)	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. 如有干涉对象，请将 3D 数模提供给 CubTEK，CubTEK 将分析是否有干涉风险。
--	--

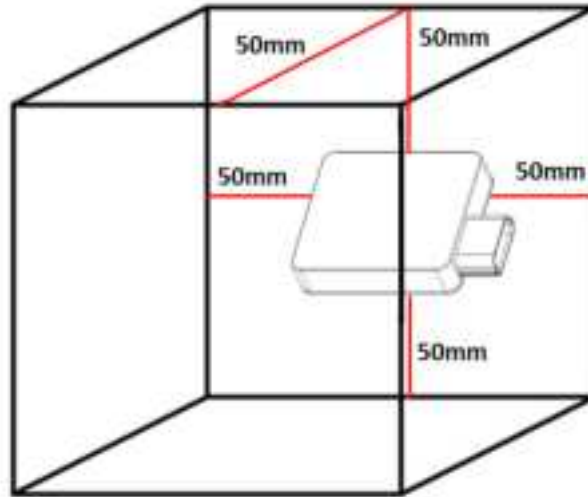


Figure 10      50mm box limit around the radar/雷达周边 50mm 方框限制



## 9.2 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 度
Polypropylene	2.55 mm	3.90 mm
ABS	2.39 mm	3.35 mm
Polycarbonate	2.33 mm	3.75 mm

\*罩盖的公差必须控制在 5%以下

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.

## 10 Installing the Calibration Function (Offline Calibration)

### 10.1 Purpose 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.

### 10.2 Calibrated configuration:

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

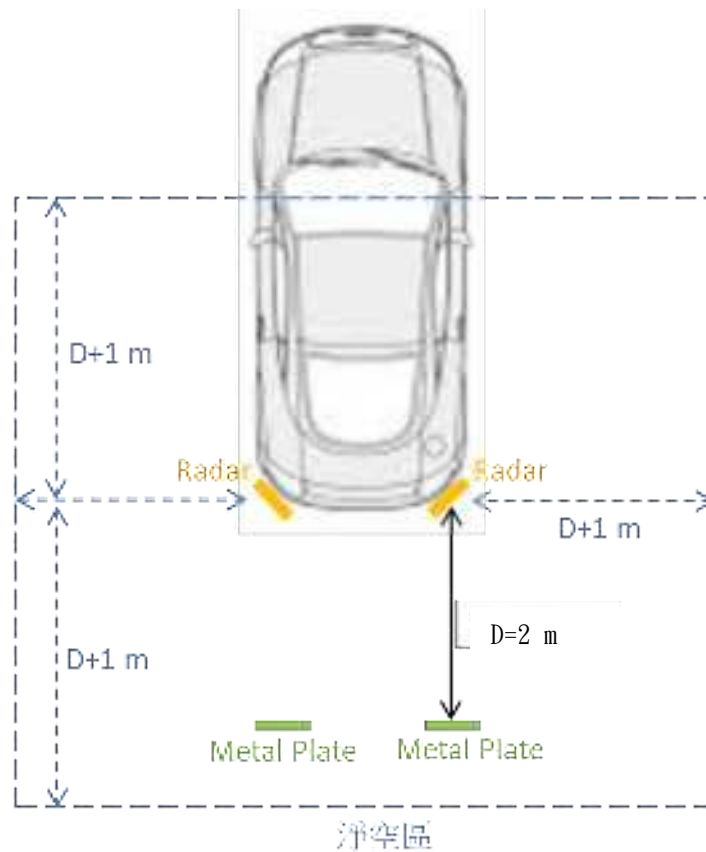


Figure 11 Radar correction configuration/雷达校正配置

### 10.3 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/车辆水平偏移	The acceptable range of deviations is wide/可接受偏差范围较大	The range of acceptable deviations is small/可接受偏差范围较小
Radar installation horizontal offset/雷达安装水平偏移	The acceptable range of deviations is wide/可接受偏差范围较大	The range of acceptable deviations is small/可接受偏差范围较小
Reflector/corner reverse horizontal offset 反射板/角反水平偏移	The acceptable range of deviations is wide/可接受偏差范围较大	The range of acceptable deviations is small/可接受偏差范围较小
Horizontal angular rotation deviation of the vehicle's driving axis/车辆行驶轴线水平角度旋转偏差	The range of acceptable deviations is small/可接受偏差范围较小	The range of acceptable deviations is small/可接受偏差范围较小
Reflector/Angle Inverse Normal Horizontal Angle Rotation Deviation 反射板/角反法线水平角度旋转偏差	The range of acceptable deviations is small/可接受偏差范围较小	The acceptable range of deviations is wide/可接受偏差范围较大

### 10.4 Calibrate the site layout

#### 10.4.1 Calibrate the reflector position

1. Metal reflector  $D = 2\text{ m}$  directly behind the radar;
2. The minimum distance is limited by the far-field conditions and hardware conditions of millimeter-wave radar.

#### 10.4.2 Environment settings

Calibrate the headroom:

1. No metal reflector or any obstacle is allowed in the area between the metal reflector and

the front surface of the radar D=2 m & 1 m behind the metal reflector.

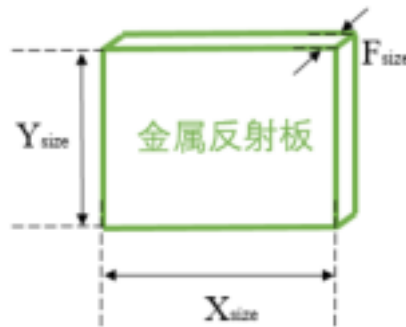
- The vertical headroom angle of the radar is  $\pm 30^\circ$  or 3m.
- The horizontal clearance angle of the radar is  $\pm 75^\circ$  or D+1m clearance around the radar.
- 

## 10.5 Metal reflector requirements

### 10.5.1 Material and size

- Metal Reflector Material: Aluminum, Iron, Stainless Steel
- The size of the metal reflector, as shown in the figure below:

Xsize	Ysize	Fsize
0.8~1 m	0.8~1 m	$\geq 3$ mm



Note: Within the size range of the metal reflector, the roughness should be  $< 0.1\text{mm}$  per  $80\text{mm} \times 80\text{mm}$  area

注：在金属反射板尺寸范围内，每  $80\text{mm} \times 80\text{mm}$  面积内的粗糙度要  $< 0.1\text{mm}$

### 10.5.2 Metal reflector layout requirements

- The distance between the metal reflector and the center of the radar is D=2m.
- The installation error of the center of the metal reflector is  $\leq \pm 5.0$  cm relative to the horizontal left and right of the radar center.
- The vertical up and down installation error of the center of the metal reflector relative to the center of the radar is  $\leq \pm 5.0$  cm.
- 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  $90^\circ$ , and the error cannot exceed  $\pm 0.5^\circ$ .

	Aoffset	Xoffset	Yoffset	D	Hsensor
Request	$90 \pm 0.5^\circ$	$\leq \pm 5.0 \text{ cm}$	$\leq \pm 5.0 \text{ cm}$	2m	At the same height as the radar installation position

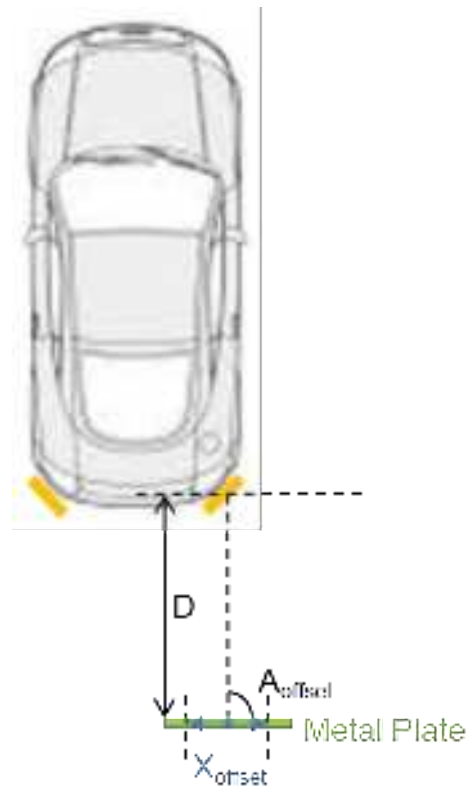


Figure 12 Horizontal arrangement (one-sided schematic)

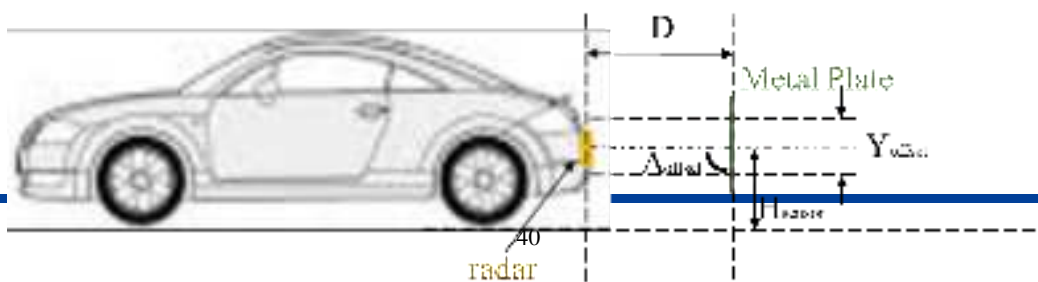


Figure 13 Vertical arrangement (unilateral schematic)

## 10.6 The process of calibration:

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  $\leq \pm 3$  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)

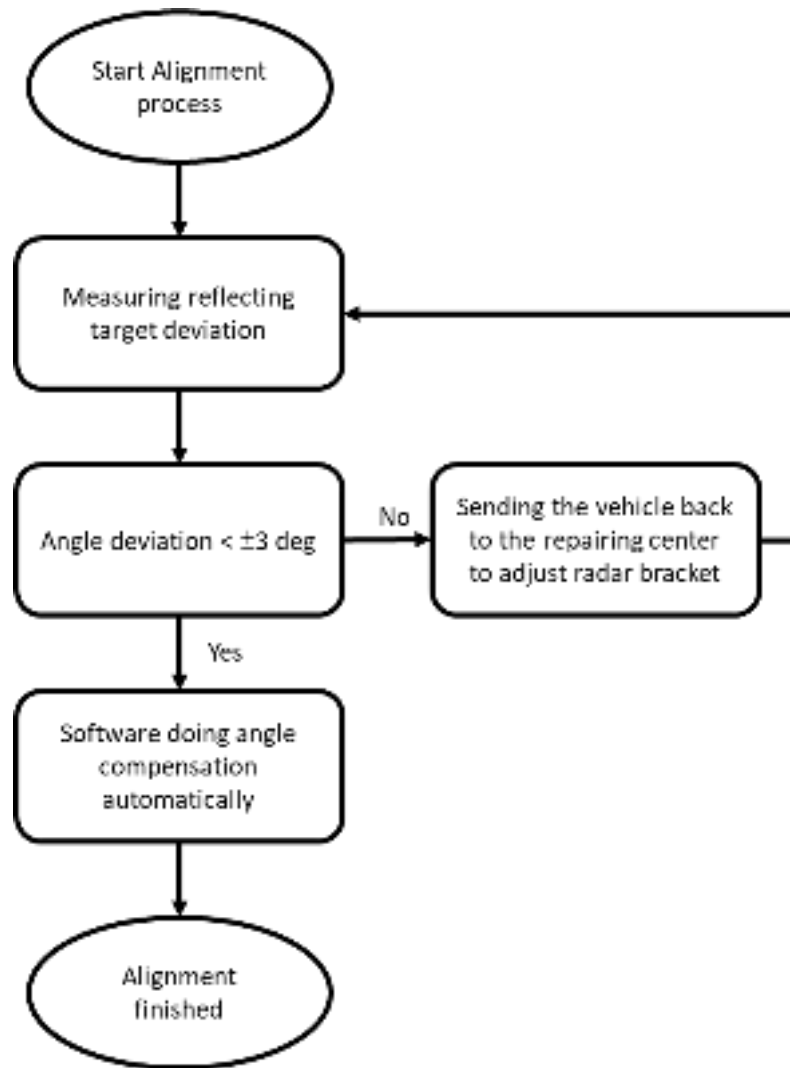


Figure 14 Calibration flow chart

## 10.7 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  $\pm 0.5^\circ$ .

## **10.8 Reasons for the failure of radar calibration :**

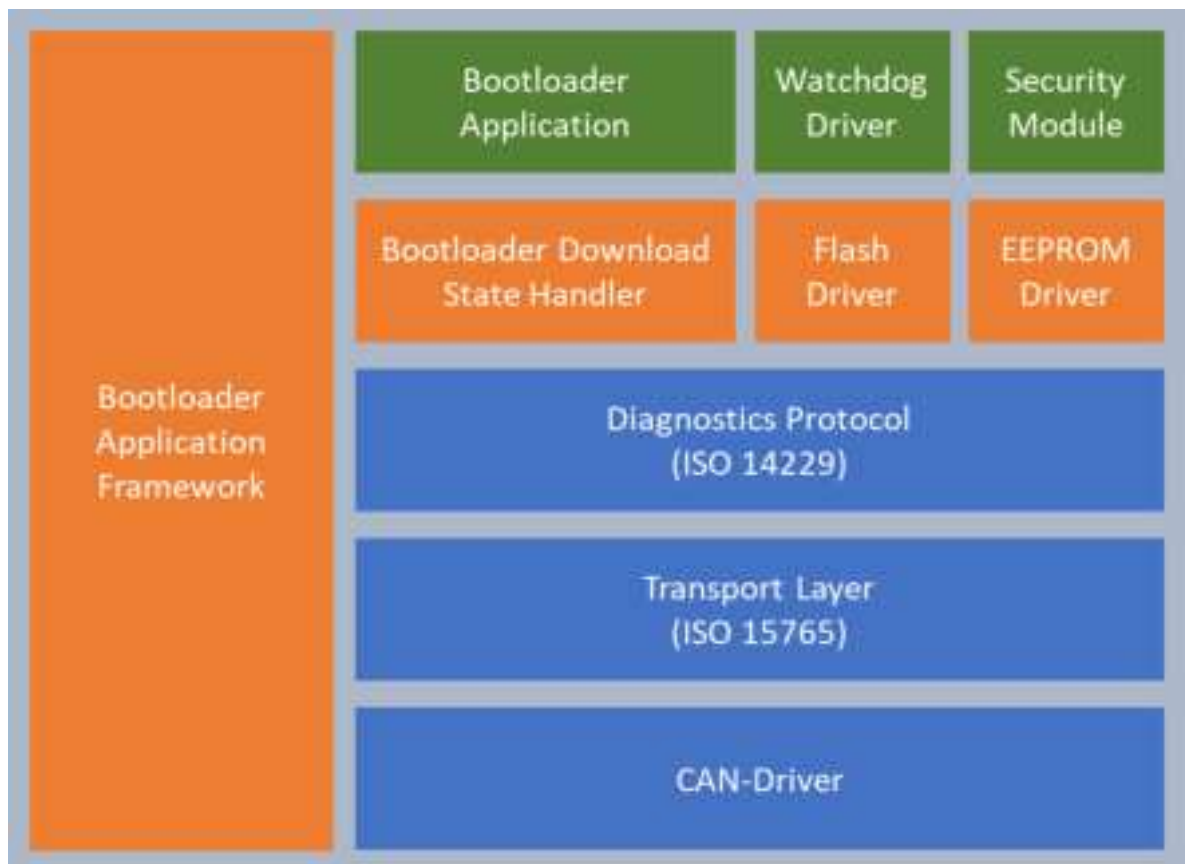
Radar calibration may fail if::

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

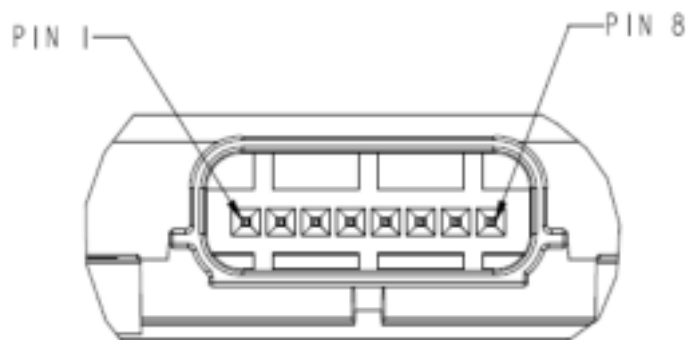


## 11 Software Upgrade Services

- Support software refresh service, the upgrade time is <2 min.
- Support ECU software self-backup, rollback function, when the system fails to refresh the software, you can go back to the previous version through the rollback mechanism to ensure the safety of the vehicle.



## 12 Introduction to connectors and wiring harnesses



连接器名称: USCAR 1X8 KEY CODE A				Circuit requirements		
Pin number/ 引脚编号	Pin Description(1)(3)(5)/ 引脚描述(1)(3)(5)	The type of load/负载类型	Current rating (A) 12V, 25°C	Loop Resistance ( $\leq m\Omega$ )	Special cables (2)	Terminal plating requirements
1	PCAN_H(融合诊断)	SIGNAL	< 100mA	/	1, 2 双绞	/
2	PCAN_L(融合诊断)	SIGNAL	< 100mA	/	1, 2 双绞	/
3	VCAN_H(车机)	SIGNAL	< 100mA	/	3, 4 双绞	/
4	VCAN1_L(车机)	SIGNAL	< 100mA	/	3, 4 双绞	/
5	VBAT	POWER	< 0.5A	/	/	/
6	ADD-1 (地址线)	SIGNAL	< 100mA	/	/	/
7	ADD-0 (地址线)	SIGNAL	< 100mA	/	/	/
8	GND	GND	< 0.5A	/	/	/
Remark						
Address lines	Left rear corner radar			Radar in the rear right corner		
ADD-1	NC			NC		
ADD-0	NC			GND		



## 13 Communication Protocols

Execution is confirmed with the customer.

## 14 Exclusionary Clauses

Although this product provides blind spot detection and warning function, please install it in accordance with the specifications, and carry out radar setting and calibration, if you do not operate according to the requirements, the radar performance will be limited or unable to work normally, resulting in a decrease in the accuracy of radar detection and warning, and it is prone to immeasurable problems.

At the same time, it may still be affected by the area in which the vehicle is traveling, the 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.

- o Highly reflective objects at heights, such as flyovers, street signs, etc.

- Under the following conditions, it may be difficult for the radar to detect the target or the radar may not work properly:

- 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.