[B122-054NA1-001]
Moving Off Information System

[MOIS]

Product specification

CubTEK Inc.

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Table of Contents

1 Introduction

This document is prepared and released by Cubtek Technology Co., Ltd. This document is the product specification of MOIS, and can also be used as a guide document for users to install and debug this product.

2 Scope

MOIS is suitable for M2, M3, N2 and N3 vehicles. The system can detect and warn the driver about pedestrians or cyclists (adults and children) in the blind spot of the vehicle's front side to avoid possible collisions.

3 Definitions

3.1 Glossary

Name	Description
Moving Off Information System	Front blind spot monitoring system, detecting vulnerable road users
Vulnerable Road User	Adult pedestrian, child pedestrian, adult cyclist, child cyclist

3.2 Definition of abbreviations

Name	Description
MOIS	Moving Off Information System
VRU	Vulnerable Road Users

4 Standards and regulations

Standard	Description	Applicable vehicles	Status
UN/ECE R159	Uniform provisions concerning the approval of motor vehicles with regard to the Moving Off Information System for the Detection of Pedestrians and Cyclists	N2, N3, M2, M3	Issued

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

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

Category M2: Passenger vehicles with no more than 9 seats, including the driver's seat, and a maximum design total mass of no more than 5000kg;

Category M3: Passenger vehicles with no more than 9 seats, including the driver's seat, and the maximum designed total mass exceeds 5000kg;

Category N: Motor vehicles with at least 4 wheels and used for carrying goods;

Category N1: cargo vehicles with a maximum design total mass of not more than 3500kg;

Category N2: Trucks with a maximum design total mass exceeding 3500kg but not exceeding 12000kg;

Category N3: Trucks with a maximum design gross mass exceeding 12,000kg;

Class O (trailer)

Category O1: Trailers with a maximum designed total mass not exceeding 750kg;

Category O2: Trailers with a maximum designed total mass exceeding 750kg, but not exceeding 3500kg;

Category O3: Trailers with a maximum designed total mass exceeding 3500kg but not exceeding 10000kg;

Category O4: The maximum design total mass exceeds 10000kg

5 Product Overview

M2, M3, N2, N3 categories of the vehicles has taller bodies and larger blind areas in front. If Vulnerable Road Users (VRUs) appears in front of such vehicles, they are not visually visible for the drivers, and it can cause serious injury and consequences for VRUs, when the vehicle is moving off.

Cubtek's MOIS product can detect and warn the driver of VRUs presence in the front blind spot area, when large vehicle is stationary or driving at low speed. Providing drivers audible and visual warning signals about potential hazards, system can help to avoid accidental collisions and injuries.

This product complies with the definition of UN/ECE R159 MOIS specification.

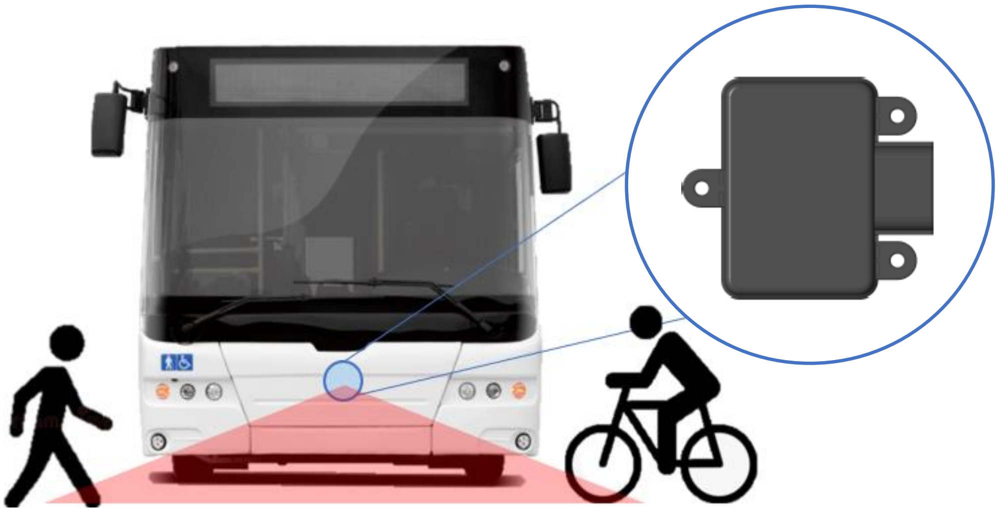


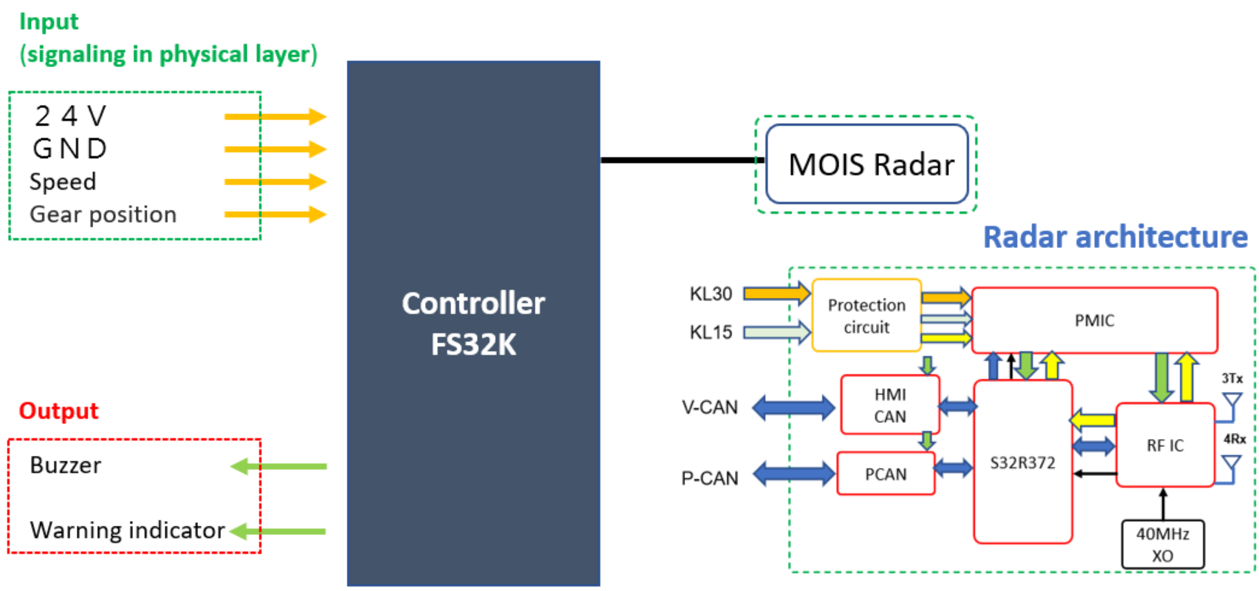
Figure 1. MOIS from CubTEK

Product technical features：

- 79GHz millimeter wave radar technology with 150° field of view (FOV);
- All-weather monitoring operation guarantee driving safety;
- High detection accuracy and wide detection range;
- Active warning with sound and visual alerts, prompt driving in time to prevent accidents;
- Adopt the anti-jamming design of Cubtek's advanced algorithm to maintain the stable performance of the radar function;
- IP69K waterproof and dustproof protection;
- Comply with the latest UN/ECE R159 regulations from 2021.

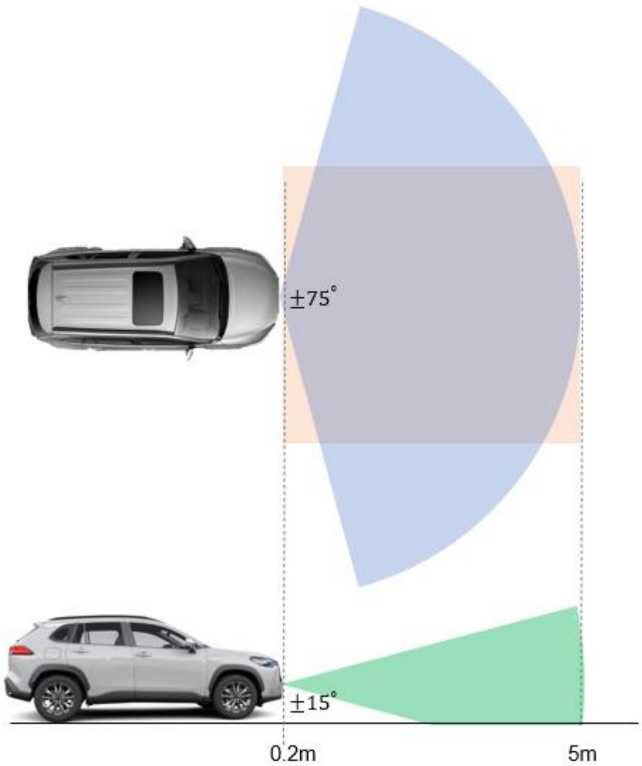
6 Introduction

6.1 Structure



6.2 Field of View (FOV)

Detection range 0.2 ~ 5m in front of the vehicle, horizontal FOV ±75°, vertical FOV ±15°.



6.3 Functionality

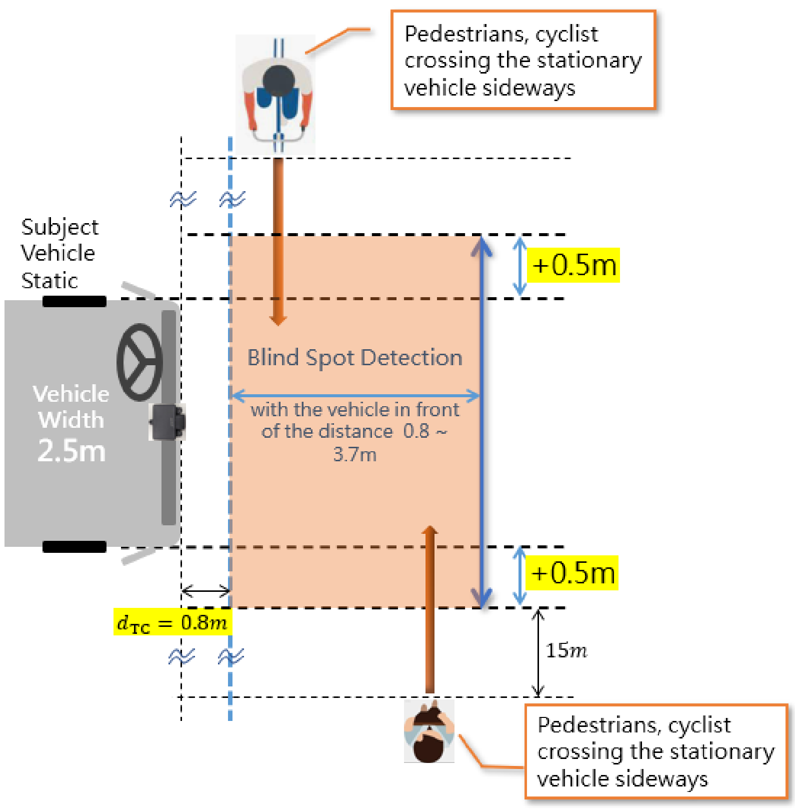
This product is mainly used for detecting VRUs, when vehicle is ready to move from a stationary position or when vehicle goes straight at low speed. The system will trigger an alarm to remind the driver, that there is a VRU in the short-range blind spot in front of the vehicle. The technical specification as follows.

6.3.1 System functions

- To detect VRU in front of the vehicle;
- To trigger an alarm to remind the driver, that there is a VRU in the short-range blind spot in front of the vehicle.

6.3.2 Usage scenarios

6.3.2.1 Static usage scenario: vehicle is stationary and VRU crosses perpendicularly to the vehicle in front area. Detection area in front of the vehicle: length is 0.8m～3.7m; lateral distance considers as a potential starting action, so width is vehicle's width plus 0.5m on the left and right sides. VRU speed is 3 or 5 km/h. System can issue a warning to the driver, before the target enters the critical range.



Vehicle's trajectory:

- Ready to move off from standstill position

VRU's trajectory:

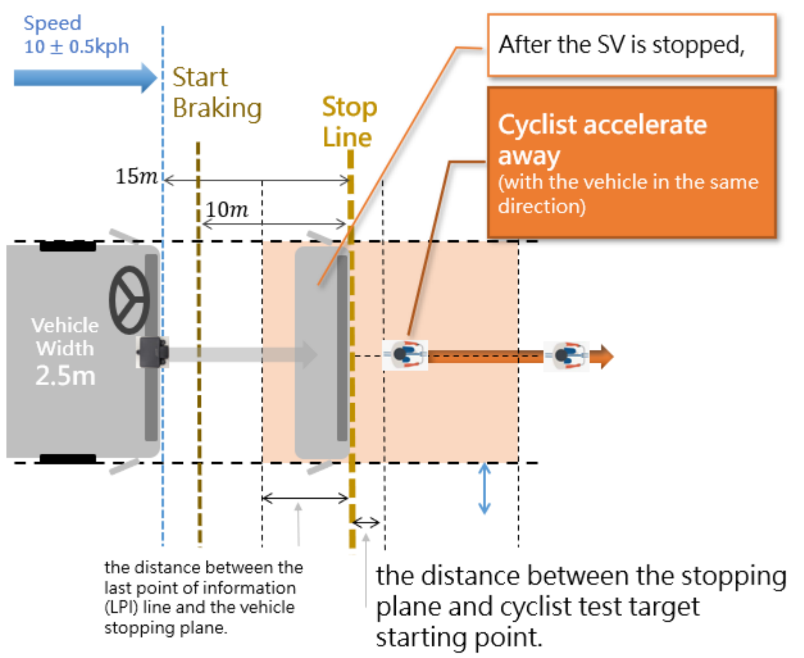
- Pedestrians or bicycles are crossing perpendicularly to the stationary vehicle in front

Detection area：

- length is 0.8~3.7m from the front bumper
- distance of the lateral blind spot considers as a potential starting action, so width is vehicle's width plus 0.5m on the left and right sides

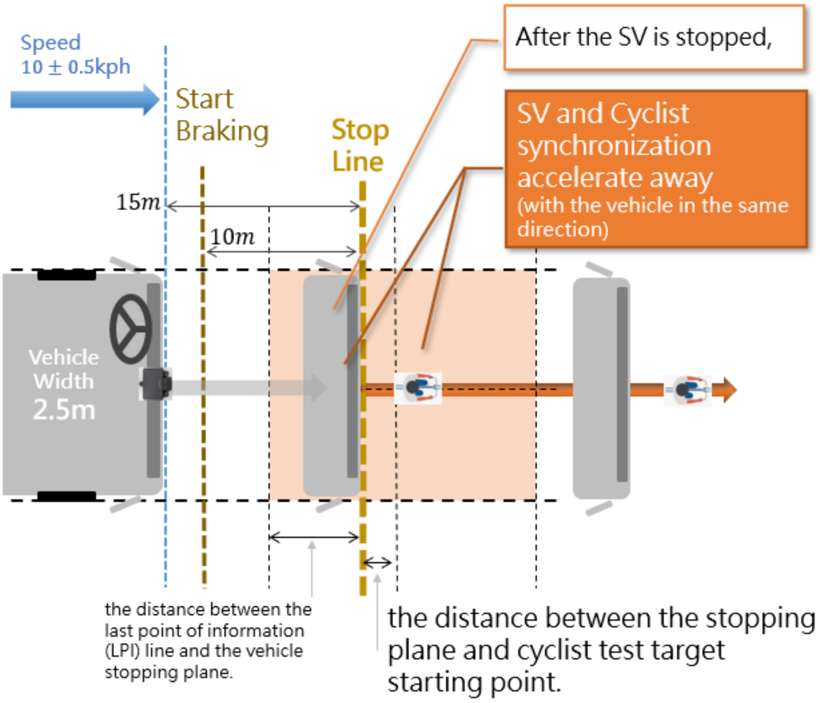
6.3.2.2 Dynamic usage scenario 1: After vehicle stops, cyclist accelerates away.

Vehicle moves/decelerates at low speed (≤ 10 km/h). During the movement, system detects static VRU on the distance of 0.8m to 3.7m in front of the vehicle and gives warning to the driver to stop the vehicle. After vehicle stops, VRU accelerates from 0km/h and move away in same as the vehicle direction. System continues to give a warning, until VRU leaves detection area.

	Vehicle's trajectory: ● Driving in a straight line at a speed of ≤ 10 km/h VRU's trajectory: ● bicycle is in the same direction as vehicle ● after vehicle stops, bicycle moves away in the same direction as the vehicle Detection area： ● length is 0.8~3.7m from the front bumper ● distance of the lateral blind spot considers as a potential starting action, so width is vehicle's width plus 0.5m to the left and right sides

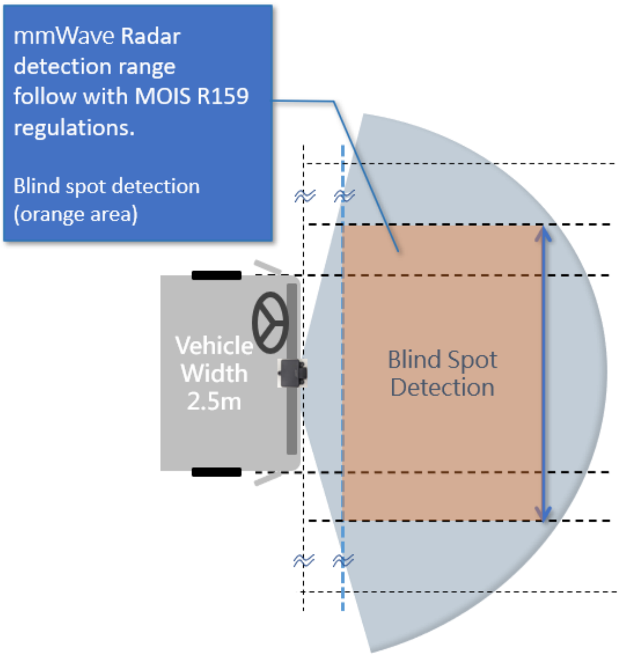
6.3.2.3 Dynamic usage scenario 2: vehicle and bicycle accelerate together in the same direction.

Vehicle moves/decelerates at low speed (≤ 10 km/h). During the movement, system detects static VRU on the distance of 0.8m to 3.7m in front of the vehicle and gives warning to the driver to stop the vehicle. After vehicle stops, VRU and vehicle starts to accelerate together from 0km/h. System continues to give a warning, until VRU leaves detection area.

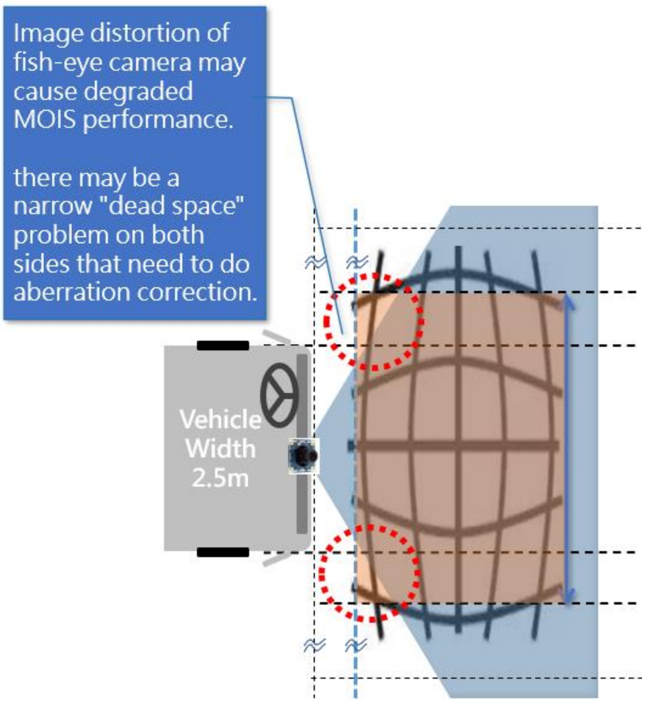
	Vehicle's trajectory: ● Driving in a straight line at a speed ≤ 10 km/h VRU's trajectory: ● The bicycle is in the same direction as the vehicle ● After the vehicle stops, vehicle and bicycle accelerate in the same direction Detection area： ● length is 0.8~3.7m from the front bumper ● distance of the lateral blind spot considers as a potential starting action, so width is vehicle's width plus 0.5m to the left and right sides

6.3.3 Benchmark of different solutions

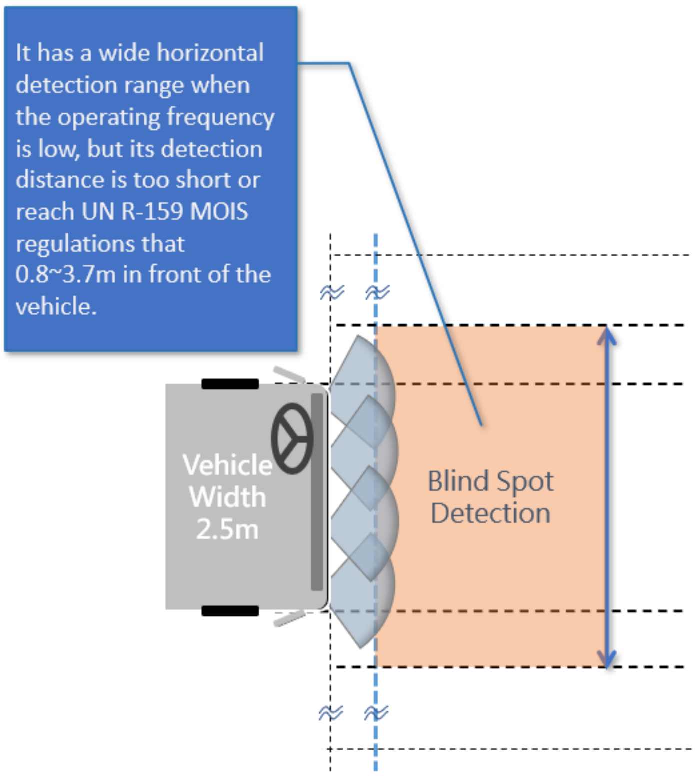
6.3.3.1 79GHz radar

	Description: Radar solution provides 150-degree FOV by radio signals reflecting from the objects, analyzes the frequency of the reflection, and quickly identify the position, distance, direction and relative speed of the target with high sensitivity and high precision; high detection accuracy and wide detection range. Comply with EU R159 MOIS regulations and blind spot detection area requirements

6.3.3.2 Lens camera (Wide angle or Fisheye)

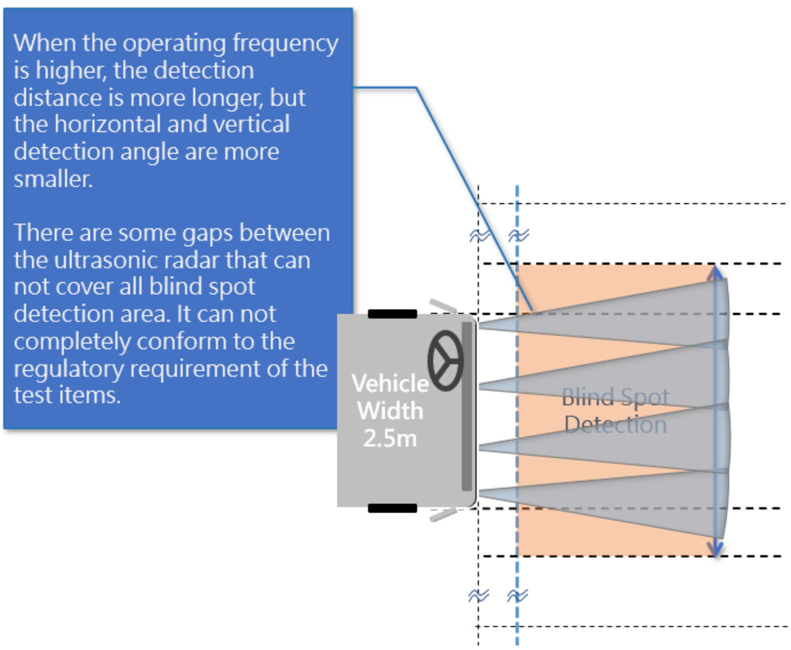
	Description: In order to obtain a large FOV, wide-angle and fisheye lenses cause the problem of image distortion. There are small "dead angle" on both sides, and additional aberration correction is required; it may also be due to software calculation. Objects might disappear from the screen

6.3.3.3 Ultrasonic sensor



Description:

Ultrasonic sensor have a wide horizontal detection range when the operating frequency is low, but detection distance is short and cannot reach the blind spot detection area of 0.8~3.7m in front of the vehicle required by UN R-159 MOIS regulations



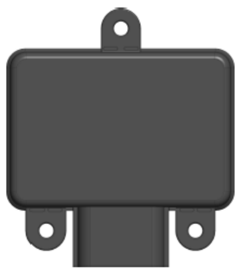
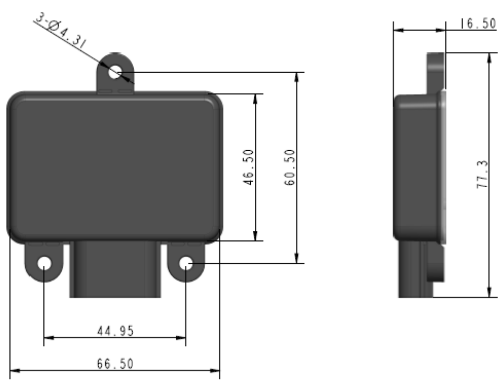
The higher the working frequency, the longer the detection distance, but the smaller the horizontal and vertical detection angles. In the short distance in front of the vehicle, there are gaps that the ultrasonic radars cannot cover each other, and the test projects cannot meet the regulatory requirements

6.3.3.4 Comparison table

	79GHz radar	Camera (Wide angle or Fisheye)	Ultrasonic sensor
FOV	150°	Sensing viewing angle 180° Video output viewing angle 165°	120°
Detection range	0.2 ~ 5m	The perception range of the surround-view lens is not large, and it is mainly used for obstacle detection within 5~10m of the vehicle body	< 5m
Environmental limit	It is rarely affected by the weather and times of the day	Similar to human vision, it is affected by visual field and weather factors	It is greatly affected by weather and temperature differences. The wave speed is related to the temperature, and the measured distance is different at different temperatures
C/P	Middle	Middle	Low
Advantage	● Small size, light weight and high spatial resolution, can identify the distance, direction and relative speed of vehicles or danger ● Strong ability to work in fog, smoke and dust, long transmission distance ● Stable performance, not disturbed by the shape and color of the target object ● Easy to install on the vehicle, RF signal easily go through the plastic bumper ● It has strong anti-interference detection performance in all weather and any times of day	● High resolution, can distinguish the size, distance and color of the target ● It is easy to realize the perception of various environmental information	● Inexpensive ● Simple structure ● Small size
Disadvantages	● The detection accuracy and resolution are slightly lower (with the development of higher frequency bands of millimeter wave technology, the continuous upgrading of antenna array technology, and the improvement of system design and algorithm, the detection distance and imaging accuracy of millimeter wave radar will also be greatly improved, and the recognition of pedestrians and other targets will be realized)	● Same as the limitation of the human eye, the image quality is easily affected by weather and light factors. In bad weather (dense fog, heavy rain or heavy snow), the sensing accuracy will be greatly reduced ● Image processing technology needs to completely simulate human vision and can only rely on complex predictions of neural networks	● Sensitive to temperature and humidity ● The maximum sensing distance is short ● Vulnerable to interference, unable to accurately describe the location of obstacles

7 Specification

7.1 Product specification

Specification	MOIS
Product drawing	
Application	MOIS
Power	＜ 5W
Operating voltage	9V ~ 32V
Operating temperature / Storage temperature	-40 ~ 85°C/ -40 ~ 90°C
Waterproof level	IP69K
Material	Cover : PP + GF30%; Base : PP
Size	 66.5(L) x 77.3(W) x 16.5(D) (mm)
Connector	8P connector Molex 31404-9110
Other modules (public version)	Controller
ASIL	ASIL-B (Optional)

Communication and interface	MOIS
CAN communication channel	2
CAN data frame	standard frame
CAN speed (HMI-CAN external interface)	500k
CAN FD (external interface)	X (not supported)
Vehicle signal - Speed	V (required)
Vehicle signal - Gear	V (required)
Vehicle signal - Door	▲ (Non-essential)
Vehicle signal – Turn direction	▲ (Non-essential)
Vehicle signal - Steering Angle	▲ (Non-essential)
Vehicle signal - Ignition (ON/OFF)	V (must)
Vehicle signal - Yaw Rate	V (must)
Max target output number	32
Max cluster output number	X (Does not support)

7.2 Performance specification

Specification		Unit	MOIS
Radar frequency		GHz	77 ~ 81
Data cycle time		ms	50
Distance	Range	m	0.2 ~ 5
	Accuracy	m	± 0.045
	Resolution	m	0.225
Velocity	Range	km/h	± 200
	Accuracy	km/h	± 0.63
	Resolution	km/h	3.2
Horizontal Angular	FOV	°	± 75
	Accuracy	°	± 0.25
	Resolution	°	13
Vertical Angular	FOV	°	± 15
	Accuracy	°	± 0.5
	Resolution	°	—

7.3 Functional specification

Specification	MOIS
Installation and calibration method	1. Off-line calibration 2. Dynamic calibration
UDS diagnostic function	X (does not support)
UDS Firmware update function	X (does not support)
Network management function	X (does not support)
Rollback and Recovery	X (does not support)
Image Size	＜ 1024 KB
Update Time	＜ 3 mins

8 Installation

8.1 Basic installation requirements

In order to achieve better effect, installation of MOIS millimeter-wave radar needs to follow basic requirements.

8.1.1 Vertical plane

- Fully operational： 550mm～700mm
- Performance Limitations： 400mm～550mm & 700mm～850mm
- Avoid installation： >850mm & <400 mm

Figure 4. Installation height requirement

1. The theoretical Y plane leveling offset between radar and vehicle is recommended to be 0mm.
2. The radar axis and the vehicle driving axis are recommended to be 0 degrees.
3. The recommended angle between the radar and the vehicle axis level is 90 degrees, with a tolerance of ≤ ±3.0 degrees.
4. The actual vertical angle between the radar and the vehicle axis is 90 degrees, with a tolerance of ≤ ±2.0 degrees.
5. The actual roll angle (Roll) between the radar and the vehicle body axis is 0 degrees, and the tolerance is ≤ ±2.0 degrees.
6. There should be no metal parts in the radar detection angle. If there are interfering objects in the surrounding 50mm area, need to inform CubTEK for evaluation.

8.1.2 Horizontal plane

- Full operation: The radar center position is aligned with the vehicle center axis, and the left and right offset is <50mm.
- Performance limitation: The center position of the radar is 50mm to 100mm from the left and right offset to the center axis of the vehicle.
- Avoid installation: the center of the radar is aligned with the center axis of the vehicle, and the left and right offsets are >10mm.

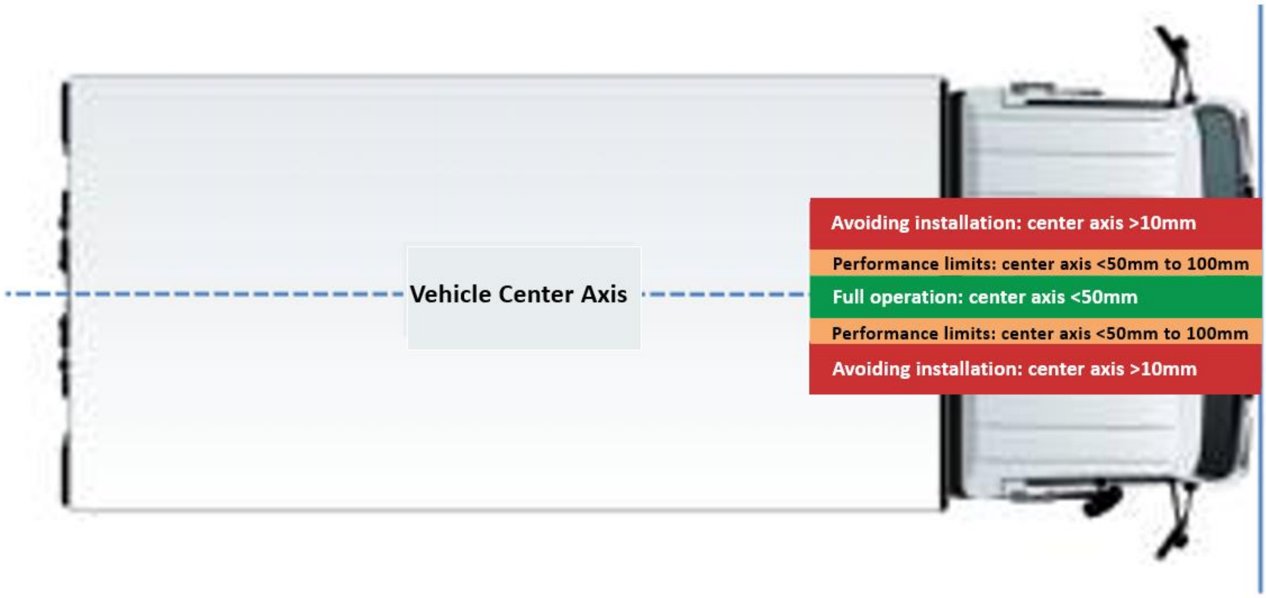


Figure 5. Installation offset requirement

Notes：

1. The radar is installed in full operation area, MOIS can implement under the best conditions.
2. The radar is installed in performance limit area, MOIS may generate false alarms and overall performance will be reduced.
3. The radar is installed in avoiding area, MOIS cannot operate normally, MOIS function will be lost.

8.2 Cover basic requirements

A flat cover has the least impact to the radar, curved cover can affect the function of the radar.

Fixed distance between the cover and the radar is important.

Radar gain is significantly attenuated at different distances.

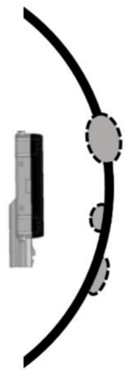
Covers are not recommended for the following situations:

1. with connection of two parts
2. with cornering
3. with bumps
4. with overlapping

5. with sharp corners

8.2.1 Recommended cover

8.2.2 Not recommended cover

1	2	3	4	5
				

8.2.3 Cover material

The material used for the cover must avoid metal materials.

In addition, metallic coatings must also be avoided for covers.

The following table is the recommended material (the tolerance value of thickness must be controlled below 5%) ：

Material	Opt. thickness 1	Opt. thickness 2
Polypropylene	2.55 mm	3.83 mm
ABS	2.39 mm	3.35 mm
Polycarbonate	2.33 mm	3.75 mm

The paint on 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 number of paint layers.

If the paint has a large attenuation factor, the radar performance will be attenuated accordingly. The effectiveness of the radar can be controlled by the material and thickness of the cover.

Due to different materials and thicknesses of the cover material, cover can cause different attenuation of the radar signal, all new materials and their thickness must be approved by Cubtek.

8.3 Cover environmental effects

8.3.1 Radar's cover

The main purpose of the radar's cover is to protect the radar from being damaged by the direct impact of flying stones, or directly covered by mud or ice and snow. Keeping the original integrity of the cover and the surface clean can effectively maintain the radar detection performance.

8.3.2 Bracket

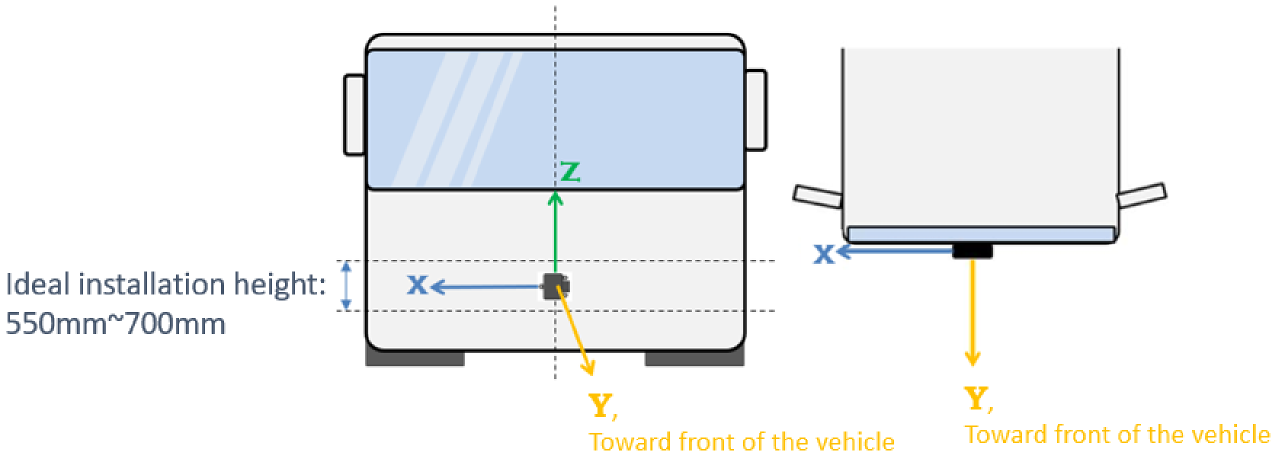
The stand provides a flat support point and has a drainage hole at the bottom. Material is metal or rigid plastic.

8.4 Radar installation method and size

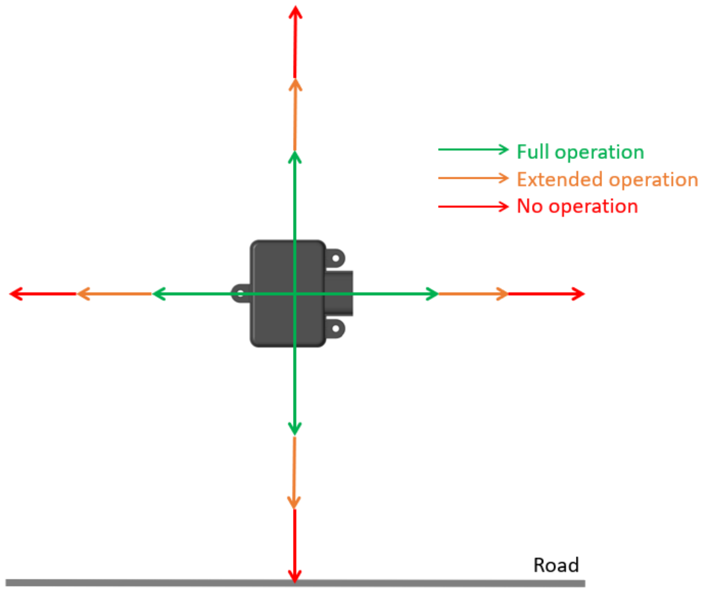
8.4.1 Radar coordinate system

Horizontally installed on the central axis of the front vehicle

Vertical installation position 55~70 cm



8.4.2 Radar operating range



8.4.3 Radar installation

In order to achieve the maximum performance of the radar, the user must comply with the following regulations for the installation of the radar. Inspection items for radar installation:

1. The radar should be installed in the standard operating area and the extended operating area.
2. The distance from the radar surface to the bumper should avoid dirt and dust.
3. The thickness of the bumper is recommended to comply with the following conditions.

Material	Opt. thickness 1	Opt. thickness 2
Polypropylene	2.55 mm	3.83 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 150° of the vertical radiation range of the radar surface.
5. The thickness of the cover should be consistent within 150° of the vertical radiation range of the radar surface. And the bumper should try to avoid bumps.
6. The cover within 150° of the vertical radiation range of the radar surface cannot include joints, overlaps, and sharp corners. The material used for the cover must avoid metal materials.
7. The connecting wire harness of the radar must have a firm fixed position.
8. The distance from the radar surface to the cover must be greater than 10mm. If the distance is too small, it is easy to have direct strong reflection from the cover, which affects the detection performance. Cubtek Technology does not provide the upper limit of the installation distance between the radar surface and the cover, but too large distance will affect the accuracy of detection.

9 Calibration

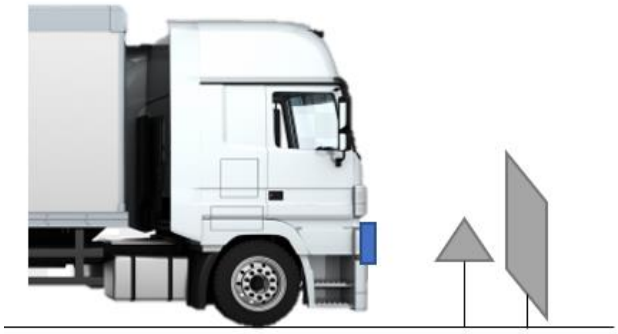
9.1 Offline calibration

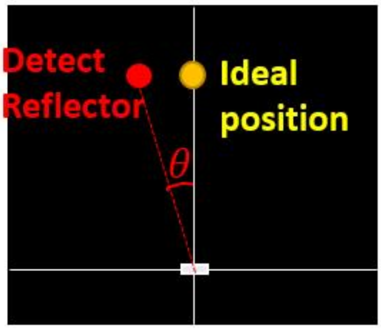
9.1.1 Calibration purpose

To distinguish the real installation angle and compensate the offset value caused by human error, to make sure radar perception is straight facing to the front-end.

9.1.2 Calibration configuration

Place a metal reflector in front the radar, so radar system can compensate observed sensing to ideal results.
Both azimuth and elevation axles can be calibrated at once.





Radar Sensing Schematic

9.1.3 Calibration Specifications

Specification	MOIS
Lower line calibration deviation allowable level range	± 3°
Lower line calibration deviation allowable vertical range	± 2°
Bottom line calibration deviation leveling accuracy	± 0.5°
Bottom line calibration deviation vertical accuracy	—

9.2 Dynamic Calibration

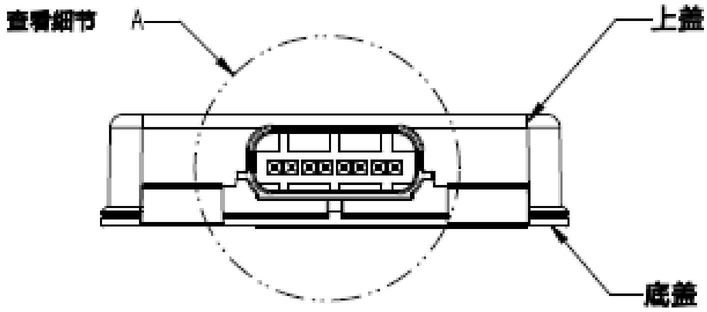
9.2.1 Calibration purpose

9.2.2 Calibration configuration

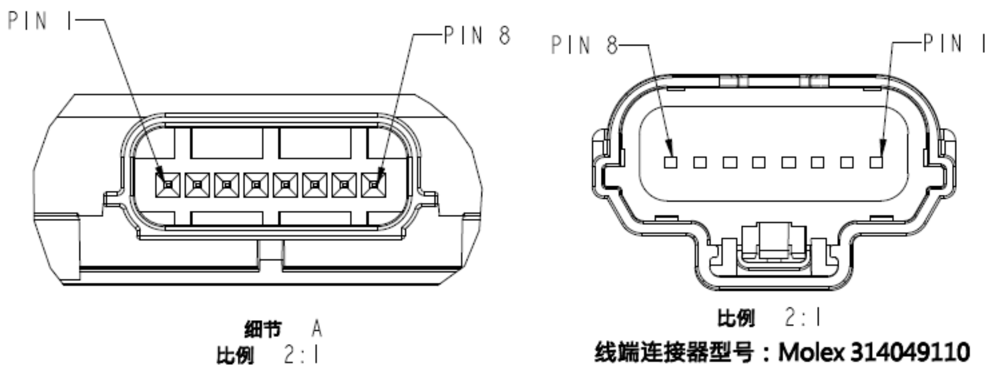
9.2.3 Calibration Specifications

Dynamic calibration specification	MOIS
Dynamic calibration deviation allowable level range	± 3°
Dynamic calibration deviation allowable vertical range	± 2°
Dynamic Calibration Deviation Leveling Accuracy	± 0.5°
Dynamic Calibration Bias Vertical Accuracy	—

10 Plug-in program and wiring harness



PIN DEFINITION	
1	NC
2	NC
3	CAN-H
4	CAN-L
5	VBAT
6	ADD-I
7	ADD-O
8	GND



11 Communication protocol

Execute according to the confirmation with the customer

12 Exclusion clause

Although this product provides MOIS functions, it may still be affected by factors such as vehicle driving area, environment, driving behavior, road conditions or climate, resulting in occasional false alarms or non-reports. Therefore, this product does not guarantee 100% accuracy. Accuracy of detection warnings, drivers should obey traffic rules, keep alert and pay attention to actual road conditions at all times, drive carefully, and do not rely too much on this product to avoid accidents。

Driver's attention is still required in the following situations：

1. Influenced by similar frequency bands near airports and military sites.
2. when driving very close to guardrails or concrete walls.
3. When driving at tunnel entrances and exits, very close to walls or close to tunnel evacuation areas.
4. Bad weather (rainstorm, snowstorm, sandstorm, etc.).
5. When a car drives over a road that raises water, snow, sand, etc.
6. When driving near curbs, potholes and tram tracks.
7. When near guardrails, electricity poles, trees, mailboxes.
8. Strong reflection objects on the ground, such as gutter covers, manhole covers, etc.