Blind Spot Warning (BSW) and Rear Cross Traffic Alert (RCTA) specification

Model Name: UMD-RI03, UMD-RI03 –L, UMD-RI03 -R

Version: V01

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1 Scope

This document describes the system development of small form factor (SFF) blind spot warning (BSW). This is includes technical specification, system function design requirements, mechanical design/ installation, software interface/communication and test verification.

2 Terms and definitions

- BSW (Blind spot warning):This system assists drivers in driving safely by detecting and warning them of the presence of other vehicles in the blind spot area
- RCTA (Rear cross traffic alert): This function assists driver in rear gear by detecting and warning them of other vehicle driving from side of rear.
- 24GHz ISM Band (Industrial scientific medical radio): It is radio bands (portions of the radio spectrum) reserved internationally for the use of radio frequency (RF) energy for industrial, scientific and medical purposes other than telecommunications. The frequency bandwidth 24~24.25 GHz can be used for worldwide radar application. We also call this is Narrow Band Radar, which is different from ultra wide band radar.
- FOV (Field of view): The maximum azimuth angle that radar system can detect the target vehicle.

3 Reference

- ISO 17387
- ES-X82010
- ISO16750

4 General description

4.1 System introduction

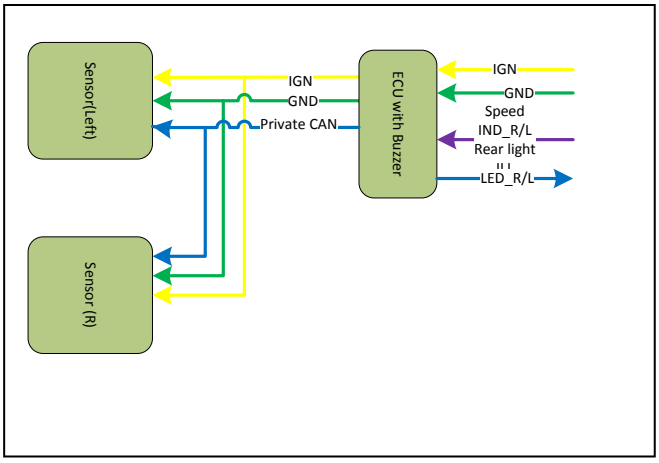
This system is composed of two 24 GHz narrow-band sensors. Its intended function is for blind spot warning (BSW) to assist driver for the driving safety.

4.2 System diagram

The system includes a master sensor and a slave sensor. Two sensors are communicated by “Private CAN”. The external interface is to connect with ignition power (IGN, 12V) and CAN message of vehicle information.

The communication interface between two sensors is CAN (Private CAN). The information transmitted through this CAN relates to vehicle data, sensor position setup data, warning parameter setup data and normal warning data output.

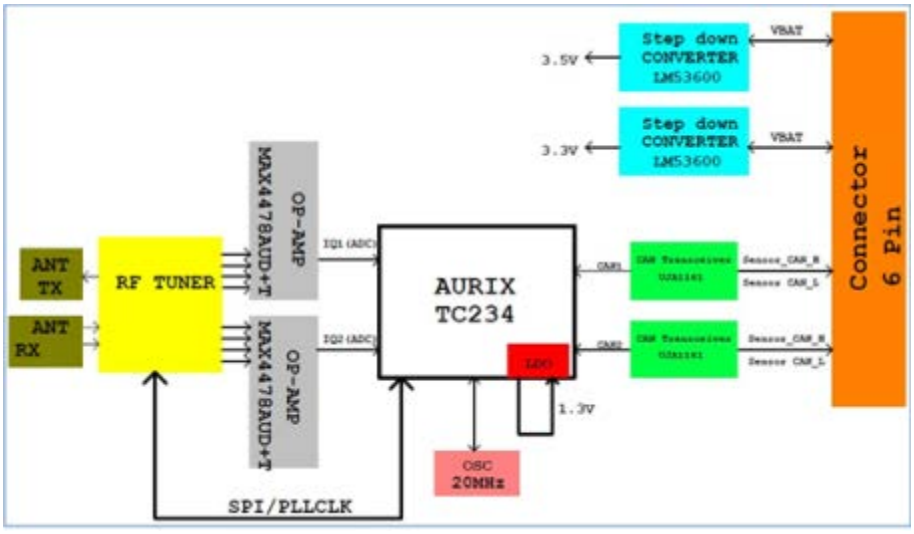
ECU will transfer the vehicle data to sensors and control the HMI warning output.



4.3 Hardware Block Diagram

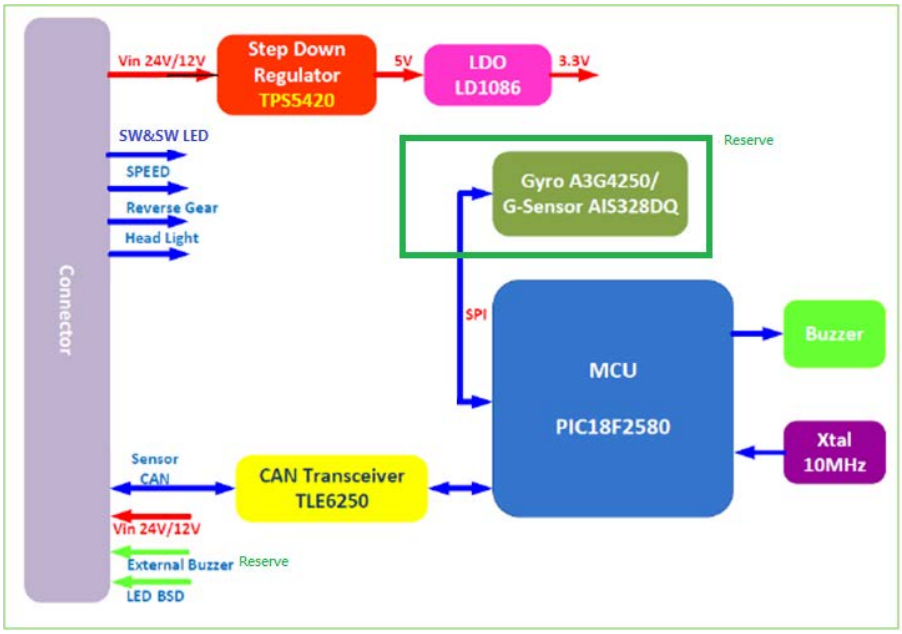
4.3.1 Right and left side Sensor

It is composed of RF tuner and DSP. It includes one Vehicle CAN (optional) and one Private CAN.



4.3.2 ECU control box

Ii is mainly composited by the MCU. It have radar conversion information 、HMI output and Gyro simulated the hardware of Yaw rate(Reserved) .



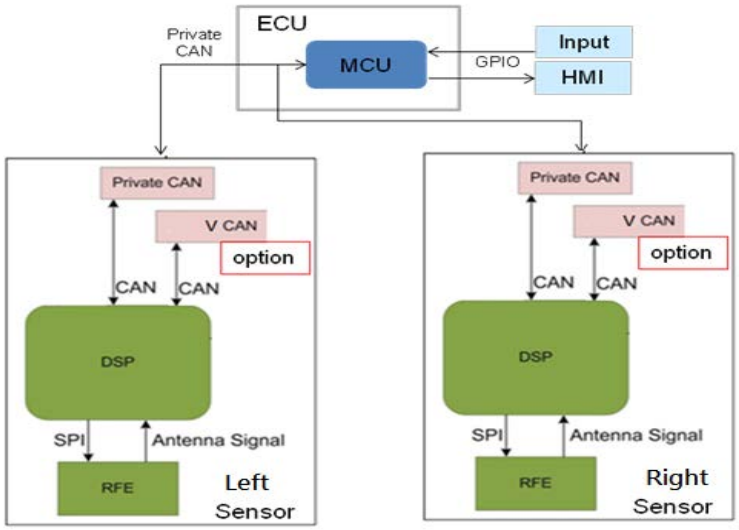
4.4 Software Implementation

- MPLAB IDE V8.86
- Matlab 2012b

The software design process is mainly for detection, tracking and warning. It also provides self-diagnosis.

4.5 Software Block Diagram

The right and left sensor software structure shows below. The communication between right and left sensor is through CAN, which is Private CAN.



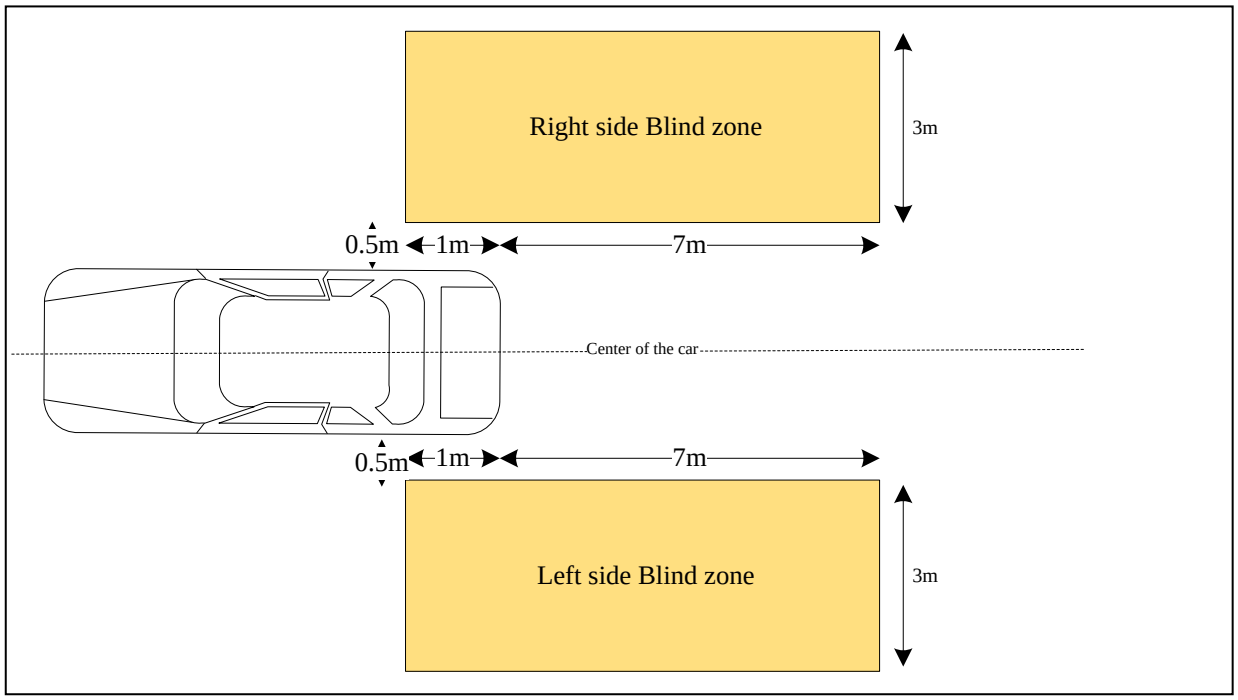
5 System Function Description

5.1 Function definition

5.1.1 BSW function

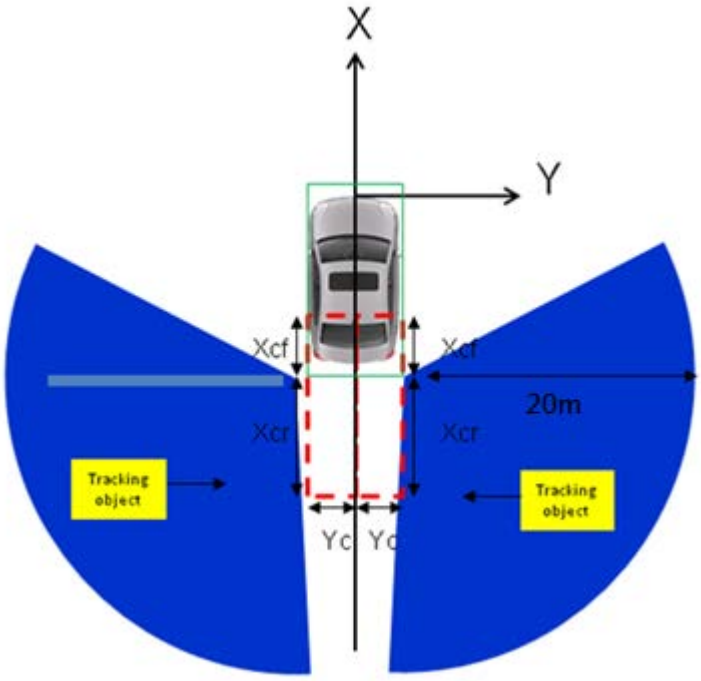
BSW system is designed for monitoring adjacent lane and providing warning. The warning zone definition is below.

- The warning distance of passenger vehicle is 7m behind the rear of subject vehicle. (Normal driving behavior for overtaking)
- There is non-warning zone at side of vehicle 0.5m.
- The warning width may be adjusted by subject vehicle speed.
- The activation speed of system is 10km/h.



5.1.2 RCTA function

RCTA warning area shows below. The collision time should be less than 2 seconds for the collision area.



Parameter	Description	Default	Unit
Xcf	The length of detection area from rear of subject vehicle in front.	1.5	m
Xcr	The length of detection area from rear of subject vehicle in in rear.	5	m
Yc	The length of center and edge of subject vehicle.	0.8	m
TTC_RCTA	Time to collision for RCTA	2.5	sec
Active_SPD_Min	The minimum active speed of RCTA	-10	kph
Active_SPD_Max	The maximum active speed of RCTA	0	kph
TV_Speed_min	The minimum speed of target vehicle	2	m/s
TV_Speed_Max	The maximum speed of target vehicle	8	m/s

5.2 Connecter pin define

There are 2 sets 6 PIN connecter in the system, Follow is usage and pin define of connecter.

- 6 PIN connector (Left sensor):

Molex MLX0314036110

- Usage:

Right sensor connection

- Pin definition of connecter:

Pin No	Signal Name	I/O/P	Usage	Note
6	**V_IN**	P	Power input	**---**
5	**GND**	P	Ground	**---**
4	**S_PRIVATE_CAN_H**	I/O	Private CAN	Twist
3	**S_PRIVATE_CAN_L**	I/O		
2	**VEHICLE_CAN_H**	I/O	Vehicle CAN	Twist(Reserved)
1	**VEHICLE_CAN_L**	I/O		

- 6 PIN connector (Right sensor):

Molex MLX0314036110

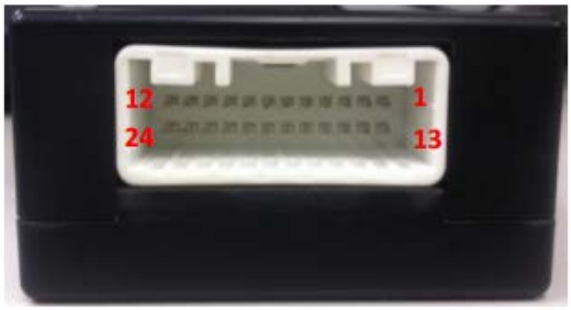
- Usage:

Left sensor connection

- Pin definition of connecter:

Pin No	Signal Name	I/O/P	Usage	Note
6	**V_IN**	P	Power input	**---**
5	**GND**	P	Ground	**---**
4	**S_PRIVATE_CAN_H**	I/O	Private CAN	Twist
3	**S_PRIVATE_CAN_L**	I/O		
2	**VEHICLE_CAN_H**	O	Vehicle CAN	Twist(Reserved)
1	**VEHICLE_CAN_L**	O		

- ECU 24PIN connector:
  HTH24FW
  - Usage:
    Right and left sensor connection.
  - PIN definition as below:



Pin	Definition	Pin	Definition
1	POWER_IN	13	POWER_IN
2	NA	14	GND
3	GND	15	GND
4	SPD	16	SW
5	VEHICLE_CAN_H (Reserve)	17	Reverse Signal
6	VEHICLE_CAN_L (Reserve)	18	Head Light
7	GND	19	Buzzer_EXT (reserve)
8	SENSOR_CAN_H	20	TURN_R
9	SENSOR_CAN_L	21	TURN_L
10	LED_GND	22	LED_GND
11	LED_GND	23	LED_R
12	SW_LED	24	LED_L

6 Technical specification

6.1 Basic parameters:

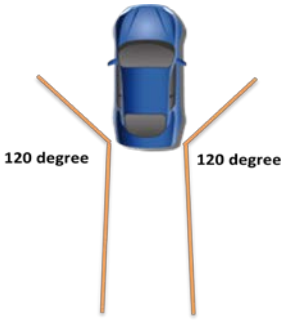
- Operating voltage range: 9 V–16 V
- Typical operating voltage: 13.5 V
- Ambient operating temperature: –40 °C to +85 °C
- Maximum power consumption: 6 W
- Operation frequency: 24 GHZ
- Waterproofing: IP67

6.2 Performance parameters:

- Frequency :
  - 24.065 – 24.225Ghz (UMD-RI03)
  - 24.075 – 24.225GHz (UMD-RI03 –L) left side
  - 24.065 – 24.215GHz (UMD-RI03 –R) Right side
- FOV: 120°
- Channel number：1024
- Output power：< 104.81 dBuV/m
- Range accuracy: 0.25 m
- Range resolution: 1.0 m
- Velocity accuracy: 0.08 m/s
- Velocity resolution: 0.32m/s
- Angle accuracy: +/-1 degree (between azimuth angle -40~+40 degrees)
- Maximum number of tracking objects: 32
- Cycle time: 40.96 ms

6.3 Field of View (FoV)

The field of view angle is about 120 degrees.



6.4 Detection target

- Truck, Passenger Car, Motorcycle.

6.5 The false alert rate and detection rate

- Low false alert rate: Radar system has lower false alert rate even driving close to complex environment. The false alert rate is lower than 5 times when driving 100km.
- Accurate detection rate (Low missing rate): In normal driving case, the accurate rate is very high.
  - 99% for Truck and Passenger Car
  - 98% for Motorcycle.

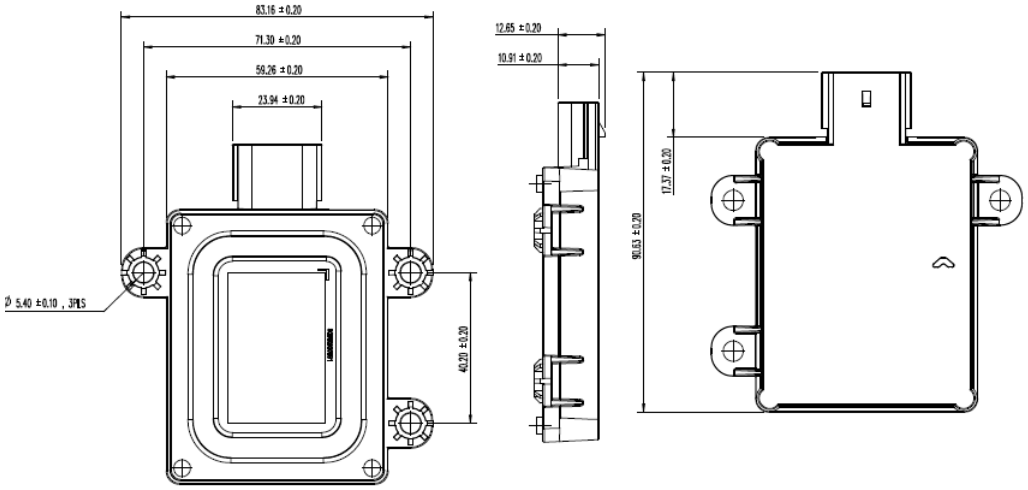
7 Mechanical requirements

7.1 Weight

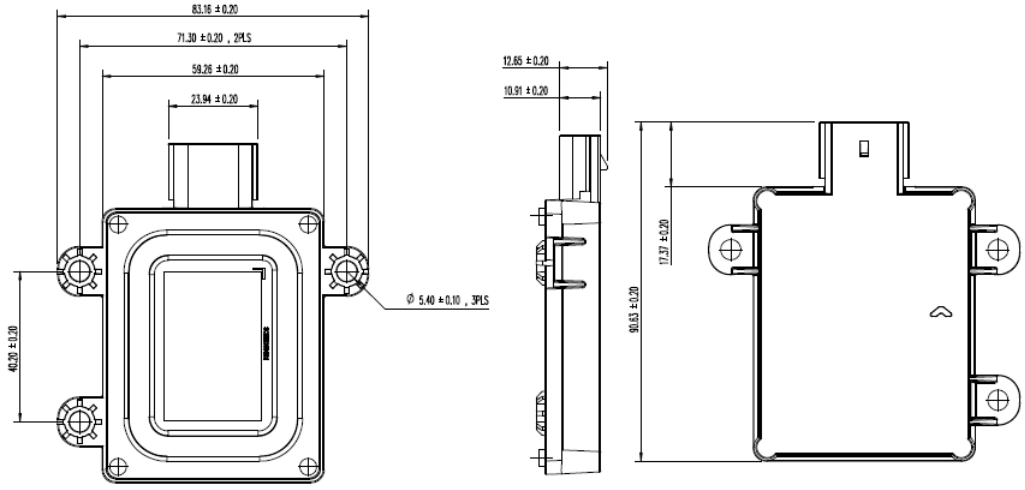
The sensor weight is 100±5g for each sensor.

7.2 Sensor size

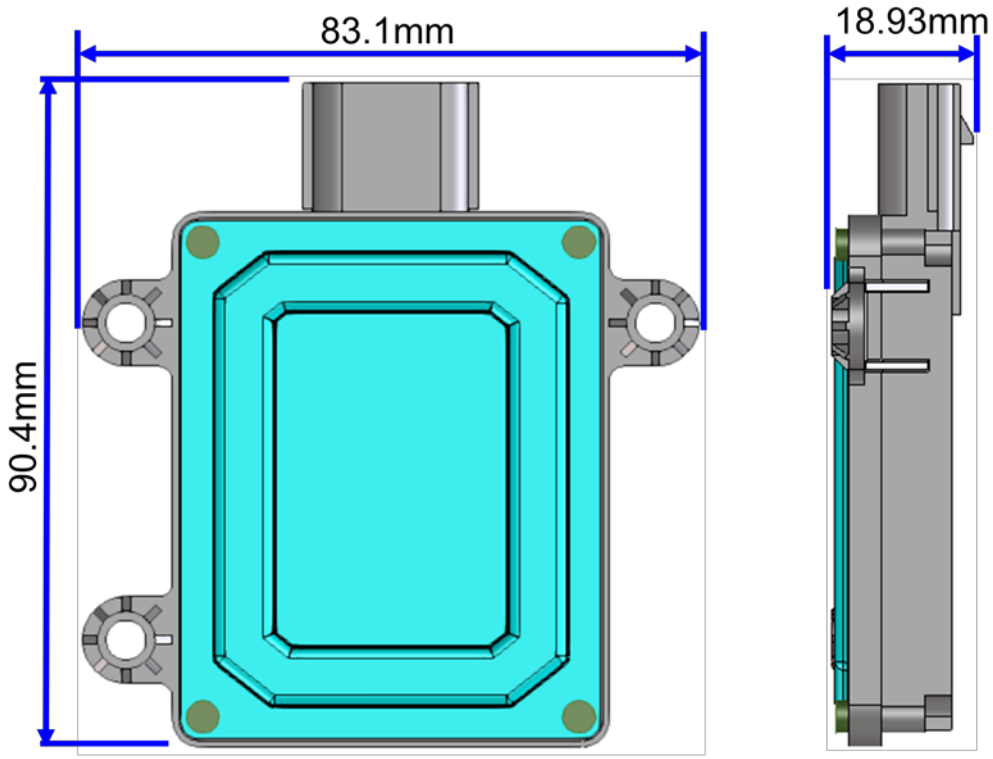
- 90.4*83.1*18.93±3 mm (L*W*H)
- The figure shows sensor outline below.



UMD-RI03, UMD-RI03 –R

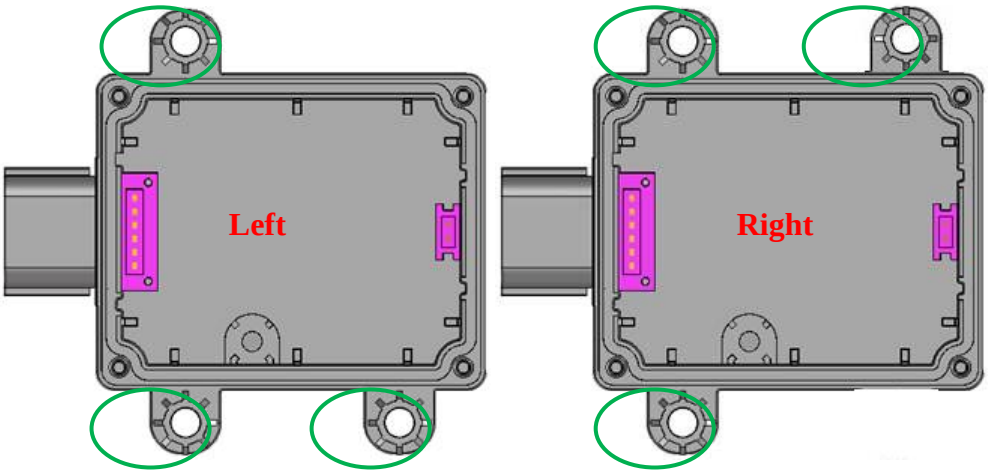


UMD-RI03 -L



7.3 Installation

- There are three locations for affixing the device as illustrated in the following diagram.
- The three locations for affixing are different between right and left sensor.



2

- Left sensor is installed inside of bumper at left rear side of subject car. The connector is downward. Refer to figure below.
- Right sensor is installed inside of bumper at right rear side of subject car. The connector is downward. Refer to figure below.

- Azimuth angle = 45°。It could follow the performance for adjusting.
- Elevation angle = 0.5~3.5° , which is related to the installation height.
- ECU box put on suitable place.

8 System Function Design

8.1 BSW warning

When speed of subject vehicle reaches 10km/h, BSW system will monitor the vehicles at adjacent lane. When there is vehicle at warning zone or closing to warning zone, the system can monitor and provide the warning message by CAN bus and output warning by LED or buzzer to prevent potential collision.

The system will provide two levels warning.

- The first level warning will provide visual warning by LED.
- The second level warning will provide not only visual warning, but also acoustic warning, like buzzer, to show the immediate risk. The buzzer design can be done by either in ECU or in buzzer on vehicle.

8.2 RCTA warning

When driver selects rear gear, RCTA system will be enabled. When there is target car enters detection zone and it may cause potential collision (TTC 2.5 seconds), the system will provide the LED and buzzer warning to remind driver. But if the speed of rear direction is larger than 10km/h, the system will not guarantee coverage.

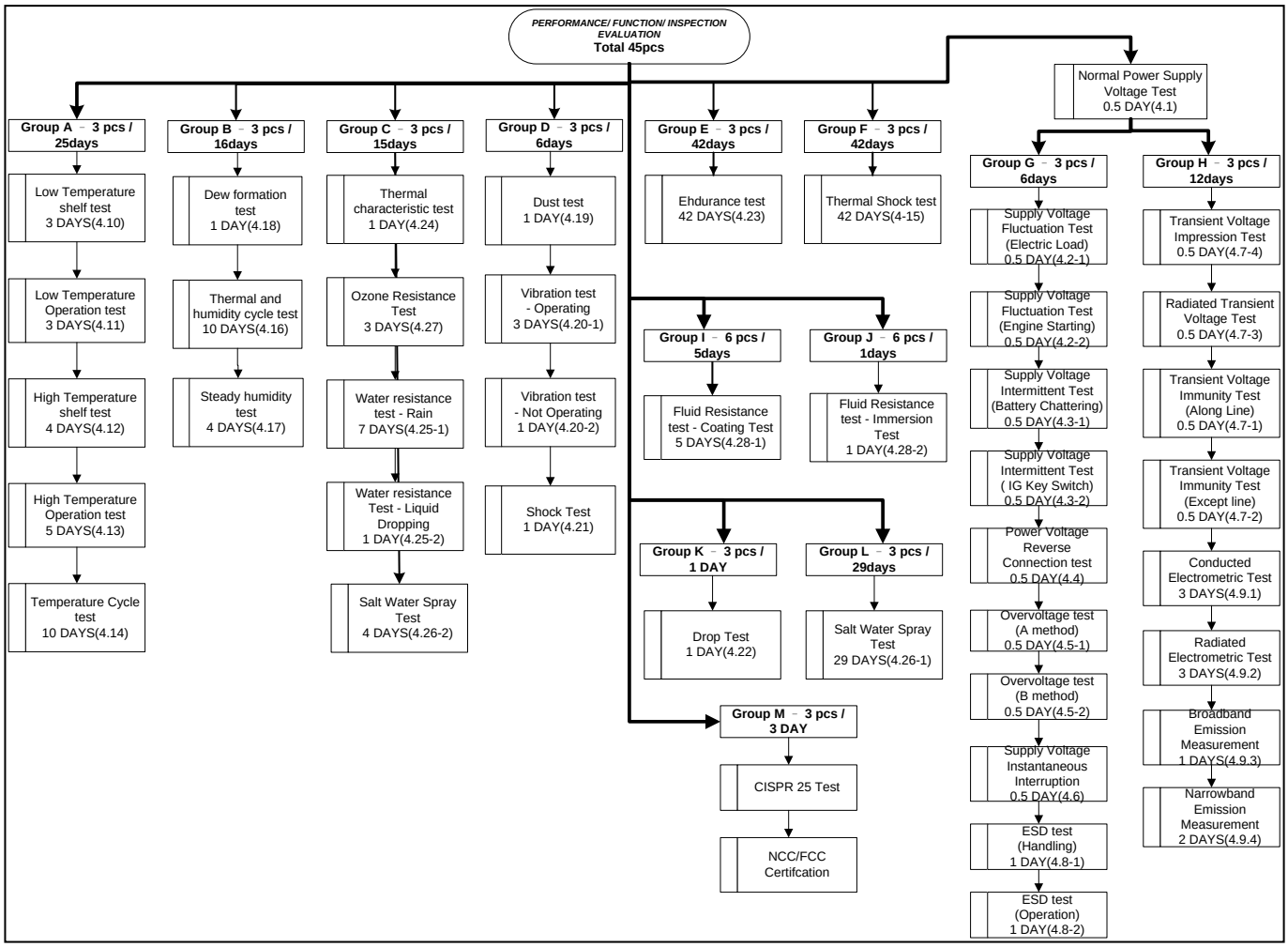
8.3 Self diagnostics

The system will perform self diagnostics during the boot up. When radar system is operating, it is still monitoring and inform driver once the system error message comes out, for example no CAN message from slave sensor.

9 Design Verification

9.1 Environmental Test

Refer to the test flow and test item below.



9.2 Performance test

Refer to ISO17387 for stationary, dynamic test and road test.

10 Federal Communications Commission (FCC) Statement

You are cautioned that changes or modifications not expressly approved by the part responsible for compliance could void the user’s authority to operate the equipment.

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 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 of the device.

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.