



[B122-035] Long-middle range radar

Product Manual

CubTEK Inc.

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1 Purpose

This document is written and published for CubTEK B122-035 (VS-93G016) Radar, Inc. as a product description for users to install and debug the product.

Note: Extended product model B122-033 (VS-93G014)

2 Scope of Application

Used in passenger cars and commercial vehicles, in order to achieve FCW, AEB, ACC and other alarm functions.

3 Noun Definitions

3.1 Noun Interpretation

Noun	Specification
Autonomous Emergency Braking	自動制動系統
Adaptive Cruise Control	主動車距控制巡航系統
Front Collision Warning	前方碰撞系統
Controller Area Network	控制器區域網

3.2 Definition of Abbreviations

Short	Name	Description
AEB	Autonomous Emergency Braking	自動制動系統
FCW	Front Collision Warning	前方碰撞系統
CAN	Controller Area Network	控制器區域網

4 Standards and regulations

Standard number	Standard name	Suitable vehicle	status
GB/T 38186 GB/T 33577	Performance requirements and test methods for automatic emergency Braking systems (AEBS) for commercial vehicles	Commercial vehicle	release
JT-T1242	Performance requirements and test procedures for automatic emergency braking systems for operating vehicles	Operating vehicle	release
JT-T1178.1	Safety technical conditions for trucks in operation	truck	release
JT-T1178.2	Safety technical conditions for trucks in operation	Tractor and trailer	release
JT-T1094	Safety technical conditions for passenger cars in operation	Service bus	release
ECE R131	Advanced emergency braking system	M2, M3, N2, N3	release
ECE R152	Advanced Emergency Braking System (AEBS)	M1, N1	release
E-NCAP AEB C to C test protocol_v3.0.2	Automatic vehicle-to-vehicle emergency braking system		draft
SAE J3087	Automatic Emergency Braking (AEB) System Performance Testing		release
ISO 19377 ISO 15623	Heavy commercial vehicles and buses — Emergency braking on a defined path — Test method for trajectory measurement		release
ECE R131	Advanced emergency braking system	M1, N1	release
VSCC 72	Emergency brake assist system	New type A, B buses, N3	release

M class : Motor vehicles with at least four wheels and used for carrying passengers;

M1 class : passenger cars with up to nine seats, including the driver's seat;

M2 class : class: passenger car with no more than 9 seats, including the driver's seat, and the maximum total design quality not exceeding 5000kg;

M3 class : class: passenger cars with no more than 9 seats, including the driver's seat, and a maximum total design mass of more than 5000kg;

N class : Motor vehicles with at least four wheels and used for carrying cargo;

N1 class : Cargo vehicles with a maximum total design mass not exceeding 3500kg;

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

N3 class : Cargo vehicles with a maximum designed total mass of more than 12000kg;

O class (掛車)

- O1 class : 最大設計總品質不超過 750kg 的掛車;
- O2 class : 最大設計總品質超過 750kg,但不超過 3500kg 的掛車;
- O3 class : 最大設計總品質超過 3500kg,但不超過 10000kg 的掛車。
- O4 class : 最大設計總品質超過 10000kg

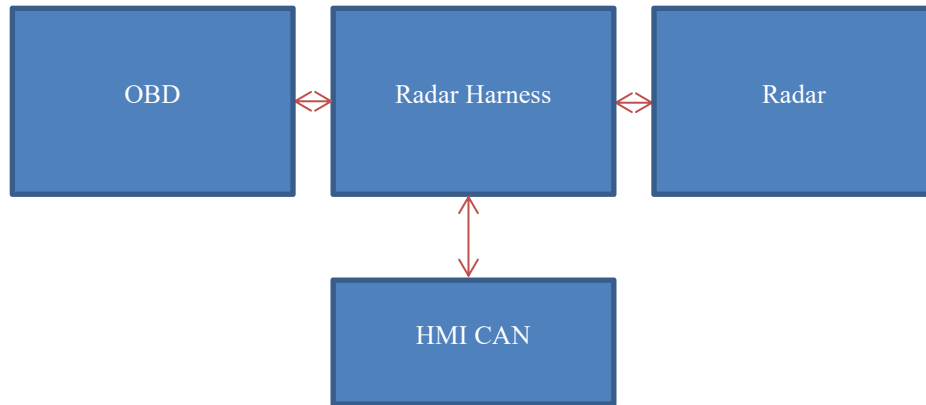
5 Product Overview

Current traffic accidents are caused by failure to maintain the distance in front of the vehicle, improper lane change, do not pay attention to the state of the car, and most people in an emergency do not have time to react and too late to brake. Therefore, in order to effectively reduce the incidence of accidents and ensure the safety of drivers and passengers, the forward safety warning system has been paid attention in recent years, which can monitor the vehicle in front of and adjacent vehicles, before the vehicle may have a forward collision accident, The CubTEK B122-035 radar is suitable for automatic emergency braking system (AEB), forward collision warning (FCW), active vehicle Distance Control Cruise system (ACC) and other functions to effectively avoid accidents.

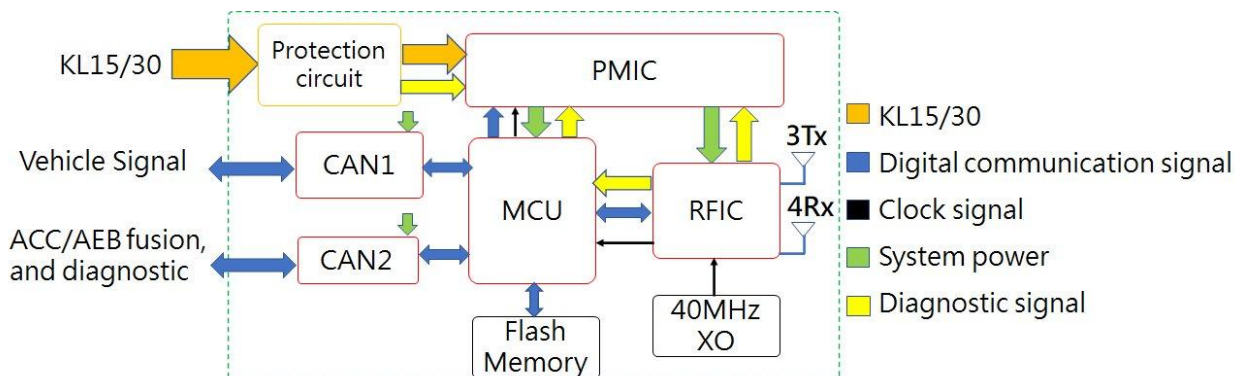
- Based on 77GHz radar technology provides detection and protection up to 170 meters in front of the vehicle and up to 90 degrees
- Three-in-one function: Long range mode + wide Angle mode + altimeter mode
- all-weather operation, comprehensive protection of driving safety
- Active early warning, timely remind the driver to prevent accidents
- provides offline calibration to effectively test installation accuracy
- provide sports car calibration, do not need to go back to the factory calibration, after-sales maintenance is not worried
- The anti-disturbance design with advanced algorithms of Suntech is adopted to keep the radar function stable
- detection shielding function, radar in case of covering parts, dirt timely alarm, to ensure normal operation
- IP69K waterproof and dustproof

6 Product Introduction

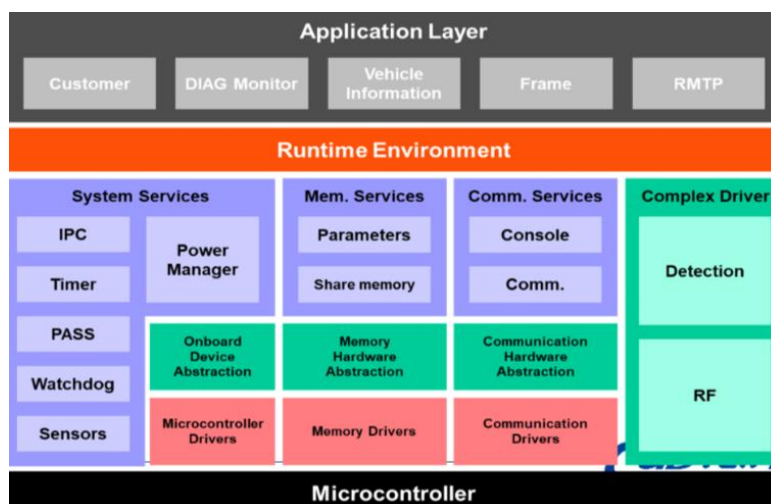
6.1 System Architecture



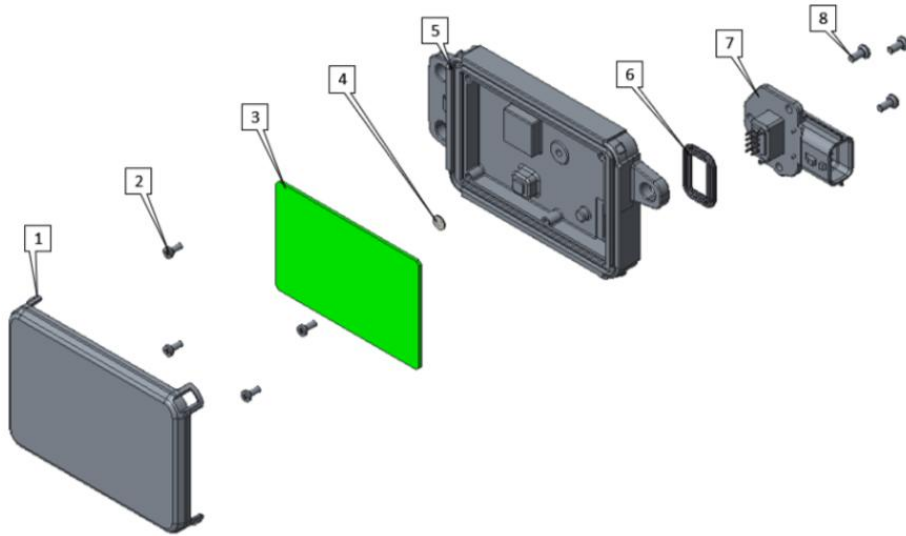
6.2 Hardware Architecture



6.3 Software architecture



6.4 Exploded Image



name	Part name	material	quantity	remark
1	Radome	PPO+PS	1	
2	M2 screws	S18C	4	Surface treatment: nickel plating
3	PCBA	FR-4	1	
4	Breathable patches	PTFE	1	
5	Aluminum base	ADC12	1	Surface treatment: electrophoresis black
6	Waterproof rubber ring	SI	1	
7	Connector package	PBT+GF15	1	
8	M3 screws	SU304	3	

6.5 FOV schematic diagram

6.5.1 Long Range Mode

It can detect 180 meters in front of the car, and the angle covers ± 12 degrees, which can be measured from a distance.

6.5.2 Wide-angle mode

It can detect 43 meters in front of the vehicle at an angle of ± 45 degrees

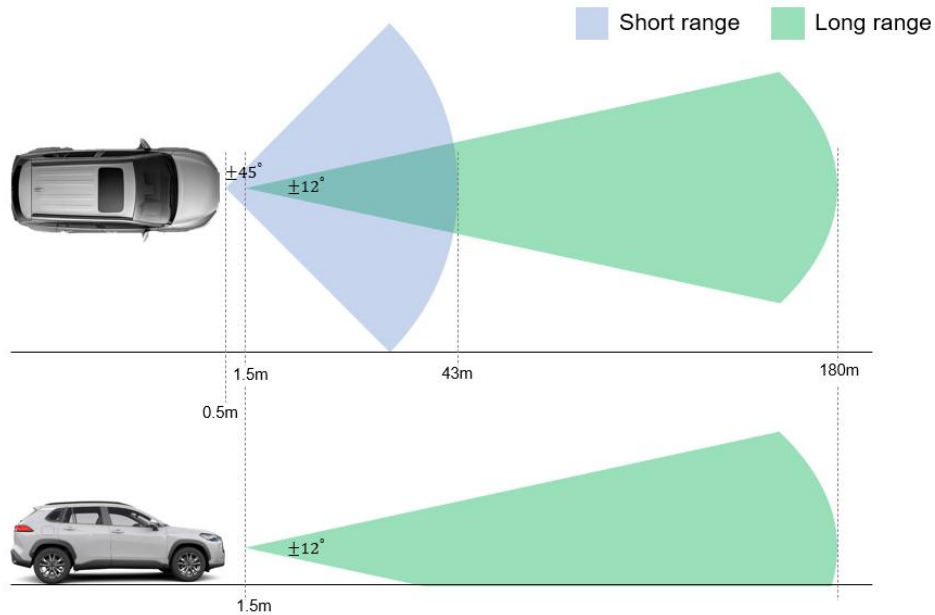


Figure 1: Wide-angle mode and long-range mode coverage

6.5.3 Altimetry mode

It can detect the front height of the vehicle 10 meters, the distance is 80 meters, and the angle covers ± 12 degrees, which can effectively distinguish roads, bridges and obstacles on the ground.

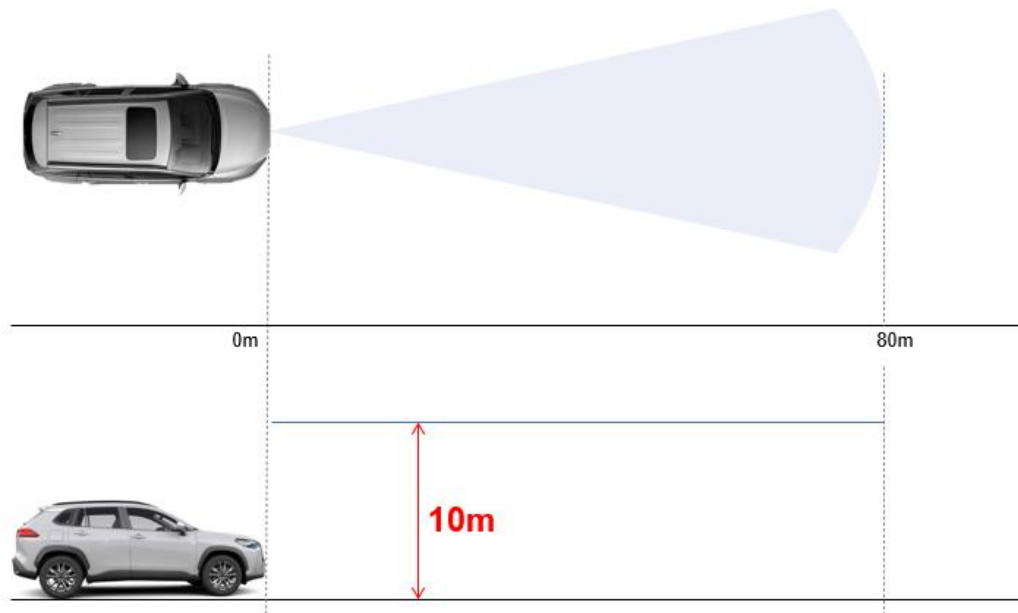


Figure 2: Altimetry mode coverage

6.6 Function Introduction

- FCW前車碰撞預警(Forward Collision Warning)

The whole operation process of front collision warning can be divided into four parts: (1) the identification of the vehicle in front, (2) the detection of the distance and speed of the two vehicles, (3) the calculation of the collision time of the two vehicles, and (4) the distance warning warning. It can monitor the vehicle in front through the radar system, determine the distance, bearing and relative speed between the vehicle in front of it, and warn the driver when there is a potential collision hazard. The FCW system itself does not apply any braking measures to avoid a collision or control the vehicle, and can assist the driver to maintain a safe distance from the vehicle in front.

- AEB自動緊急煞車系統(Autonomous Emergency Braking System, AEB System)


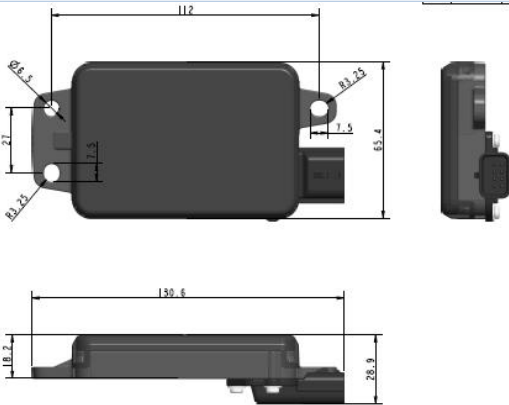
AEB is one of the forward collision avoidance active safety systems, which mainly detects the target vehicle in front through the sensor, and then uses the controller to calculate the collision hazard degree, and finally the actuator performs automatic braking.

- ACC主動車距控制巡航系統(Adaptive Cruise Control)

Radar detection in front of the vehicle adjusts the distance to the car in front of the vehicle and automatically adjusts the speed of the vehicle, reducing the fatigue caused by driving in long-term medium/high-speed road conditions, thereby improving driving safety.

7 Product Specifications

7.1 Product Specifications

雷達產品規格 Specification Introduction	前方碰撞雷達 AEB Radar
產品圖 Product drawing	
應用 Application	AEB、ACC
功耗 Power	< 5W
工作電壓 Operating voltage	9V-32V
工作溫度/儲存溫度 Operating temperature / Storage temperature	-40~85°C/ -40~90°C
防水等級 Waterproof level	IP69K
材質 Material	Cover :PPO+PS; Base: ADC12
外觀尺寸 Size	 尺寸 Size: 130.6 (L) x 65.4 (W) x 28.9 (D) (mm) ; 重量 weight : 184g ±5%
接外掛程式型號 Connector	8P Connector YAZAKI 7283-8855-30
系統匹配 (公版)Other modules (Public version)	No controller
功能安全等級 ASIL	B
雷達通訊與介面規格	前方碰撞雷達

Communication and Interface Specification	AEB Radar
CAN 通道 CAN communication channel	2 ways
CAN 資料幀 (對外介面) CAN data frame	Standard frames
CAN 速度 (HMI-CAN 對外介面)	500k
CAN FD (對外介面)	X (Not supported)
CAN 提供車速誤差範圍	≤1.4 m/s
車輛訊號 - 文件位 Vehicle signal - Gear	X (N/A)
車輛訊號 - 車門 Vehicle signal - Door	X (N/A)
車輛訊號 - 方向燈 Vehicle signal - Turn Indicator	X (N/A)
車輛訊號 - 方向盤轉角 Vehicle signal - Steering Angle	X (N/A)
車輛訊號 - 點火訊號 (開/關) Vehicle signal - Ignition (ON/OFF)	X (N/A)
車輛訊號 - 橫擺角 Vehicle signal - Yaw Rate	▲ (Not necessary)
最大輸出目標數 Max target output number	16 pcs
最大輸出點雲數 Max cluster output number	192 pcs

7.2 Performance Specifications

雷達性能規格 Radar performance Specification		單位 Unit	前方碰撞雷達 AEB Radar
雷達頻率 Radar Frequency		GHz	76-77
數據週期 Data cycle time		ms	62.5
距離 Distance (遠距模式 Long Range Mode)	範圍 / Range	m	1.5-180
	精度 / Accuracy	m	±0.36
	解析度 / Resolution	m	1.5
距離 / Distance (近距模式 Short Range Mode)	範圍 / Range	m	0.5-43
	精度 / Accuracy	m	±0.17
	解析度 / Resolution	m	0.8
速度 Velocity	範圍 / Range	km/h	±225
	精度 / Accuracy	km/h	±0.27
	解析度 / Resolution	km/h	1.08
水準角度 Horizontal Angular (遠距模式 Long Range Mode)	範圍 / Range (FOV)	°	±12
	精度 / Accuracy	°	±0.15
	解析度 / Resolution	°	4
水準角度 Horizontal Angular (近距模式 Short Range Mode)	範圍 / Range (FOV)	°	±45
	精度 / Accuracy	°	±0.15
	解析度 / Resolution	°	4
垂直角度 Vertical Angular	範圍 / Range	°	±12
	精度 / Accuracy	°	X (Not supported)
	解析度 / Resolution	°	-

7.3 功能規格

雷達功能規格 Function Specification	前方碰撞雷達 AEB Radar
安裝标定方式 Installation and calibration method	1. Offline calibration 2. Dynamic calibration
UDS 診斷功能 UDS diagnosite function	V (Support)
UDS 更新功能 UDS Firmware update function	V (Support)
網路管理功能 Netork management function	X (Not supported)
回滾備份 Rollback and Recovery	X (Not supported)
更新包大小 Image Size	< 3096 KB
更新時長 Update Time	<5 mins

8 Installation Specifications

8.1 Basic Requirements for Installation

In order to achieve the best use effect, the CubTEK B122-035 radar needs to be installed according to the following specifications.

- A. Distance from the ground at the centre of Radar:

Full Operation : 400mm ~ 700mm

Performance limit : 700mm ~ 1100mm & 300mm ~ 400mm

Avoid installation : > 1100mm & < 300 mm

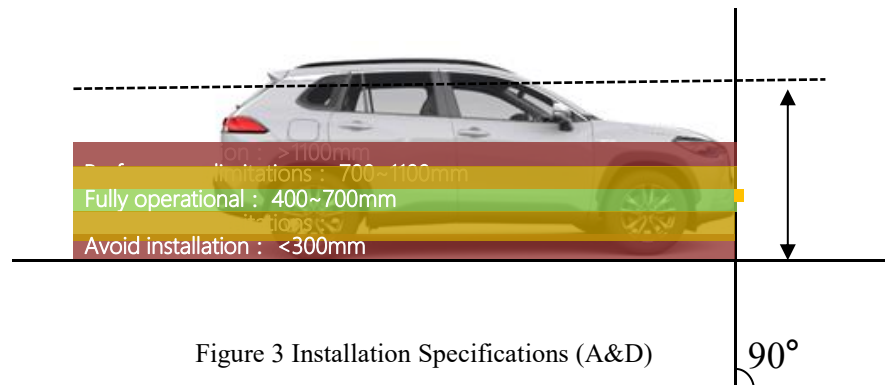


Figure 3 Installation Specifications (A&D)

- B. The theoretical Y-plane horizontal offset between the radar and the vehicle is recommended to be 0mm
- C. The angle between the radar axis and the vehicle driving axis is recommended to be 0 degrees
- D. The horizontal angle between the radar and the driving axis of the vehicle is recommended to be 90 degrees, and the tolerance $\leq \pm 3.0$ degrees



Figure 4 Installation specifications (E)

- E. The actual vertical angle between the radar and the driving axis of the vehicle is 90 degrees, and the tolerance is $\leq \pm 2.4$ degrees
- F. The actual roll angle between the radar and the axis of the vehicle body is 0 degrees, and the tolerance is $\leq \pm 2.0$ degrees
- G. There must be no metal parts in the radar detection angle, and if there are interference objects in the

surrounding 50mm box, CubTEK must be provided for evaluation

8.2 Basic requirements for radar front coverage conditions

:A flat bumper has the least impact on the radar, and a cornered bumper affects the functionality of the radar. In addition, it is important to have a fixed distance between the bumper and the radar. If the distance is different, the radar gain will be significantly attenuated. The following situations are not recommended for bumpers

1. Avoid the connection area of the bumper
2. Bumpers to avoid cornering
3. Avoid bulges on the bumper
4. Avoid overlapping bumpers
5. Avoid sharp corners of the bumper



Figure 5: The situation of the bumper recommendation

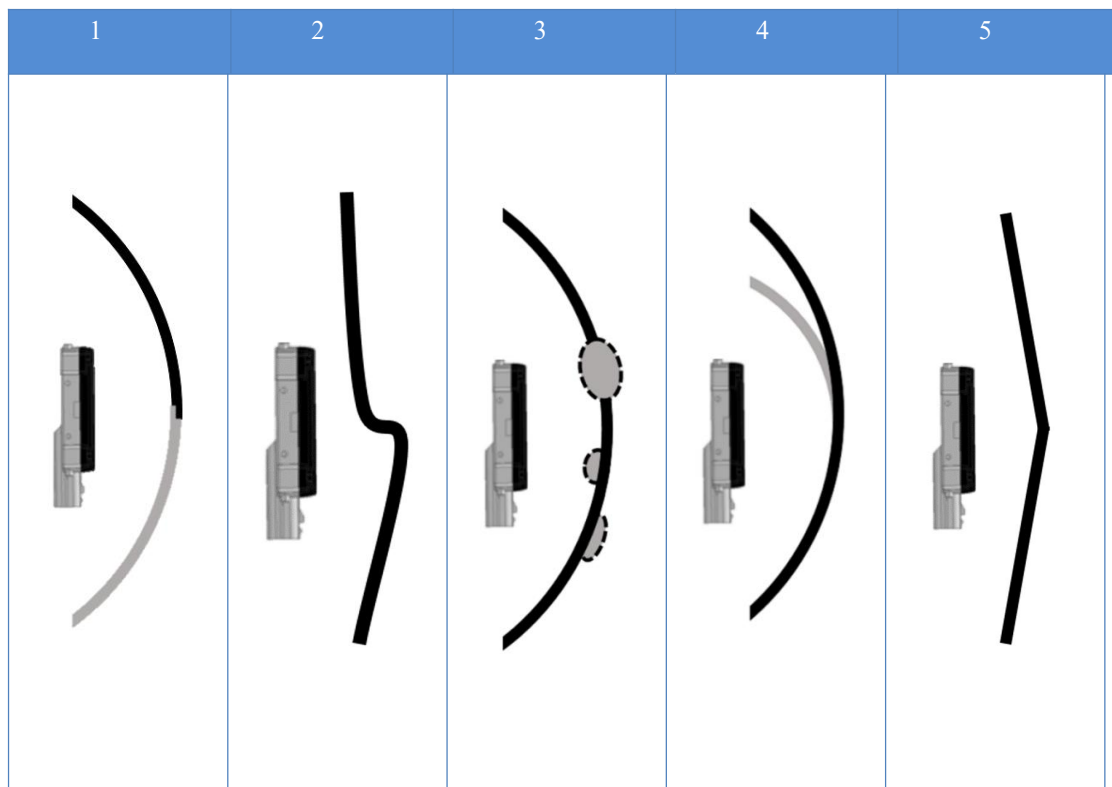


Fig.6 The situation that the bumper is not recommended

8.3 Environmental impact of radar coverage

8.3.1 Shielding

- Because the radiation of the IC may interfere with the antenna signal of the radar, we need to increase the shielding to filter out the unwanted signal. Shielding reduces the impact on the IC and increases radar stability.
- The minimum distance between the cover and the radar is 5 mm.
- The vertical installation inclination angle of the cover is recommended $|\theta| \geq 8^\circ$ (If it is less than this value, please provide the number and body of the covered piece, and Cubtek will analyze whether there is a risk of interference)

8.3.2 Brackets

The bracket provides a flat point of support and has a drainage hole at the bottom. The material is metal or rigid plastic.

8.4 Radar installation method and size

8.4.1 Radar coordinate system

- A. The horizontal installation position is shown in Figure 7, installed in the front of the car, the center line of the body
- B. Vertical installation position 45~120cm

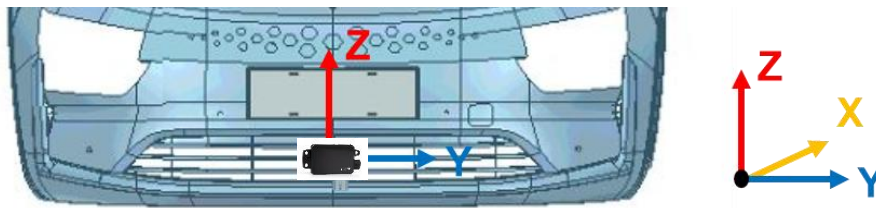


Figure 7 radar coordinate system

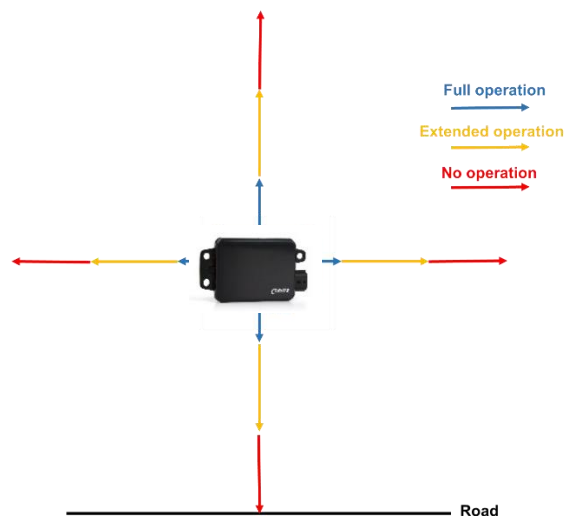


Figure 8 radar operating range

8.4.2 Radar Installation

In order to achieve maximum radar effectiveness, users must comply with the following radar installation regulations. Radar installation inspection items:

1. The radar should be installed in the standard operation area and the extended operation area, as shown in Figure 8.
2. The distance from the radar surface to the bumper should avoid dirt and dust.
3. It is recommended that the thickness of the bumper should be subject to the following conditions. The tolerance of the covering parts must be controlled below 5%.

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

4. There should be no other metal parts or wiring harnesses within the vertical radiation range of 120° on the radar surface.
5. The thickness of the inner bumper in the vertical radiation range of 120° on the radar surface should be consistent. And the bumper should try to avoid bulges.
6. The bumper within the vertical radiation range of 120° on the radar surface cannot contain connections, overlaps, and sharp corners. The material used for the bumper must avoid metal.
7. The connecting harness of the radar must have a secure fixed position.
8. The distance from the radar surface to the bumper must be greater than 20mm, if the distance is too small, signal attenuation will occur. There is no upper limit for the distance from the radar surface to the bumper installation, but too large a distance will affect the accuracy of detection.

Description	Product Specifications:
apply	Forward Collision Warning
location	The front of the car
Mounting angle	90° (Figure 9 illustrates the description)
The allowable error value of the mounting angle	$\leq \pm 3^\circ$

Figure 9. Mounting angle

9 Install the calibration function

9.1 Offline calibration

9.1.1 Purpose of Calibration

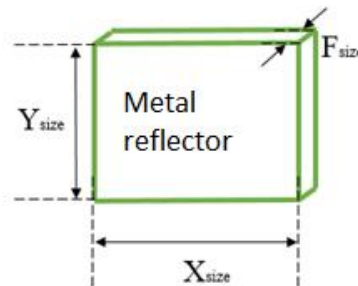
The purpose is to measure the deviation angle between the radar axis and the driving direction axis of the body in the horizontal and vertical directions, and to compensate the software to make the two axes coincide or within a permissible range.

9.1.2 Calibration Configuration

1. Vehicles equipped with millimeter-wave radar
2. Equipment: Metal reflector, absorber material (recommended only, not required). The minimum distance is limited by the far-field conditions and hardware conditions of millimeter-wave radar.
3. Material & Size:

Metal Reflector Material: Aluminum, Iron, Non-Rigid Steel. The size of the metal reflector is shown in Figure 10, and the layout requirements of the metal reflector are shown in Figure 11:

X_{size}	Y_{size}	F_{size}	
800 mm	800 mm	≥ 3.0 mm	



a

Figure 10. Metal reflector size

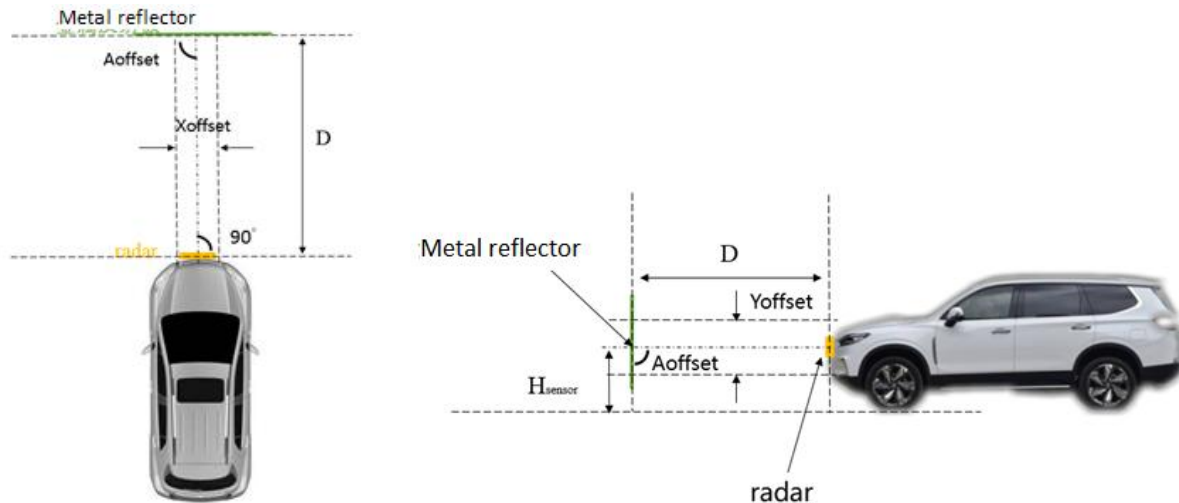


Fig. 11. Metal reflector layout requirements

4. Procedure:

The basic calibration environment is set up as shown in Figure 13, through the target of the reflector, the deviation angle between the radar axis and the axis of the driving direction of the body in the horizontal and vertical directions can be measured, and the measured deviation angle in the horizontal and vertical directions is within the installation requirements of Cubtek (horizontal deviation angle $\leq \pm 3^\circ$, vertical deviation angle $\leq \pm 2.4^\circ$), then the software will automatically compensate and calibrate the horizontal & vertical angle and complete the calibration.

However, if the measured horizontal and vertical deviation angles exceed 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 time required for calibration can be measured after the calibration of the production line is established, and the calibration time is subject to the actual measurement (at present, the calibration time of Cubtek's internal test is about 10~20 seconds).

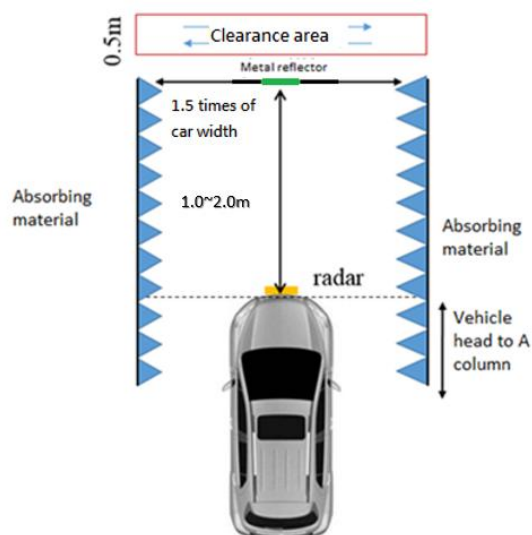


Figure 13. Basic calibration environment setup

9.1.3 Calibration Specifications

The actual perpendicular angle to the vehicle's axis of travel	Actual roll angle with the axis of the vehicle body (Roll)
$90^\circ \cdot \text{tolerance} \leq \pm 2.4^\circ$	$0^\circ \cdot \text{tolerance} \leq \pm 2.0^\circ$

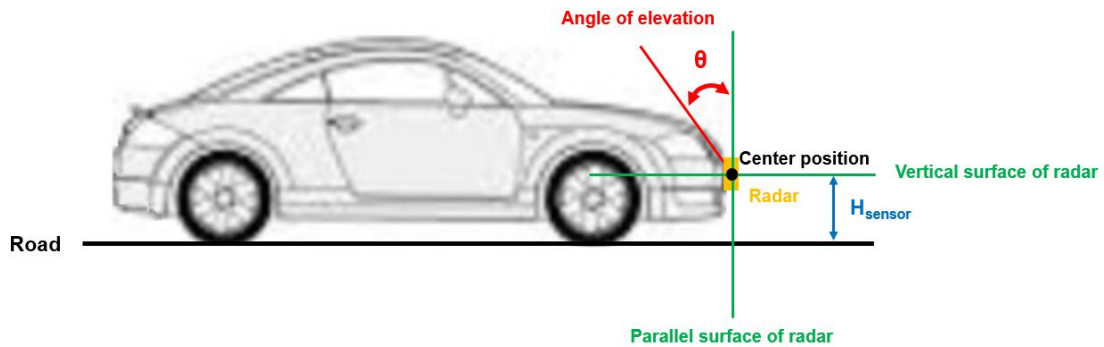


Figure 14. Elevation angle and installation height

9.2 Dynamic Calibration

9.2.1 Purpose of Calibration

The purpose is to measure the deviation angle between the radar axis and the body driving axis in the horizontal and vertical directions by static objects in the surrounding area (correction area) between the vehicle traveling in a straight line of the vehicle, and the software compensation is carried out to make the radar detection deviation within the allowable range.

9.2.2 Calibration Configuration

1. Vehicles equipped with millimeter-wave radars
2. The radar can obtain Yaw rate information
3. Radar can obtain acceleration information
4. Keep the vehicle in a straight line
5. The vehicle must travel at a speed of more than 40 km/h
6. The radar installation deviation should be $\leq \pm 3^\circ$ horizontally and $\pm 2.4^\circ$ vertically
7. Radar adaptive calibration plus and minus display level: positive in the clockwise direction and negative in the counterclockwise direction; Vertical: Positive up and negative down

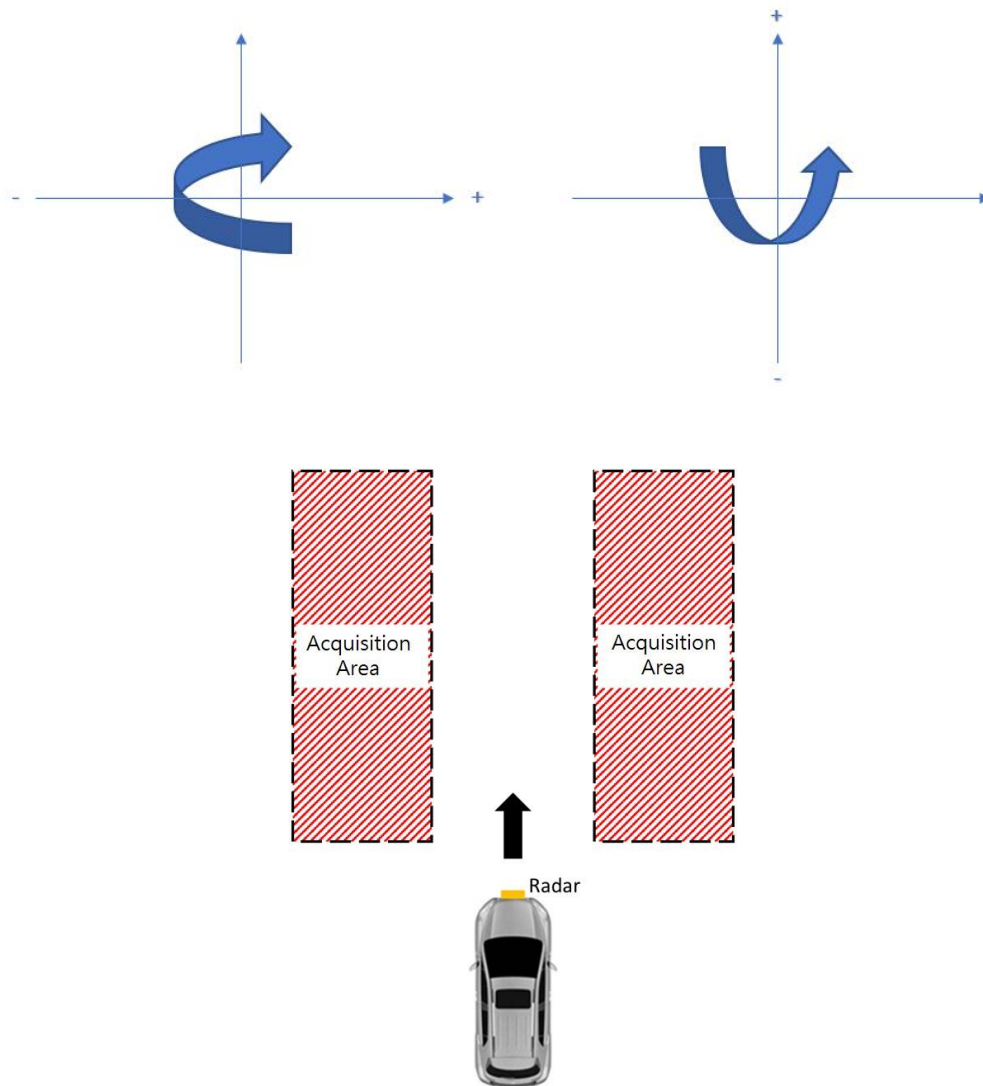


Fig. 15. Self-adjusting calibration of plus or minus signs

Figure 16. Self-adjusting calibration area

9.2.3 Calibration process

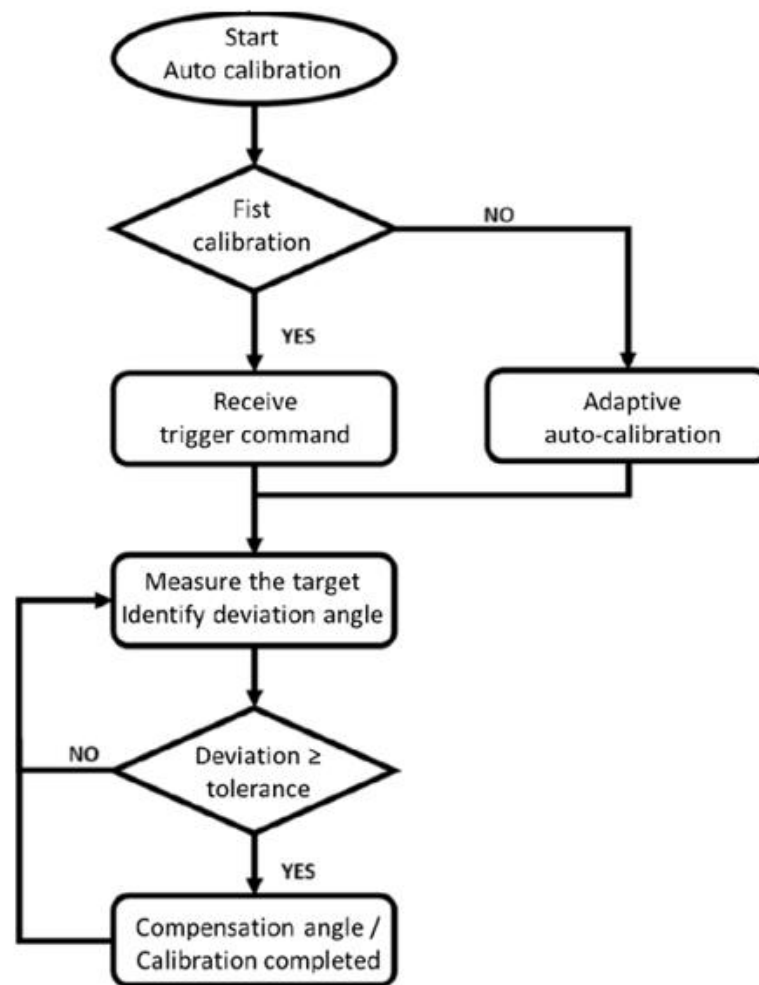


Figure 17 Calibration flow chart

When the radar is installed or replaced for the first time and has not been calibrated by EOL, it needs to be triggered by a diagnostic tool for self-adjusting calibration.

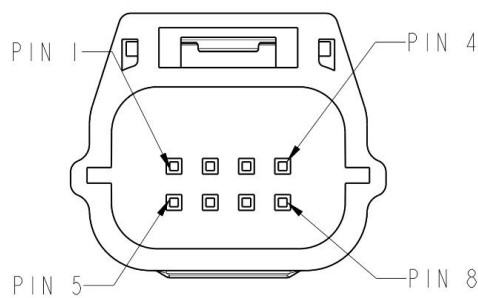
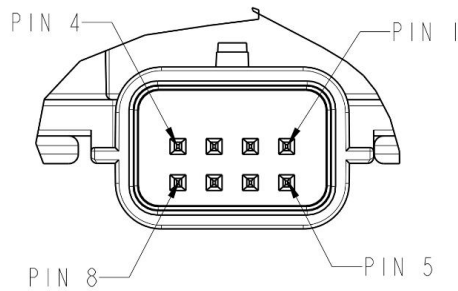
Under normal conditions, each calibration cycle of the radar is within 30 minutes, if the calibration cannot be completed within the time, the calibration result will be fed back and output, and if the calibration is completed within the time, the calibration process will be terminated.

The time and result of self-adjusting calibration will be different according to the condition of road driving, radar self-calibration is a cumulative and continuous process, the surrounding static objects are covered by people, cars or other objects, the vehicle turns or the speed is less than 40km/h, the radar will not be able to accumulate the samples required for calibration, in the calibration process, only when the calibration conditions are met, the radar will begin to accumulate calibration samples, when the cumulative samples reach a certain required number in time, that is, the calibration is completed.

During the calibration process, if there are uncontrollable factors such as overtaking, you should change lanes or slow down the speed as much as possible, and keep no moving vehicles within 20 meters in front of the lane to ensure that the calibration and accuracy are completed within the calibration time.

10 Introduction to connecting external programs and wiring harnesses

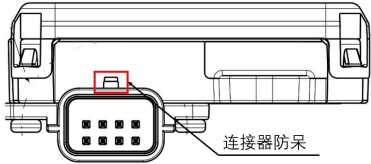
10.1 PIN Definition



线端连接器型号 Yazaki 7283-8855-30

Pin number	Port definition	Butt end	Steady state operation	Impulse current, time	Demand power properties	Static power consumption	remark
1	Ground(-)	Ground to power	$<0.5A$	$<1A$, $<5mS$	/	$<0.1mA$	Wire Diameter : CAVS 0.3mm ²
2	N/A	/	/	/	/	/	Waterpro of plugs
3	HMI_Can_L	Connect to MPC CAN2_L	$<100mA$		3, 4 Twisted pair		Wire Diameter :CAVS 0.3mm ²
4	HMI_Can_H	Connect to MPC CAN2_H	$<100mA$				
5	12V (+)~24 V (+)	KL30 (24V)	$<0.5A$	$<1A$, $<5mS$	/	$<0.1mA$	
6	N/A	/	/	/	/	/	Waterpro of plugs
7	N/A	/	/	/	/	/	
8	N/A	/	/	/	/	/	

10.2 Fool-proof Instructions

Fool-proof module	Icon	remark
Connector foolproof		

11 Communication Protocols

Execution is confirmed with the customer

12 Exclusionary Clauses

The purpose of this product is to provide detection targets for system fusion judgment, but it may still be affected by the vehicle driving area, environment, driving behavior, road conditions or climate... Drivers should abide by traffic rules, stay alert and pay attention to the actual road conditions at any time, drive cautiously, and do not overly rely on this product to avoid accidents.

Motorists are still required to pay attention to the following conditions:

1. Affected by the similar frequency bands near airports and military sites
2. When driving very close to a guardrail or concrete wall
3. When driving at the entrance and exit of the tunnel, very close to the wall or close to the tunnel evacuation area
4. Bad weather (heavy rain, heavy snowfall, sandstorm, etc.)
5. When driving a car over a road that raises water, snow, sand, etc
6. When driving near curbs, potholes, and tram tracks
7. When near guardrails, poles, trees, or mailboxes

13 Simplified EU Declaration of Conformity

The simplified EU declaration of conformity referred to in Article 10(9) shall be provided as follows: Hereby, [CUBTEK SHANGHAI 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:

<https://www.cubtek.com/about.aspx>

14 Simplified FCC Declaration of Conformity

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

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.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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.

This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. This device should be installed and operated with minimum distance 20cm between the radiator & your body.