Millimetre-Wave Radar(77GHz)

1. Description

Based on pulse-echo principle, Millimetre-Wave Radar is used to monitor the surroundings of the vehicle, such as Blind Spot Detection (BSD), Lane Change Assistance (LCA), Rear Cross Traffic Alert (RCTA) and Car Door Open Warning (DOW). In addition, it can be used on autonomous vehicles for active obstacle avoidance.

For communication, Millimetre-Wave Radar consists two CAN interfaces that are responsible for data exchange between radar and automobile, and two High-side Drivers that are used to drive external load directly.

2. Benefits
    (1) Sensitive millimeter wave system (e.g. detection of low reflecting objects)
    (2) Fast reaction time (first-time detection), therefore fast reaction on suddenly appearing obstacles (e.g. pedestrians, changing scenes)
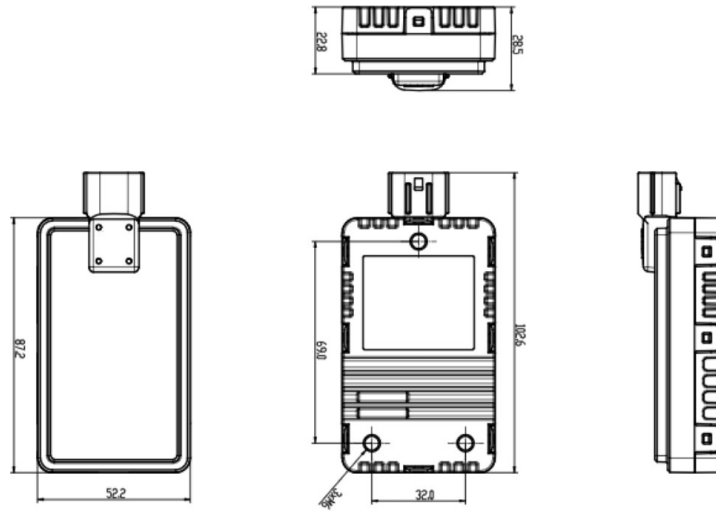   (3) Large detection range
    (4) Active obstacle avoidance

3. Overview

Structure:
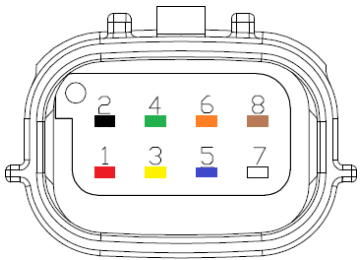
* Unit: mm

Connector PIN Assignment：

Interface Definition	Pins	Name	Color	Function
	1	Vbat	Red	Power(9-36V)
	2	GND	Black	Ground
	3	RCANL	Yellow	Can low
	4	RCANH	Green	Can high
	5	-	Blue	Reserved
	6	-	Orange	Reserved
	7	OUT1	White	Output1(reserved)
	8	OUT2	Grey	Output2(reserved)

4. Specification

Azimuth Angle *	±60°（±1°）
Elevation Angle	±5°
Angle resolution	1°
Maximum Range *	70 m (±0.16m)
Speed Range *	-50 m/s ~ +15 m/s (±0.14m/s)
Update Interval	50 ms
Maximum Tracking Targets	64
DC Voltage	9V ~ 36 V
DC Power	< 3W
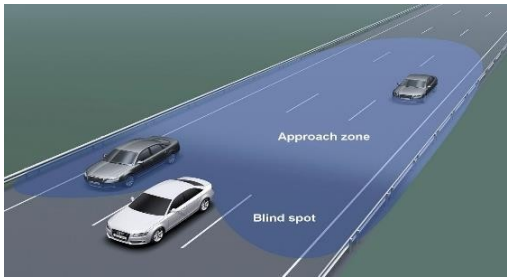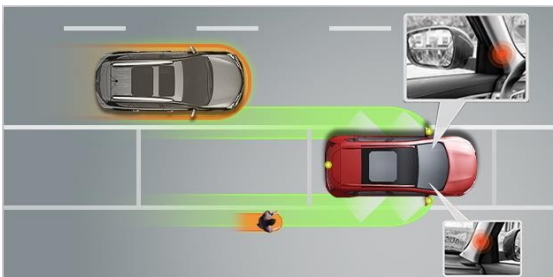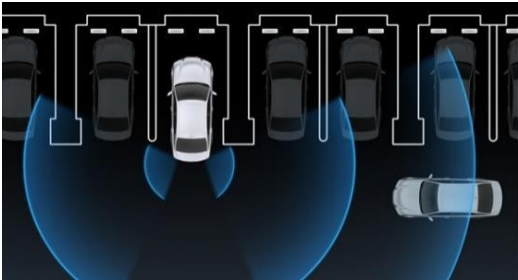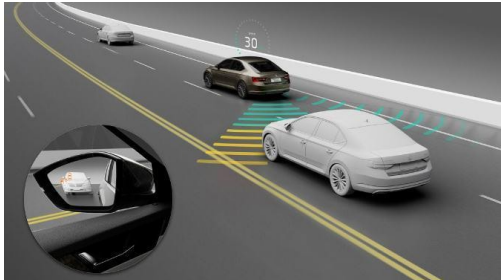
Size	102.5 mm×52 mm×28.5 mm
Temperature	-40℃~ +85℃
Output Interface	Double CAN with 500Kbps plus Option Double High Side Driver
Connector	Sumitomo 61897608

* The Numbers in brackets are accuracy.

5. Application

BSD	DOW
RCTA	LCA

Autonomous Vehicle

＊The vehicle is equipped with two Millimetre-Wave Radars for BSD, DOW, RCTA, LCA.
＊The autonomous vehicle is equipped with 4 Millimetre-Wave Radars.
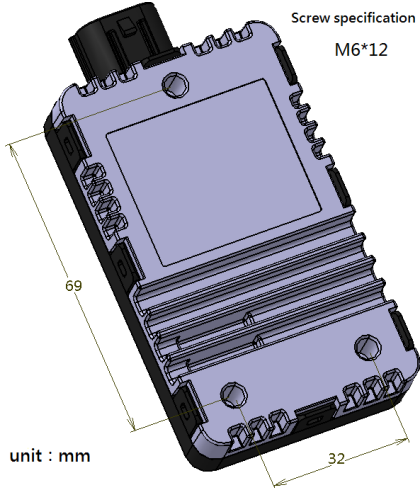
6. Installation

Most of Millimetre-Wave Radars are installed at the place of bumper in the rear of the vehicle.

In open-ended mounting style, it is required that Millimetre-Wave Radar be placed at least 10mm away from other things around in order to keep ventilation even in winter, when the interval is frozen due to snow and ice.

In non-open mounting style, if Millimetre-Wave Radar is mounted inside the fascia, the area of fascia where millimeter wave gets through cannot be made up of metal material which can impede the transmission of millimeter wave.

(1) Position

Installation Standard	
Installation Direction	Specification

＊Install vertically and make sure the interface is facing down.

＊Pitch angle will lead to the detecting distance reduction.

＊Installation height (recommended): 50-100cm

(2) Requests for Fascia

| Temperature Tolerance	-40℃ ~ 100℃
Material	Hybrid sandwich materials which is free of air intervals when the temperature is changed
Water Absorption	≤ 0.1% in the condition of 23℃/50%RH
Heat Resistance	No degeneration staying beyond 24h in the condition of +90℃ without ventilation
Anti-ultraviolet Performance	Persistently
Tendency to Stick with Rain Drops	Low water adhesion

＊The property can be different if synthetic material or density is different, even the same specific material is used.

(3) Connection
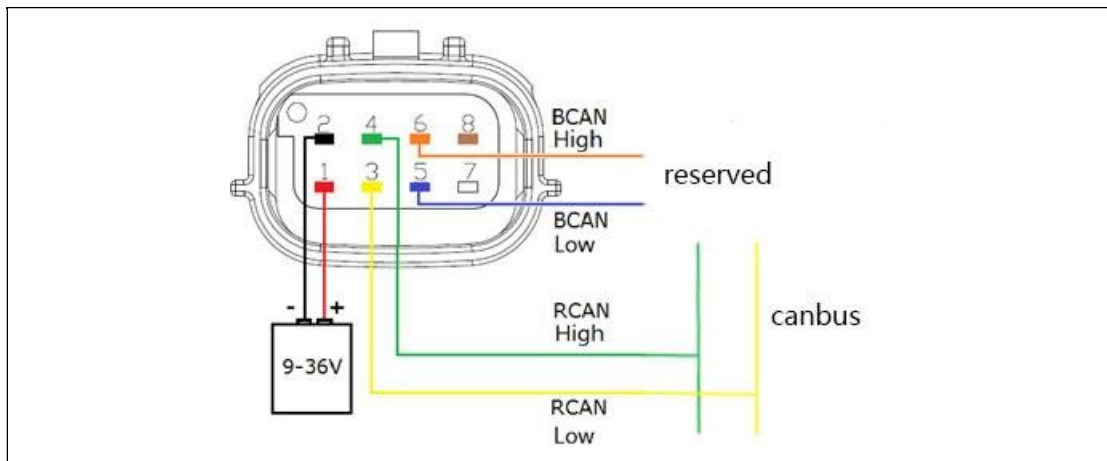
＊Objects info will be returned as can frames once the power is on, and no other steps are needed.

7. Test for Autonomous Vehicle

The speed of the Autonomous Vehicle is less than 15km/s. And the vehicle is equipped with 4 Millimetre-Wave Radars (3 in the front and 1 in the rear).

(1)Single Object Test

Object Types	Object Number	Distance （m）	Test Instruction	Result
people	1	10	Keep still or move	stalbe
people	1	15	Keep still or move	unstable
people	1	10	Cut from large angel	Very unstable
people	1	15	Cut from large angel	Very unstable
car	1	15	Keep still	stalbe
car	1	15	move	stalbe
car	1	15	Cut from large angel	stalbe

(2)Multi-objects Test

Object Types	Object Number	Distance （m）	Test Instruction	Result
people	2	10	Keep still or move	Unstable when space of two people is small, stable in other cases
people	2	15	Keep still or move	Very unstable when space of two people is small, unstable in other cases
people	3	10	Keep still or move	Unstable when space of any two people is small, stable in other cases

people	3	15	Keep still or move	Very unstable when space of any two people is small, unstable in other cases
car	2	15	Keep still	Unstable when two cars are side by side, stable in other cases
car	2	15	move	stable

(3)Large Object

Object Types	Object Number	Distance （m）	Test Instruction	Result
Large truck	1	10	Keep still or move	Stable, return one point of the object
Large truck	1	15	Keep still or move	Stable, return one point of the object

 * The test is just for your reference.

Appendix: Can protocol

CAN data frame format:

1. The radar is in Intel format with the MSB in the high position and the LSB in the low position.

	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Byte0	7	6	5	4	3	2	1	0 LSB
Byte1	15	14 MSB	13	12	11	10	9	8
Byte2	23	22	21	20	19	18	17	16 LSB
Byte3	31	30	29 MSB	28	27	26	25	24
Byte4	39	38	37	36	35	34	33	32 LSB
Byte5	47	46	45	44	43	42 LSB	41 MSB	40
Byte6	55	54	53 LSB	52 MSB	51	50	49	48
Byte7	63	62 MSB	61	60	59	58	57	56

CAN ID	Message Name	LSB POS	Length	Range	Units	Scaling	Offset
0x500-0x53F	Radial Range	0	15	0~327.67	m	0.01	0
0x500-0x53F	Reserved1	15	1	-			
0x500-0x53F	Radial Speed	16	14	-81.92~81.91 (+)= away from sensor	m/s	0.01	0
0x500-0x53F	Reserved2	30	2	-			

0x500-0x53F	Radial Acceleration	32	10	-25.6~25.55 (+)= away from sensor	m/s/s	0.05	0
0x500-0x53F	Angle	42	11	-102.4~102.3 (+)= clockwise	Degree	0.1	0
0x500-0x53F	Power	53	10	-91.2~11.1	dBm	0.1	-40
0x500-0x53F	Reserved3	63	1	-			

2. Frames are returned every 50ms(20Hz)
3. 8 Can ID Ranges can be selected as follow:

0	1	2	3	4	5	6	7
0x500-0x53F	0X540-0X57F	0X580-0X5BF	0X5C0-0X5FF	0X600-0X63F	0X640-0X67F	0X680-0X6BF	0X6C0-0X6FF

Each radar has a fixed Can ID range and different Can ID ranges can be used to distinguish between multiple radars connected to one canbus.

4. Maximum 64 frames are returned by a radar once, and invalid frames will be ignored. 64th frame (its data is invalid) will be returned every time to mark that all frames have been returned once.

Example:

An object is detected by a radar (Can ID:0x500-0x53F), then only two frames are returned(a random ID effective frame and 0x53F frame), other frames will be ignored.

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