Automotive Radar Overview 2018
Teardown and RF analysis of large panel of Radar
RF report by Stéphane ELISABETH
October 2018 – version 1
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Executive Summary

• This comparative review has been conducted to provide insights into the structures, technical choices, and designs of 15 automotive Radar sensor products from the leading suppliers. The suppliers include Veoneer (Formerly Autoliv), Bosch Sensortec, Continental, Aptiv (Formerly Delphi Technologies), Denso, ZF/Autocruise, and Valeo.

• We analyze and compare 6 devices that use the 24 GHz frequency band, featuring chipset supplied by STMicroelectronics, Infineon, Analog Devices or UMS and targeting sort ranges application like blind spot detection. We have also looked at 9 devices working in the 77 GHz frequency band more dedicated to multimode radar or long range radar sensing. On this other segments several companies like Infineon, NXP even TowerJazz shares the market. We look at their package dimensions and internal structures, Chipset technologies, antenna design and dimensions, and RF PCB cross-sections, to provide a comprehensive review of Radar Sensors.

• Radar Sensors’ packaging and chipset differ widely according to application. In more than 390 pages, this report includes multiple comparisons based on physical analyses of 15 Radar sensors. It offers device manufacturers and chipset providers the unique possibility of understanding Radar sensor technology evolution.

• At the end, the report will open on the next generation of radar using large available bandwidth of 4 GHz on the 79 GHz frequency band featuring RFCMOS radar chipset from Ainstein. We look at its characteristics and compare the new architecture to former radar on 24 GHz and 77 GHz.
## Radar Sensor

<table>
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<th>Type</th>
<th>OEMs</th>
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<td>AC100</td>
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<td>24 GHz</td>
<td>Valeo</td>
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</table>

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Autonomous Driving Car Roadmap: Radar
Radar Module Market Forecast

![Radar module forecast graph]

- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022

- 77G
- 79G
- 24G

Overall market forecast in $M for the years 2016 to 2022.
### Physical Comparison – Device Size and Complexity

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## Physical Comparison – Board Size and Complexity

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### Physical Comparison – RF Design

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- **ARS4-A** (Continental)
- **MRR1Plus** (Bosch)
- **LRR4**
- **MMR1Veoneer**
- **SRR2** (Delphi)
- **RACAM** (DENSO)
- **DNMW008**
- **SRR3** (Delphi)
- **K-77** (Ainstein)
# Physical Comparison – RF Design

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Cost Comparison – RF Chipset

- 24 GHz
  - Device size & Complexity
  - Board Size & Complexity
  - RF Design
  - Cost of the RF Chipset

- 77 GHz
  - Device size & Complexity
  - Board Size & Complexity
  - RF Design
  - Cost of the RF Chipset

- From 24 GHz to 79 GHz
  - RF Chipset
Physical & Cost Comparison – RF Chipset

- 24 GHz
  - Device size & Complexity
  - Board Size & Complexity
  - RF Design
  - Cost of the RF Chipset
- 77 GHz
  - Device size & Complexity
  - Board Size & Complexity
  - RF Design
  - Cost of the RF Chipset

From 24 GHz to 79 GHz
- RF Chipset
MODULES HISTORY – 24 GHz

- **2011**: SRR2-A
- **2012**: SRR3-B
- **2013**: NB24BS
- **2014**: AC100
- **2015**: MBHL2

**Physical Analysis**
- **24 GHz**
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB24BS
  - AutoCruise AC100
  - Valeo MBHL2
- **77 GHz**
  - Continental ARS4-A
  - Bosch MRR3Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- **79 GHz**
  - Ainstein T-79

**Related Reports**
- **Autoliv**
- **Veoneer**
- **Valeo**

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Overview / Introduction

Company Profile & Supply Chain

Market Analysis

Physical & Cost Comparison

Physical Analysis

- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB2485
  - AutoCruise AC100
  - Valeo MBHL2

- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
  - Ainstein T-79

- 79 GHz
  - Denso K-77

Related Reports

About System Plus
ARS4-A

77 GHz Adaptive Cruise Control
Short Range Radar
Continental – ARS4-A – Package View & Dimensions

Physical Analysis
- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB2485
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
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  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

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- Continental – ARS4-A – Package View & Dimensions

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Continental – ARS4-A – Main ICs

Physical Analysis
- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB2485
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
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  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

Main Board Dimensions:

Continentl ARS4-A – Main Board Global View – Optical View
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Continental – ARS4-A – RF Board

Physical Analysis

- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB2485
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR3Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

RF Board Dimensions:
Continental – ARS4-A – RF Board
Continental – ARS4-A – RF Board

Physical Analysis

- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB248S
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

Related Reports

About System Plus
Continental – ARS4-A – RF Board

**Physical Analysis**
- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB2485
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

Related Reports
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Continental – ARS4-A – RF Board

Physical Analysis
- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB2485
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

Related Reports
About System Plus
Continental – ARS4-A – RF Board – Rx MMIC

- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB248S
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

- Die Dimensions:
- Die Technology:
Physical Analysis
- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB248S
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
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  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-77
Continental – ARS4-A – RF Board – Antenna

- **Physical Analysis**
  - 24 GHz
    - Continental SRR2-A
    - Continental SRR3-B
    - Veoneer NB2485
    - AutoCruise AC100
    - Valeo MBHL2
  - 77 GHz
    - Continental ARS4-A
    - Bosch MRR1Plus
    - Bosch LRR4
    - Veoneer MMRV1
    - Aptiv SRR2
    - Aptiv RACAM
    - Aptiv SRR3
    - Denso DNMW008
    - Ainstein K-77
  - 79 GHz
    - Ainstein T-79

- **Related Reports**
  - About System Plus
Continental – ARS4-A – RF Board – Cross-section

- 24 GHz
  - Continental SRR2-A
  - Continental SRR3-B
  - Veoneer NB248S
  - AutoCruise AC100
  - Valeo MBHL2
- 77 GHz
  - Continental ARS4-A
  - Bosch MRR1Plus
  - Bosch LRR4
  - Veoneer MMRV1
  - Aptiv SRR2
  - Aptiv RACAM
  - Aptiv SRR3
  - Denso DNMW008
  - Ainstein K-77
- 79 GHz
  - Ainstein T-79

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Related Reports

**RF & System**
- **Aptiv’s Third Generation of 77 GHz-Based Short-Range Radar (SRR3)**
- **Ainstein T-79: Automotive 79GHz Short Range Radar**
- **AWR1642 77 & 79 GHz RFCMOS Radar Chipset from Texas Instruments**
- **Continental SRR3-B 24GHz Blind-Spot Radar**
- **Autoliv’s 3rd Generation Automotive Night Vision Camera with FLIR’s ISC0901 Microbolometer**
- **Continental MFC430TA – Forward Automotive Camera for Advanced Driver Assistance Systems**

**Market and Technology Reports - Yole Développement**
- **Radar Technologies for Automotive 2018**
- **MEMS and Sensors for Automotive - Market and Technology Trends 2017**
Business Models Fields of Expertise

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Reports
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Costing Tools

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Market Analysis
Physical & Cost Comparison
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VAT ID Number for EU members: ......................................
Tel: ..................................................................................
Email: .............................................................................
Date: ..............................................................................
Signature: ........................................................................

BILLING CONTACT

First Name: ........................................................................
Last Name: ......................................................................
Email: .............................................................................
Phone: .............................................................................

PAYMENT

By credit card:
Number: |__|__|__|__| |__|__|__|__| |__|__|__|__|
Expiration date: |__|__|/|__|__|
Card Verification Value: |__|__|__|

By bank transfer:
HSBC - CAE- Le Terminal -2 rue du Charron - 44800 St Herblain France
BIC code: CCFRFRPP
• In EUR
  Bank code : 30056 - Branch code : 00955 - Account : 09550003234
  IBAN: FR76 3005 6009 5509 5500 0323 439
• In USD
  Bank code : 30056 - Branch code : 00955 - Account : 09550003247
  IBAN: FR76 3005 6009 5509 5500 0324 797

RETURN ORDER BY:
FAX: +33 2 53 55 10 59
MAIL: SYSTEM PLUS CONSULTING
22, bd Benoni Goullin
Nantes Biotech
44200 Nantes – France
EMAIL: sales@systemplus.fr

*For price in dollars please use the day’s exchange rate
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SYSTEMPLUS
CONSULTING
1. INTRODUCTION
The present terms and conditions apply to the offers, sales and deliveries of services managed by System Plus Consulting except in the case of a particular written agreement. Buyer must note that placing an order means an agreement without any restriction with these terms and conditions.

2. PRICES
Prices of the purchased services are those which are in force on the date the order is placed. Prices are in Euros and worked out without taxes. Consequently, the taxes and possible added costs agreed when the order is placed will be charged on these initial prices. System Plus Consulting may change its prices whenever the company thinks it necessary. However, the company commits itself in invoicing at the prices in force on the date the order is placed.

3. REBATES and DISCOUNTS
The quoted prices already include the rebates and discounts that System Plus Consulting could have granted according to the number of orders placed by the Buyer, or other specific conditions. No discount is granted in case of early payment.

4. TERMS OF PAYMENT
System Plus Consulting delivered services are to be paid within 30 days end of month by bank transfer except in the case of a particular written agreement. If the payment does not reach System Plus Consulting on the deadline, the Buyer has to pay System Plus Consulting a penalty for late payment the amount of which is three times the legal interest rate. The legal interest rate is the current one on the delivery date. This penalty is worked out on the unpaid invoice amount, starting from the invoice deadline. This penalty is sent without previous notice. When payment terms are over 30 days end of month, the Buyer has to pay a deposit which amount is 10% of the total invoice amount when placing his order.

5. OWNERSHIP
System Plus Consulting remains sole owner of the delivered services until total payment of the invoice.

6. DELIVERIES
The delivery schedule on the purchase order is given for information only and cannot be strictly guaranteed. Consequently any reasonable delay in the delivery of services will not allow the buyer to claim for damages or to cancel the order.

7. ENTRUSTED GOODS SHIPMENT
The transport costs and risks are fully born by the Buyer. Should the customer wish to ensure the goods against lost or damage on the base of their real value, he must imperatively point it out to System Plus Consulting when the shipment takes place. Without any specific requirement, insurance terms for the return of goods will be the carrier current ones (reimbursement based on good weight instead of the real value).

8. FORCE MAJEURE
System Plus Consulting responsibility will not be involved in non execution or late delivery of one of its duties described in the current terms and conditions if these are the result of a force majeure case. Therefore, the force majeure includes all external event unpredictable and irresistible as defined by the article 1148 of the French Code Civil?

9. CONFIDENTIALITY
As a rule, all information handed by customers to system Plus Consulting are considered as strictly confidential. A non-disclosure agreement can be signed on demand.

10. RESPONSIBILITY LIMITATION
The Buyer is responsible for the use and interpretations he makes of the reports delivered by System Plus Consulting. Consequently, System Plus Consulting responsibility can in no case be called into question for any direct or indirect damage, financial or otherwise, that may result from the use of the results of our analysis or results obtained using one of our costing tools.

11. APPLICABLE LAW
Any dispute that may arise about the interpretation or execution of the current terms and conditions shall be resolved applying the French law. It the dispute cannot be settled out-of-court, the competent Court will be the Tribunal de Commerce de Nantes.