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mmWave Radar

VIA ELECPARTS INC.

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1 OUTLINED

1.1 Scope

This document is applicable to the development cycle of the blind spot detection radar between Party A and Party B. This document specifies the product development requirements of the product. If the parties change, adjust or supplement the relevant contents of this document in the form of letters, emails, calls, meeting minutes, etc. during the development cycle time, the product development requirements and specifications shall be implemented according to the changed, adjusted or supplemented forms.

1.2 Terminology

Noun	Explanation
Relative speed	The difference between the speed of the subject vehicle and the speed of the target vehicle.
Time to Collision	If the target vehicle is in the path of the subject vehicle and the current closing speed of the target vehicle remains constant, the time required for the target vehicle to crash with the subject vehicle is estimated.

1.3 Abbreviation

Abbreviation	Full Name
BSD	Blind Spot Detection
LCA	Lane Change Assist
RCTA	Rear Cross Traffic Assist
FCTA	Front Cross Traffic Assist
TTC	Time To Collision
RCR	Rear Corner Radar
FCR	Front Corner Radar
FCRL	Front Corner Radar Left
FCRR	Front Corner Radar Right
RCRL	Rear Corner Radar Left
RCRR	Rear Corner Radar Right

2 PRODUCT DEVELOPMENT REQUIREMENTS

2.1 Application

The blind spot radar is suitable for M and N class vehicles. The system can detect and warn the driver if there are moving objects (truck, car) in the blind spot warning area to avoid possible collision.

2.2 Product Overview

Most of the current traffic accidents are caused by failing to maintain driving distance, changing lanes inappropriately, or not paying attention to driving conditions, which leads to tragedies. Therefore, in order to effectively reduce the rate of accidents and ensure the safety of drivers and passengers, safety warning systems for the front and rear of vehicles have been emphasized in recent years.

As a blind spot radar installed at the corners of the vehicle, this product functions included BSD/LCA, FCTA, RCTA, front short-range radar and rear short-range radar. The radar sensor can monitor the front and rear lanes and adjacent lanes in real time to see if there is a target approaching, especially to detect the target in the blind spot of the rearview mirror. When a vehicle is approaching or there is a moving car in the blind zone, the monitoring system will alert the driver with a level 1 alarm or level 2 alarm through sound, light, etc. Before the vehicle may be involved in an accident, VIA mmWave Radar will take the initiative to warn the driver, effectively avoiding the rate of accidents.

To address this issue, the product by adding a set of radar on the side of the vehicle, when the vehicle is traveling, according to different speeds and conditions of the vehicle side of the blind spot detection, the radar can provide alarm signals to remind the driver to pay attention to the warning area of the vehicle into the safety of passengers and passers-by.

Product technical features：

1. Based on mmWave radar technology to provide detection and protection up to 80 meters and 120 degrees.

2. Corner radar warning function: BSD, LCA, RCTA, Rear Short-Range Radar, Front Short-Range Radar, and FCTA.

3. All-weather operation, comprehensive protection of driving safety.

4. Active warning, timely alert drivers to prevent accidents.

5. Anti-interference design with advanced algorithms to keep the radar functioning stably.

6. Support IP69K waterproof and dustproof.

2.3 System Architecture

Blind spot radar requires power supply. Communication inputs can be provided through the HMI CAN interface, which provides the same value of vehicle speed, gear, direction lights, etc. as the vehicle status from the vehicle information to fulfill the radar's input requirements. With the same HMI CAN interface, the radar can output an alarm signal, allowing the user to decide how to display the alarm after receiving the signal.

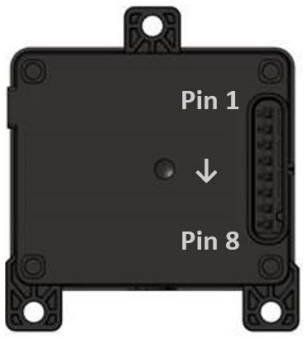
2.4 Product Specification

Specification Introduction	Blind Spot Radar
Application	Blind Spot Radar
Power	< 3W
Operating voltage	9V - 32V
Operating temperature / Storage temperature	-40~85°C/-40~85°C
Ingress Protection	IP69K
Size	74.3 (L) × 82.3 (W) × 35.3(D) (mm)
Weight	84 g±5%g

2.5 Communication and Interface Specification

Communication and Interface Specification	Blind Spot Radar
CAN communication channel	2 channels
CAN data frame	Standard frame
DSP CAN Speed	1M/4M
HMI CAN Speed	500K
Vehicle signal - Speed	V (Must be)
Vehicle signal - Gear	V (Must be)
Vehicle signal - Turn Indicator	V (Must be)

2.6 Connector Pin



2.7 Radar performance Specification

Radar performance Specification		Unit	Blind Spot Radar
Radar Frequency		GHz	PANA 76-77 GHz Other 77-81 GHz
Data cycle time		ms	50
Horizontal Angular	Range (FOV)	°	±60
	Accuracy	°	± 0.25
	Resolution	°	13

2.8 Function Specification

Function Specification	Corner Radar
UDS diagnostic function	V (Allowed)
UDS Firmware update function	V (Allowed)
Rollback and Recovery	V (Allowed)

2.9 FOV diagram

Detection range from vehicle front 0.4 to 80m with Horizontal Angular FOV ±60° and Vertical Angular FOV ±10°

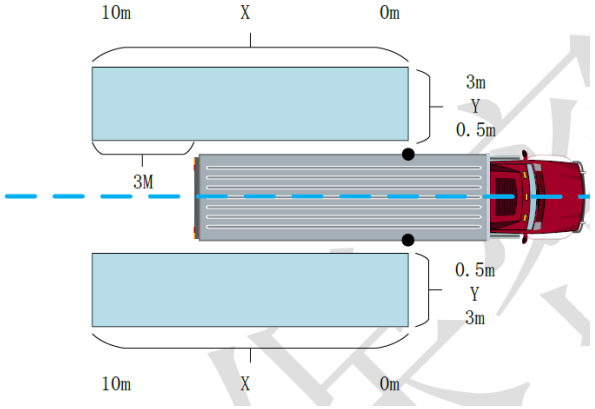
Horizontal

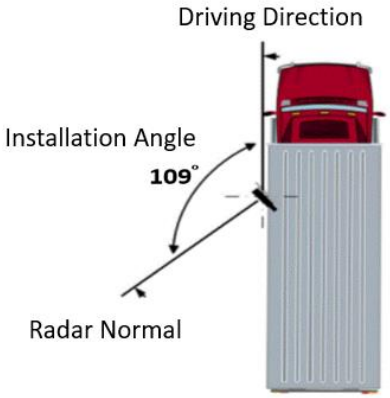
Vertical

2.10 Functional introduction

2.10.1 BSD TYPE I and II

BSD TYPE I (BSD function)





Alarm activation

BSD: Vehicle speed greater than or equal to 16km/h, (can be adjusted according to the customer)

The relative speed should be >30km/h no alarm when subject vehicle overtakes the target vehicle.

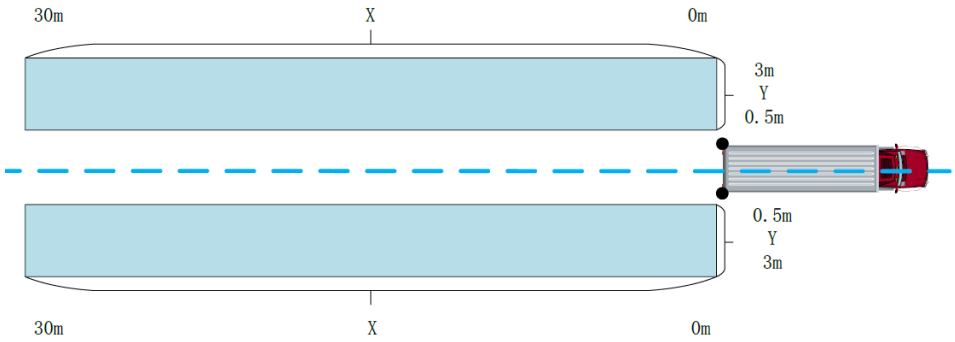
Warning mode

BSD/LCA Warning mode

Phase	Phase 1	Phase 2
Warning Area	Vehicle enters BSD/LCA area	The vehicle enters the BSD/LCA area and has turned on the turn signal
Warning method	Level 1	Level 2

BSD TYPE II (LCA function)

Detection range is from vehicle end to 30m, and the lateral range is 3m with Horizontal Angular FOV ±60°.



Alarm activation

The relative speed should be >30km/h no alarm when subject vehicle overtakes the target vehicle with TTC<2s (can be adjusted according to the customer).

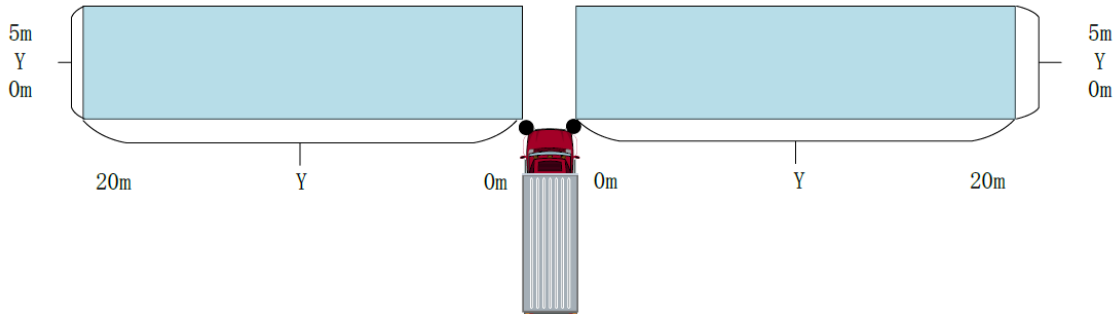
Warning mode

BSD/LCA Warning mode

Phase	Phase 1	Phase 2
Warning Area	Vehicle enters LCA area	The vehicle enters the LCA area and has turned on the turn signal
Warning method	Level 1	Level 2

2.10.2 FCTA function

Detection range is lateral from radar to 20m and longitudinal from vehicle corner front to 5m in vehicle front area.



Alarm activation

- Start function when vehicle is in D gear
- Activated when vehicle speed is less than or equal to 24 km/h (customer adjustable)
- TTC < 2 sec. warning for front oncoming traffic (customer adjustable)

Warning mode

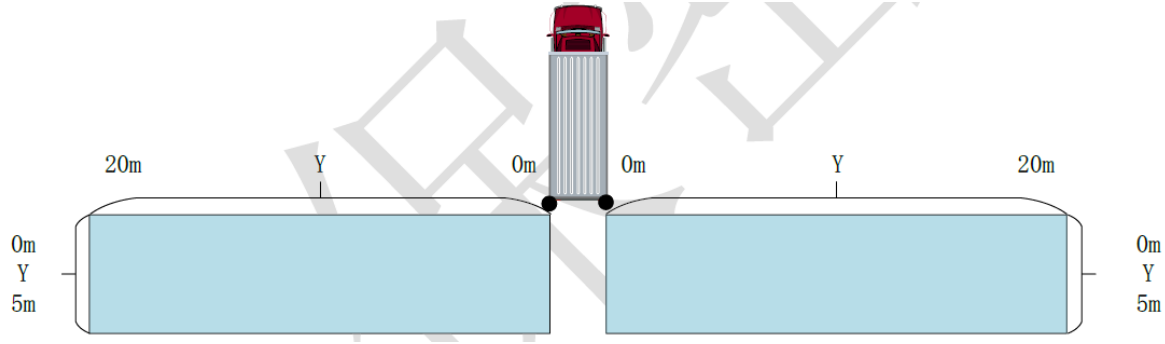
BSD/LCA Warning mode

Phase	Phase 2
Warning Area	The vehicle enters the FCTA area and meet activated condition
Warning method	Level 2

2.10.3 RCTA function

Detection range is lateral from radar to 20m and longitudinal from vehicle corner front to 5m in vehicle front area.

Alar



- Activated when vehicle speed is less than or equal to 24 km/h (customer adjustable)

- TTC < 2 sec. warning for rear oncoming traffic (customer adjustable)

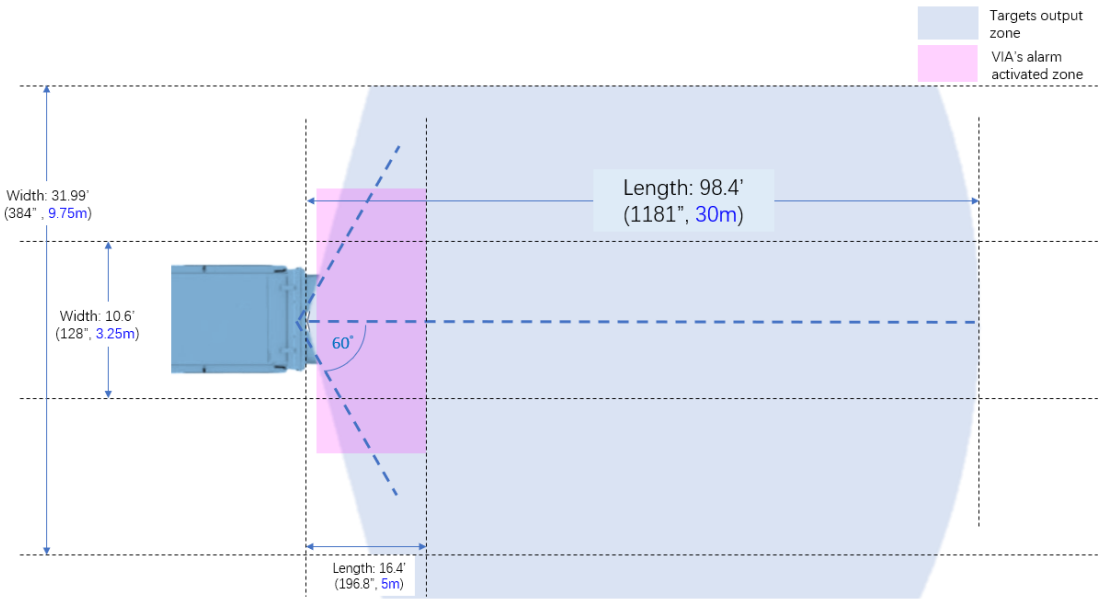
Warning mode

BSD/LCA Warning mode

Phase	Phase 2
Warning Area	The vehicle enters the RCTA area and meet activated condition
Warning method	Level 2

2.10.4 PANA Rear short-range radar function

To detect 30m behind the vehicle, detect high risk of collision to the rear of the vehicle, output the location of the target object to the VIA system, the customer's system issued by the way of warning.



Alarm activation

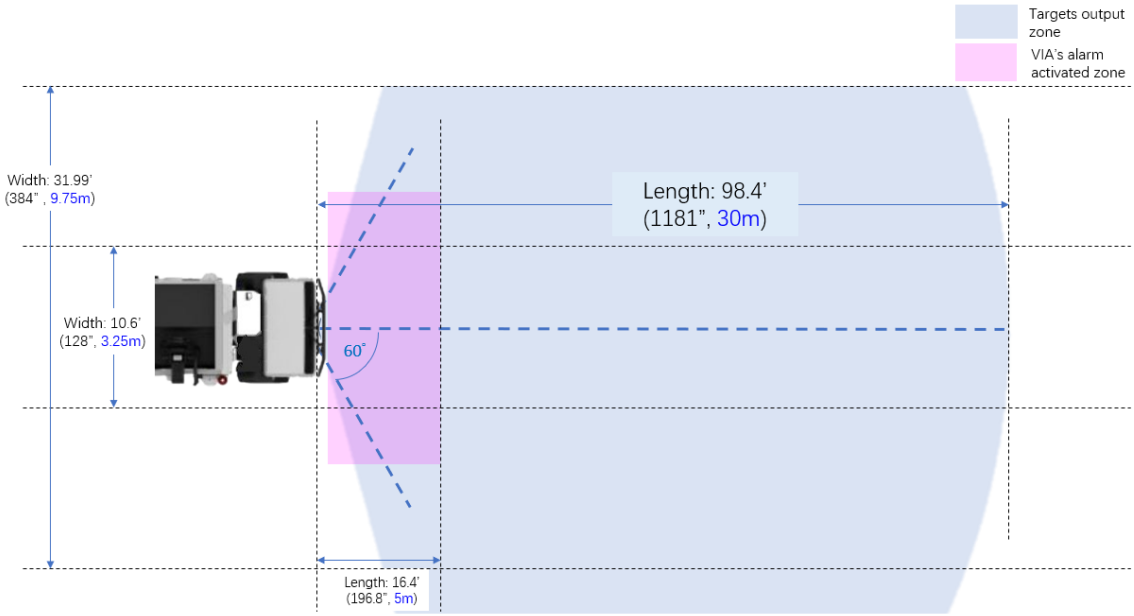
- Activation function while radar is power on.

- Monitoring range can be adjusted according to customer requirements.

2.10.5 PANA Front short-range radar function

To detect 30m front the vehicle, detect high risk of collision to the front of the vehicle, output the location of the target object to the VIA system, the customer's system issued by the way of

warning.



Alarm activation

- Activation function while radar is power on.

- Monitoring range can be adjusted according to customer requirements.

-The detected target is a car.

3 INSTALLATION INSTRUCTIONS

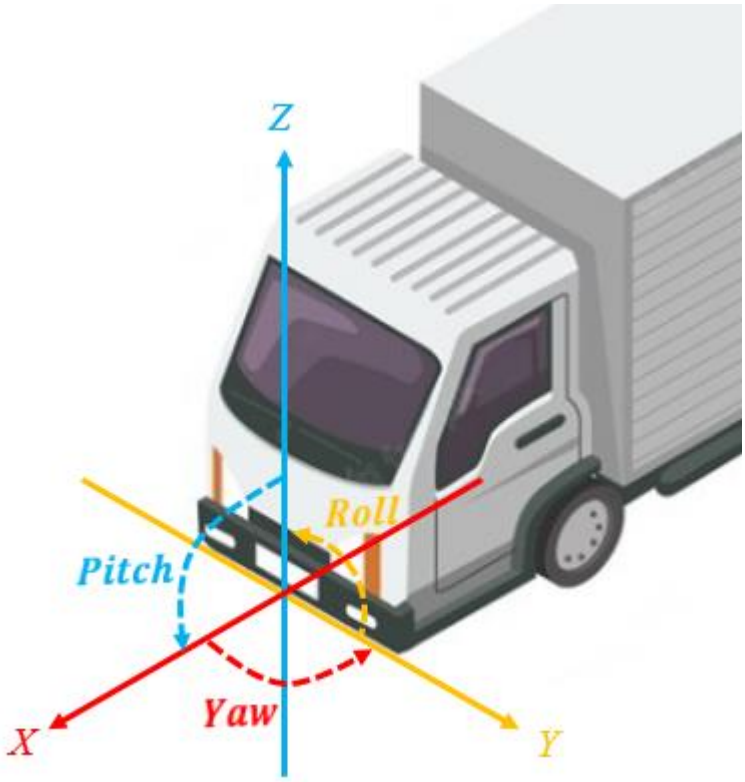
3.1 Installation requirements

In order to achieve better results, the following specifications need to be followed when installing the blind spot detection radars.

3.2 Radar installation method

3.2.1 Radar coordinate system

According to ISO coordinate rules, the positive value of the X-axis points to the front of the vehicle, the positive value of the Y-axis points to the left of the vehicle, and the positive value of the Z-axis points to the top of the vehicle. The angle of rotation around the X-axis is Roll, the deviation angle of rotation around the Y-axis is Pitch, and the angle of rotation around the Z-axis is Yaw.

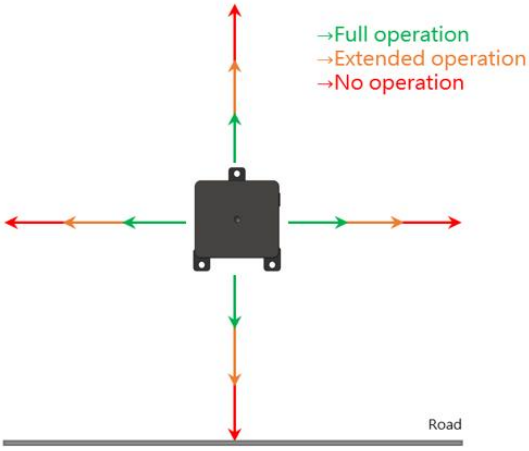


3.2.2 Radar center height from ground

- Full operation： 889 mm～1067 mm
- Avoid installation：<500 mm& >1500 mm

Attention：

1. The radar is installed in the fully operational position for optimal performance.
2. If the radar is installed at the performance limit position, false alarms may occur and overall performance may decrease.
3. The radar is installed in a location that avoids installation and cannot operate normally, resulting in poor performance.



Radar Performance Diagram

3.2.3 Instructions for Writing Radar Installation Vehicle Body Parameters

According to the tool instructions, enter the radar installation position, installation height, and vehicle width. Please note that incorrect data input may result in missed detections. If the installation height

exceeds the recommended value specified in the datasheet, the radar may experience detection risks within its FOV.

3.3 Radar installation Notes

In order to achieve the optimal performance of the radar, users must comply with the following radar installation regulations, otherwise the radar performance will be limited, leading to a decrease in the accuracy of radar detection and warning. Inspection items for radar installation:

1. The connector direction of radar： back side out.
2. The recommended deviation between the radar axis and the vehicle driving axis is 0 degrees.
3. The radar is installed in the fully operational position for optimal performance.
4. The allowance of deviation of the X-axis angle rotation (Roll) is ± 0 degrees.
5. The allowance of deviation of the Y-axis angle rotation (Pitch) is ± 0 degrees.
6. The allowance of deviation of the Z-axis angle rotation is (Yaw) ± 1 degree.
7. The distance from the radar surface to the bumper should avoid dirt and dust.
8. The connecting harness wires of the radar must have a fixed position.
9. The distance from the radar surface to the bumper must be greater than 5mm. If the distance is too small, it is easy to have direct strong reflection from the outer cover (bumper), which affects the detection performance. This product does not specify the upper limit of the installation distance from the radar surface to the bumper, but excessive distance can affect the accuracy of detection.
10. No allow metal parts within the radar detection perspective. If there are interference objects within a 50mm around it, it must be evaluated by the VIA upgraded department.
11. Parameter setting is required after installation.
12. The housing installation fixing hole can withstand locking torque of M4 screws (including gaskets) ≤ 8kgf.cm.

4 ENVIRONMENTAL IMPACT OF THE FRONT COVER OF BLIND SPOT RADAR

4.0.1 The cover condition basically requires the radius of curvature

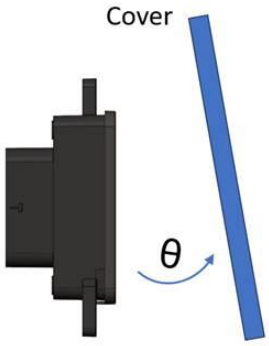
The best installation position of radar is a flat bumper. The bumper-holding in the corner will affect the function of radar. It is suggested that the horizontal and vertical curvature radii of the covering parts should meet the requirement of R > 400 mm.

4.0.2 Distance between radar and cover

The distance between the cover and the radar is recommended to be at least 5 mm.

4.0.3 Installation angle of radar and cover

It is suggested that the installation inclination angle of the cover in the vertical direction is $|\boldsymbol{\theta}| \geq \mathbf{8}°$ (If it is less than this value, please provide the numerical model and entity of the panel, and VIA will analyze whether there is interference risk.)



4.1.0 Recommended material for blind spot radar cover

If it is necessary to mask the outer layer of the radar, the following requirements must be met. The material used for radar masks must avoid metal materials. In addition, metal coatings must also be avoided for masking purposes. The following table shows the recommended materials:

Material	First ideal thickness	Second ideal thickness
Polypropylene	2.55 mm	3.90 mm
ABS	2.39 mm	3.58 mm
Polycarbonate	2.33 mm	3.49 mm

※ The tolerance of cover material shall be controlled under 5% based on the specification.

※ The coating of the mask will also affect the radar signal. The signal of RF antenna is not only affected by the material of paint, but also related to the thickness of paint. If there is a large attenuation factor in the coating, the radar efficiency will be attenuated accordingly. The performance of radar can be controlled by the material and thickness of the mask. Because different materials and thicknesses of masks will cause different attenuation of radar signals.

※ If any abnormal conditions occur after installation, please contact VIA for detailed discussion and evaluation.

5 EXCLUSION CLAUSES

The front blind spot radar of this product is an assistant system. Please install it according to the instruction, and complete radar setting and calibration. If it is not operated according to the requirements, the radar performance will be limited or it will not work normally, resulting in a decrease in the accuracy of radar detection and warning, and it is easy to fail. Estimation problem.

At the same time, occasional false alarms or non-alarms may still be caused by factors such as the driving area, environment, driving behavior, installation status, calibration status, road conditions or climate of the vehicle. Therefore, this product does not guarantee a 100% detection and warning accuracy. Drivers should comply with traffic rules, remain alert, and always pay attention to actual road conditions. They should drive cautiously and not overly rely on this product to avoid accidents. Many factors can affect the performance of assistant driving devices, resulting in their inability to perform as expected. These factors include： (but are not limited to)

◆ Under the following conditions, even if the alarm conditions are not met, the system may still give an alarm

① When driving in a tunnel.
② When driving a car on a road that raises water, snow, sand, soil, etc.
③ When driving uphill or downhill sections, or on rough roads (such as sloping roads).
④ When driving near curbs, potholes, and tram tracks.
⑤ Strong reflective objects on the ground, such as ditch covers, manhole covers, etc.
⑥ Highly reflective objects at high altitudes, such as skybridge, road signs, etc.
⑦ It is possible to detect objects outside of the lane on curve (mountain roads, freeway ramp, etc.).
⑧ When the speed error given by the vehicle information is greater than 5km/h during acceleration and deceleration.
⑨ Change the gear position before the brake is completely stopped in the reverse state.

◆ Under the following conditions, radar may be difficult to detect targets or unable to function properly:

① When the radar detection area is blocked by objects such as nearby walls or vehicles.
② When the radar is blocked by foreign matter such as mud, heavy snow, sand, etc.
③ Driving in environments with excessive reflection areas such as shrubs and trees.
④ Affected by similar frequency bands near airports and military sites.
⑤ Radio interference from radar sensors equipped on nearby vehicles
⑥ Bad weather (rainstorm, heavy fog, heavy snow, sand storm, etc..
⑦ When driving uphill or downhill sections, or on rough roads (such as sloping roads).
⑧ The moving target is too close to the stationary object.
⑨ The moving target enters the alarm area from outside the FOV.

Under the following conditions, the radar may have difficulty detecting a target or may not be able to properly localize a target

- ◆ Small targets (e.g., pedestrians, children) in close proximity to a large stationary object (e.g., vehicle, wall) that remains stationary and does not move, the radar may only be able to form a Target for the large stationary object. o If the radar is mounted outside of its operating location (e.g., the radar is mounted too high), the radar may have difficulty detecting or failing to properly localize low-level targets.
- ◆ If the radar is mounted out of operational position (e.g., radar mounted too high), the radar may have difficulty detecting or determining low targets properly.

FCC Statement

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 50 cm between the radiator and a human body.

ISED Statement

This device contains licence-exempt transmitter(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

(1) this device may not cause interference,

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

L'émetteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) L'appareil ne doit pas produire de brouillage;

(2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 50 cm between the radiator and a human body.

Cet équipement est conforme aux limites d'exposition aux rayonnements de la ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec une distance minimale de 50 cm entre le radiateur et un corps humain.