

Texas Instruments AWR1843AoP

Automotive 77/79 GHz Radar Chipset with AoP

SP19481 - RF report by Stéphane ELISABETH
Lab. Analysis done by Nicolas RADUFFE

August 2019 – Sample

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- This reverse technology study has been conducted to provide insight on technology data of the [Texas Instrument XAWR1843AoP 76-81 GHz Radar Chip](#).
- The AWR1843AoP is the most integrated radar chipset currently available on the market. It features seven channels (four receivers (Rx) and three transmitters (Tx)) along with an MCU, a DSP, all on the same chip and antennae. Not surprisingly, this new chipset is extremely compact and advanced compared to its competitors.
- With a portfolio that now contains four different chip solutions, TI targets multiple automotive and industrial applications, from ultra-short-range radar detection (USRR) to radar imaging (RI). Also, TI's portfolio ranges from low-power, highly integrated devices, to high-performance radar working in the 79 GHz band. TI seeks to replace the 24 GHz market for short-range applications, which is expected to decrease in 2020 with the coming European restriction law. Also, having the MCU and the DSP on the same die along with the antennae on top of the package allows TI to drastically reduce the PCB footprint, with an almost 80% space reduction compared to other solutions.
- This report reviews the AWR1843AoP, including a complete package and die analysis, cost analysis, and price estimate for the component. Also included is a physical and cost comparison with TI's own AWR1642 (featuring 4 Rx and 2 Tx with MCU and DSP) and AWR1243 (featuring 4 Rx and 3 Tx without MCU and DSP).

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Texas Instruments mmWave PortFolio



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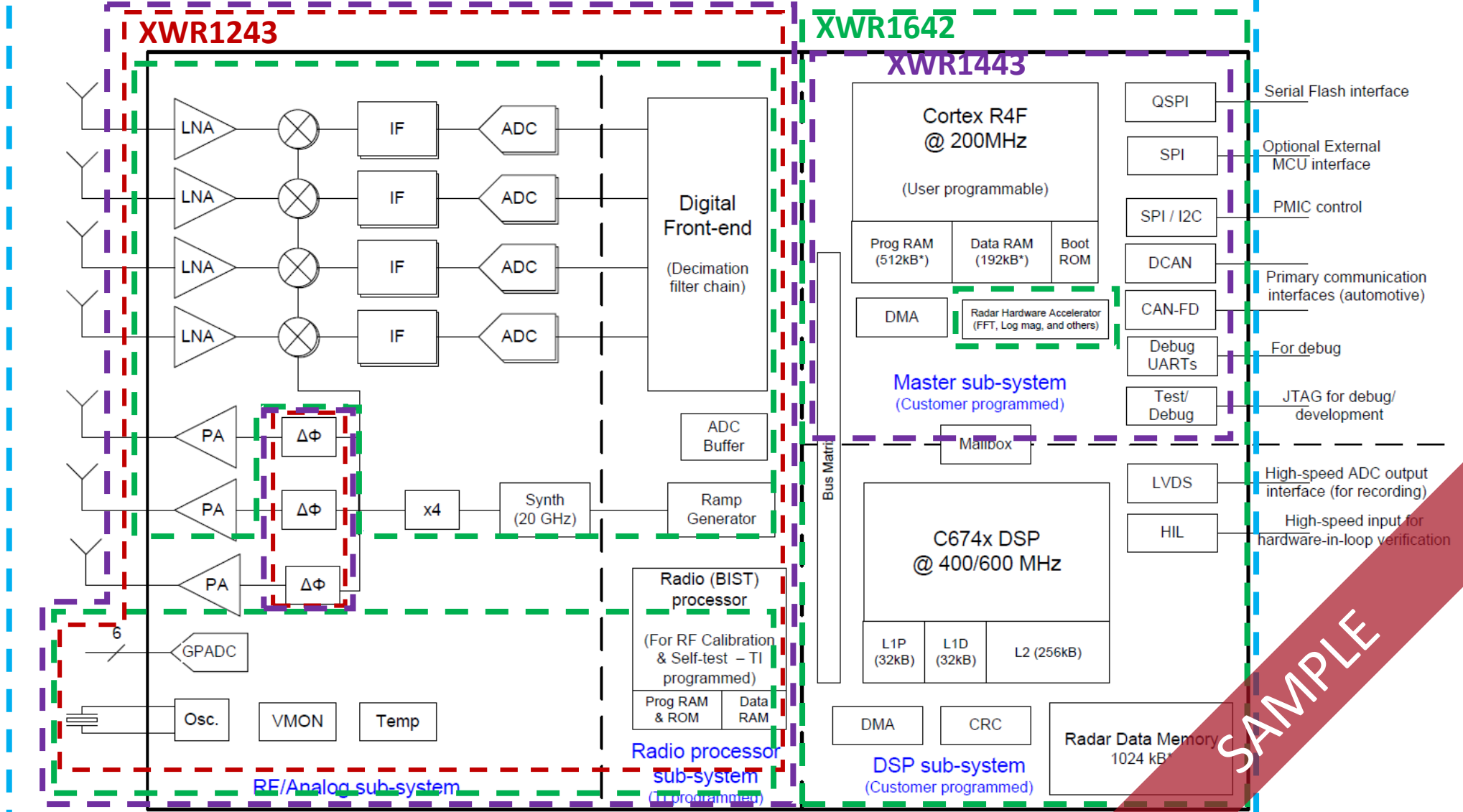
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XWR1843AoP



* Up to 512kB of Radar Data Memory can be switched to the Master R4F program and data RAMs



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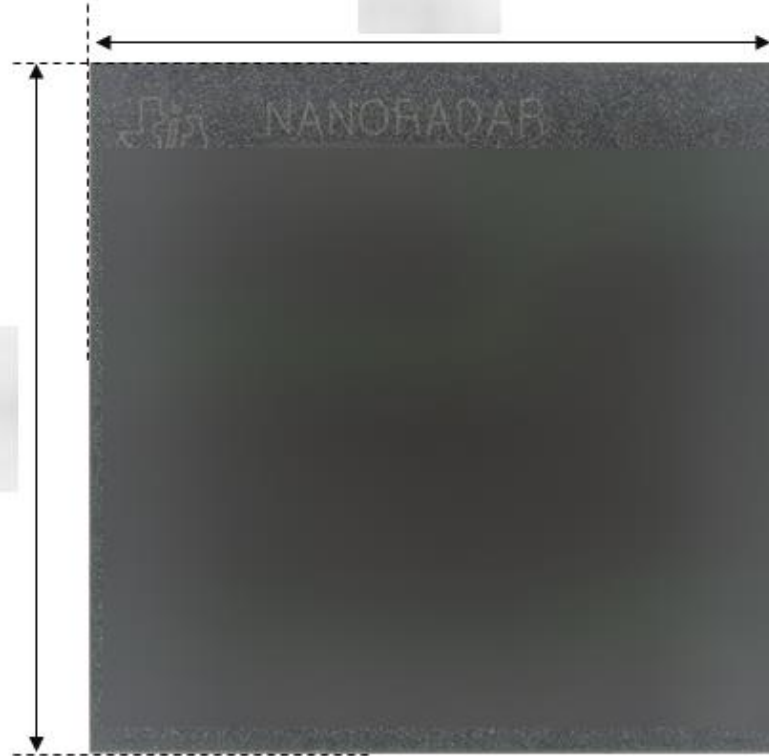
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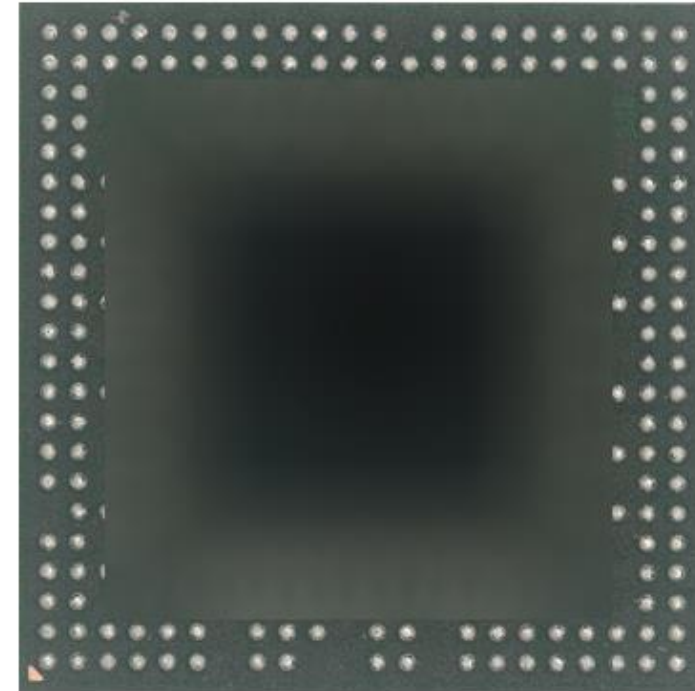
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- Package:
- Dimensions:
- Pitch:



Package Top View
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- Marking:



Package Bottom View
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Package Side View
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Package Cross-Section

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Package Global View

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- **Copper Line Thickness:**

- Line #1 :
- Line #2 :
- Line #3 :
- Line #4 :

- **Dielectrics Layers Thickness:**

- Solder Mask :
- Line #1 :
- Prepreg :
- Line #2 :
- Solder Mask:

- **Micro-Via Dimension:**

- #1 Diameter:
- #1 Depth:
- #2 Diameter:
- #2 Depth:

- **Measured Line/Space Width in Cross-Section:**

-



Package Cross-Section – SEM View

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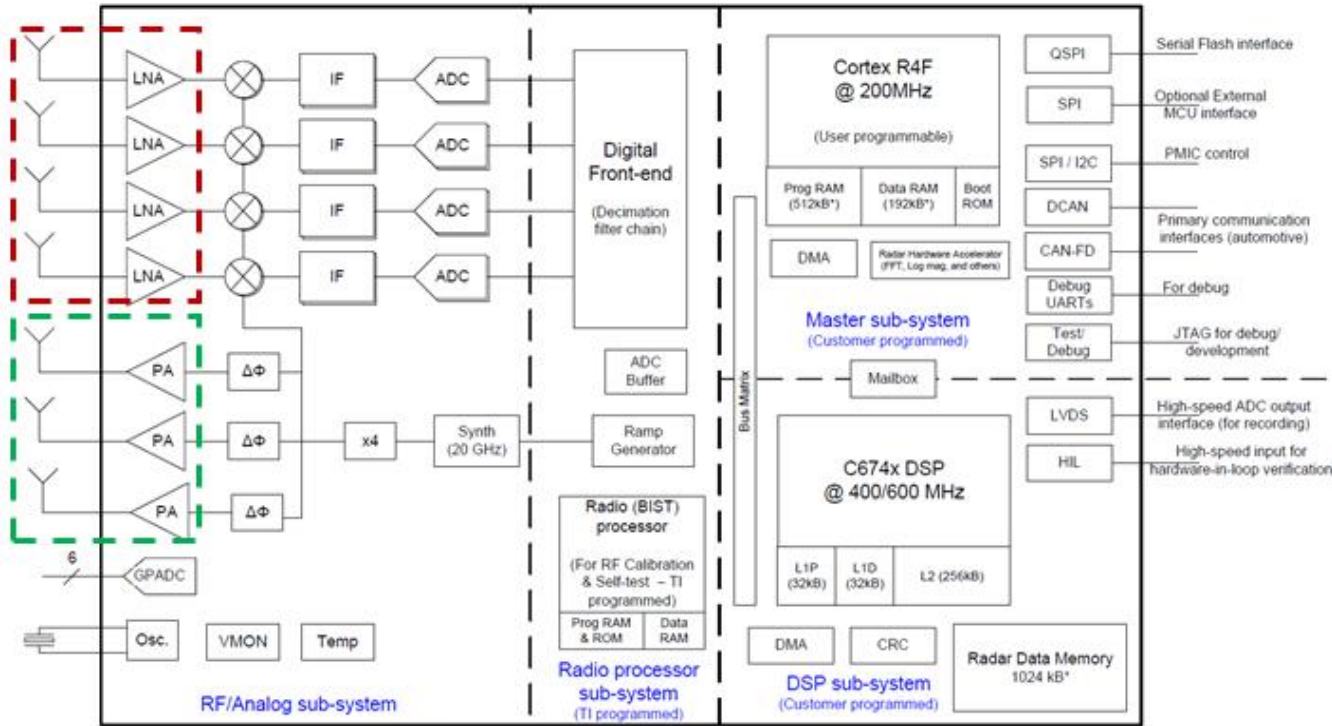
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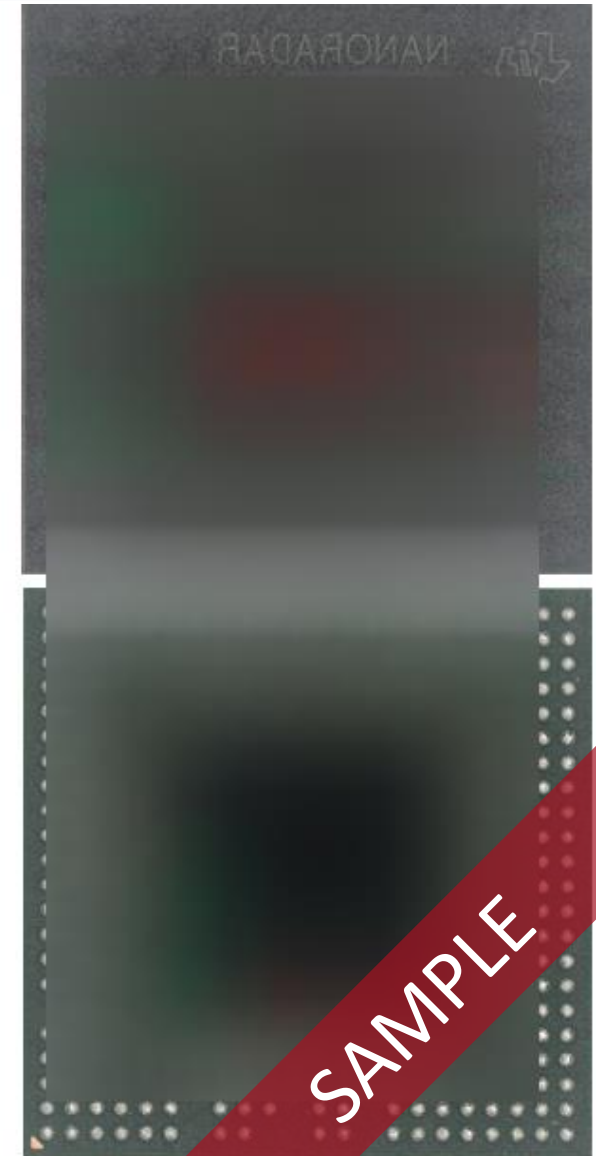
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* Up to 512kB of Radar Data Memory can be switched to the Master R4F program and data RAMs

Source: Texas Instruments

AWR1843 Schematic Diagram
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Package Opening – Optical View
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Package Opening – Optical View
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Die Overview – RF/Analog Subsystem

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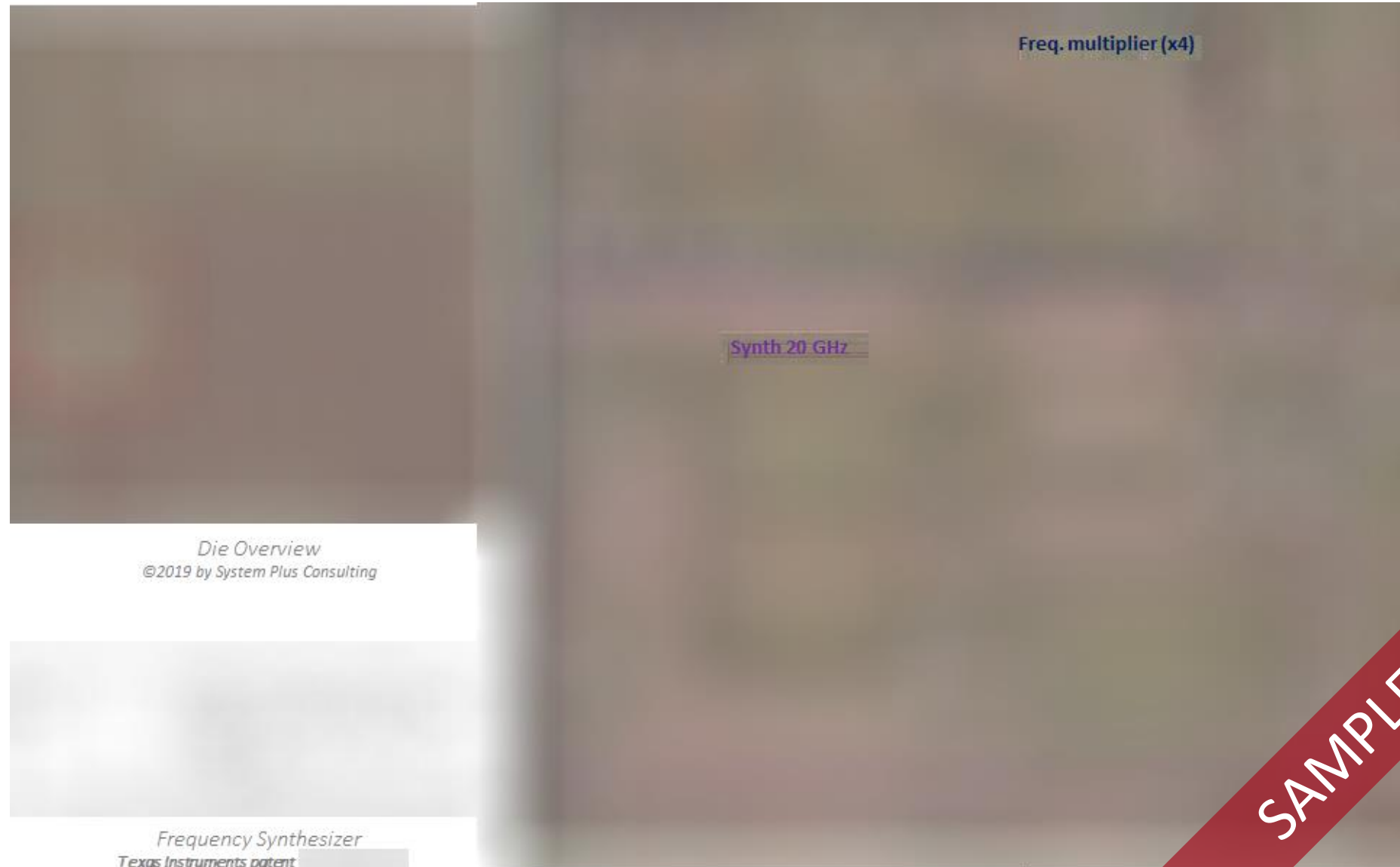
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AoP Packaging Process Flow (1/3)

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Front-End Cost

Front-End	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
Raw wafer Cost (Si)						
Clean Room Cost						
Equipment Cost						
Consumable Cost						
Labor Cost						
Yield losses Cost						
Front-End Cost						
Gross Profit						
Mask Set Depreciation						
Front-End Price						

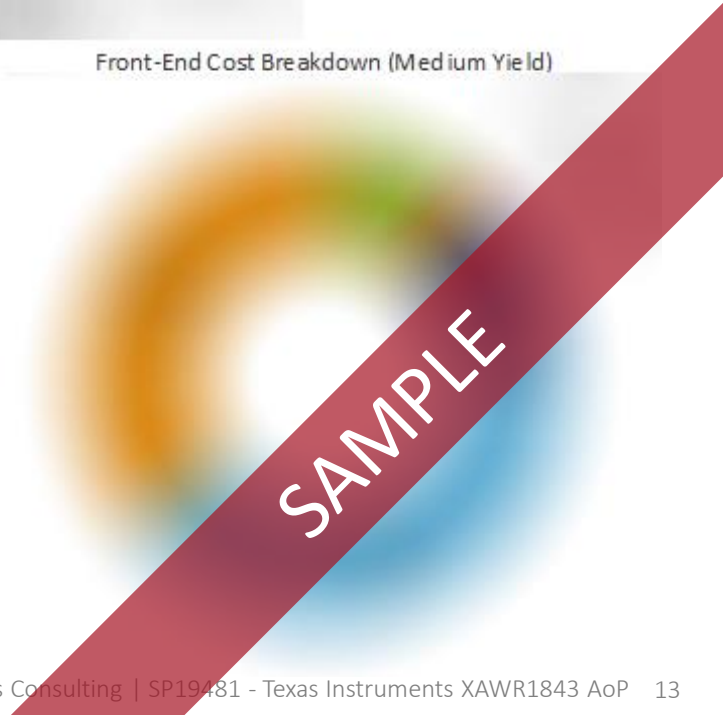
Front-End Cost Breakdown (Medium Yield)

[Redacted]

The **front-end cost** for the Radar IC ranges from [Redacted] according to yield variations.

The largest portion of the manufacturing cost is due to the [Redacted]

We take into account a gross margin of [Redacted] to estimate the wafer price ranges from [Redacted] according to yield variations.



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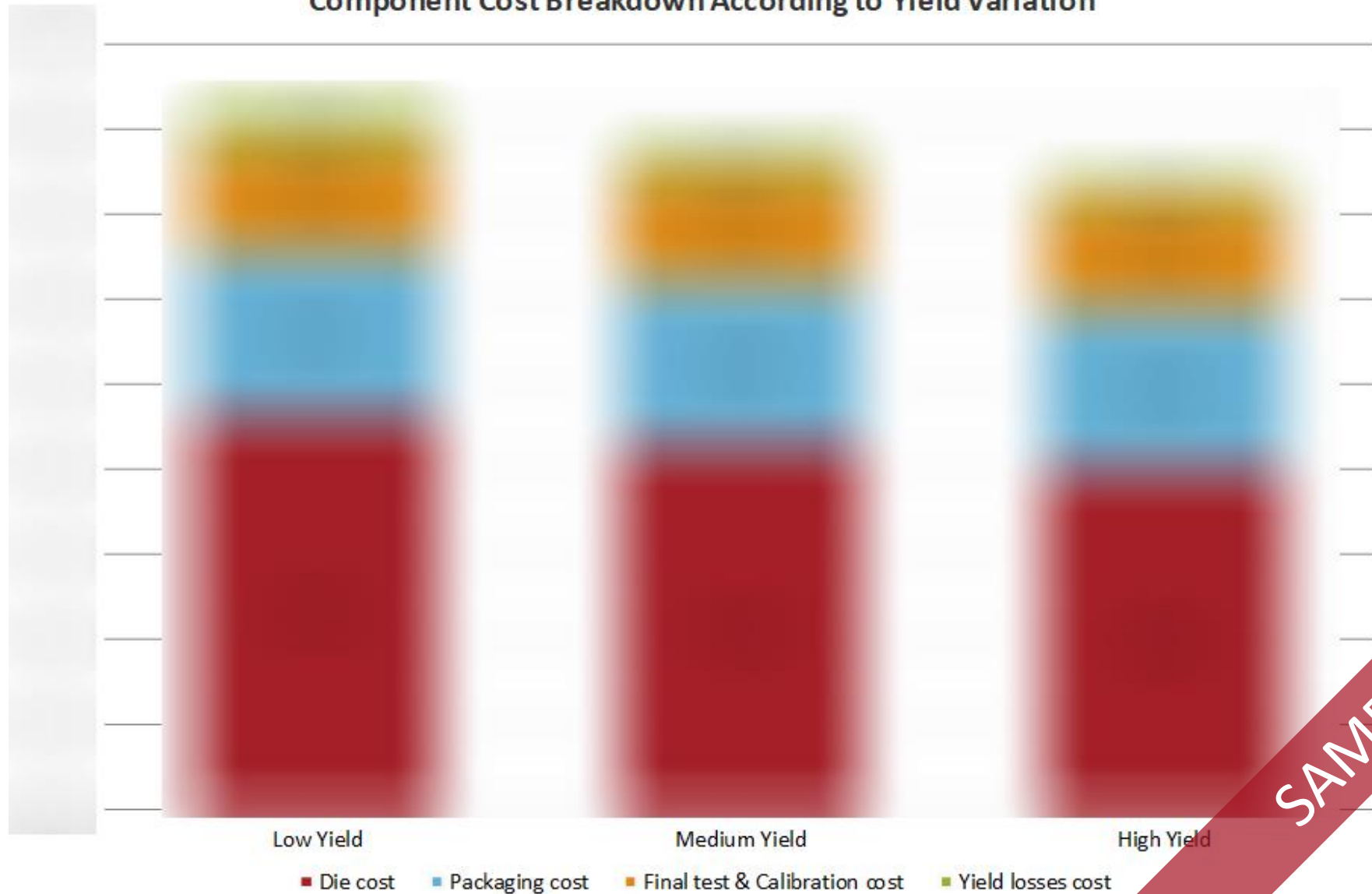
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Component Cost Breakdown According to Yield Variation



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AoP 79 GHz RFCMOS Radar Chipset Estimated Selling Price

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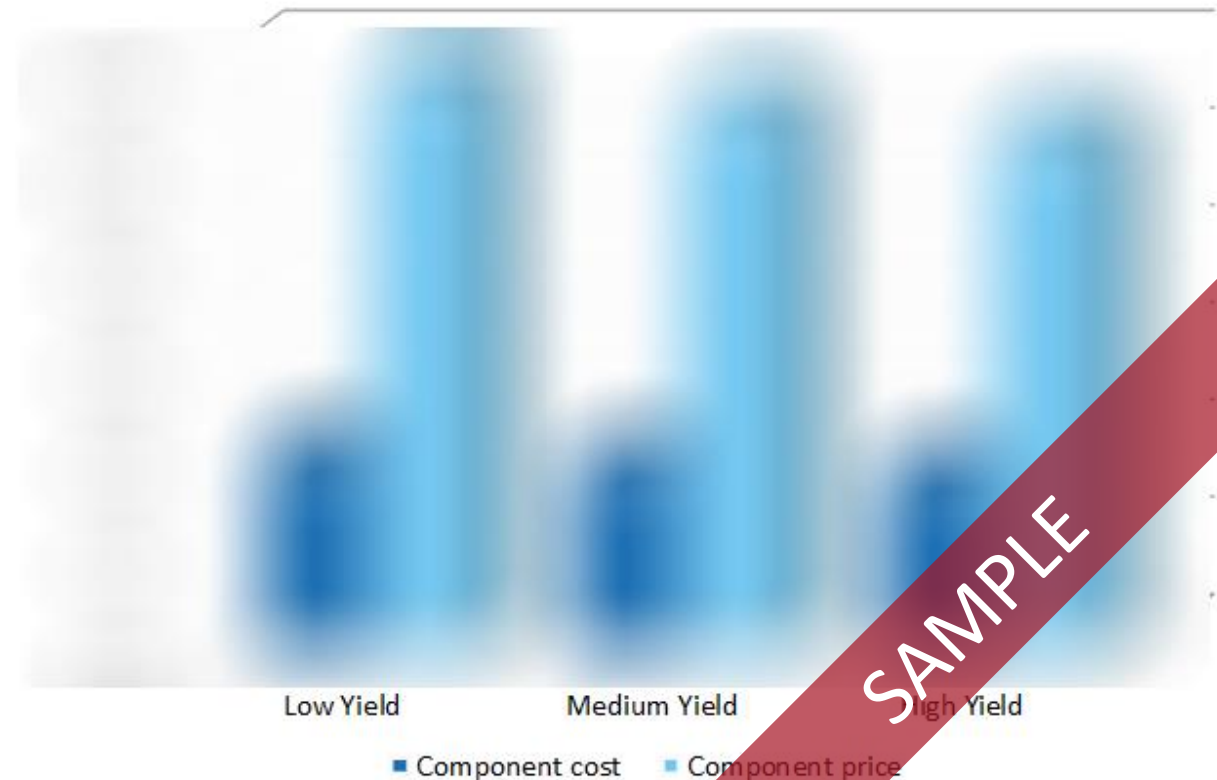
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	Low Yield		Medium Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
Component cost						
Texas Instruments Gross Profit						
Component price						

We estimate that Texas Instruments realizes a gross margin of [redacted] on the Radar Chipset, which results in a final component price ranging from [redacted].

This corresponds to the selling price for large volume to OEMs.

AWR1843AoP Cost & Price According to Yield Variation



Texas Instruments mmWave PortFolio Comparison

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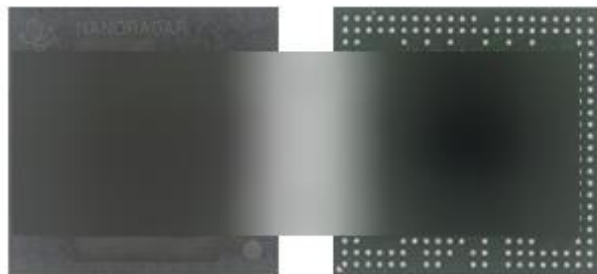
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Component Cost Breakdown (Medium Yield)

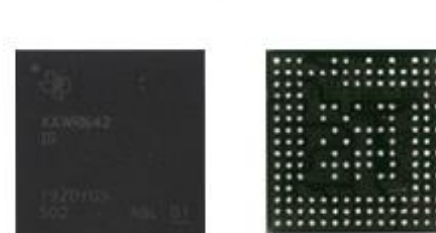
- Die cost
- Packaging cost
- Final test & Calibration cost
- Yield losses cost



Component Cost – AWR1843AoP
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Component Cost Breakdown (Medium Yield)

- Die cost
- Packaging cost
- Final test & Calibration cost
- Yield losses cost



Component Cost – AWR1642
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-
-
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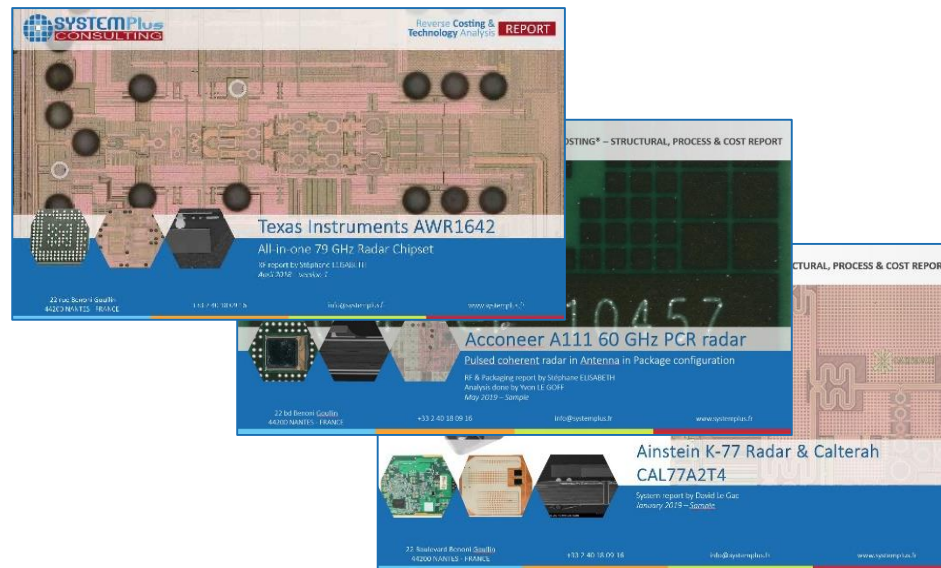
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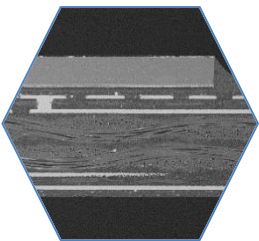
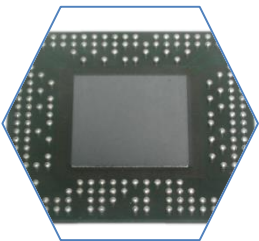
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Texas Instruments AWR1843AoP 77/79 GHz Radar Chipset

World's first 76-81 GHz automotive single-chip radar in a System-on-Chip device with integrated Antenna-on-Package.



Last year, Texas Instruments (TI) entered the radar chipset market with the first highly-integrated radar sensor chip, the AWR1642. Unlike its competitors, TI chose to integrate more than just a transmitter, receiver and local oscillator on the same System-on-Chip (SoC) by adding a microcontroller unit (MCU) and a digital signal processor (DSP). This year, the company is trying to keep ahead of its competitors by upgrading its previous chip with an integrated Antenna-on-Package (AoP) in the AWR1843AoP.

This makes the AWR1843 the most integrated radar chipset currently available on the market. It features seven channels, four receivers (Rx) and three transmitters (Tx), along with an MCU, a DSP, all on the same chip and antennae. Not surprisingly, this new chipset is extremely compact and advanced compared to its competitors.

With a portfolio that now contains four different chip solutions, TI targets multiple automotive and industrial applications, from ultra-short-range radar detection (USRR) to radar imaging (RI). Also, TI's portfolio ranges from low-power, highly integrated devices to high-performance radar working in the 79 GHz band. TI is seeking to replace 24 GHz devices for short-range applications, for which the market is expected to decrease in 2020 due to upcoming European legal

restrictions. Also, having the MCU and the DSP on the same die along with the antennae on top of the package allows TI to drastically reduce the PCB footprint, with an almost 80% space reduction compared to other solutions.

This report reviews the AWR1843AoP, including a complete package and die analysis, cost analysis, and price estimate for the component. Also included is a physical and cost comparison with TI's own AWR1642, featuring 4 Rx and 2 Tx with an MCU and DSP, and AWR1243, featuring 4 Rx and 3 Tx without an MCU and DSP.

COMPLETE TEARDOWN WITH

- Detailed photos
- Precise measurements
- Materials analysis
- Manufacturing process flow
- Supply chain evaluation
- Manufacturing cost analysis
- Estimated sales price
- Comparison with other Texas Instruments mmWave devices

Title: Texas Instruments AWR1843AoP 77/79 GHz Radar Chipset

Pages: 100

Date: August 2019

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Price: EUR 3,990

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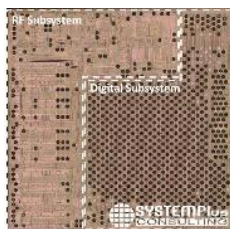


Dr. Stéphane Elisabeth has joined System Plus Consulting's team in 2016. He has a deep knowledge of Materials characterizations and Electronics systems. He holds an Engineering Degree in Electronics and Numerical Technology, and a PhD in Materials for Microelectronics.



Nicolas Radufe is in charge of physical analysis at System Plus Consulting. He has a deep knowledge in chemical and physical analyses. He previously worked in microelectronics R&D for CEA/LETI in Grenoble and for STMicroelectronics in Crolles.

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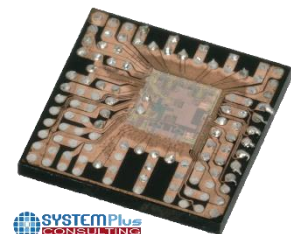
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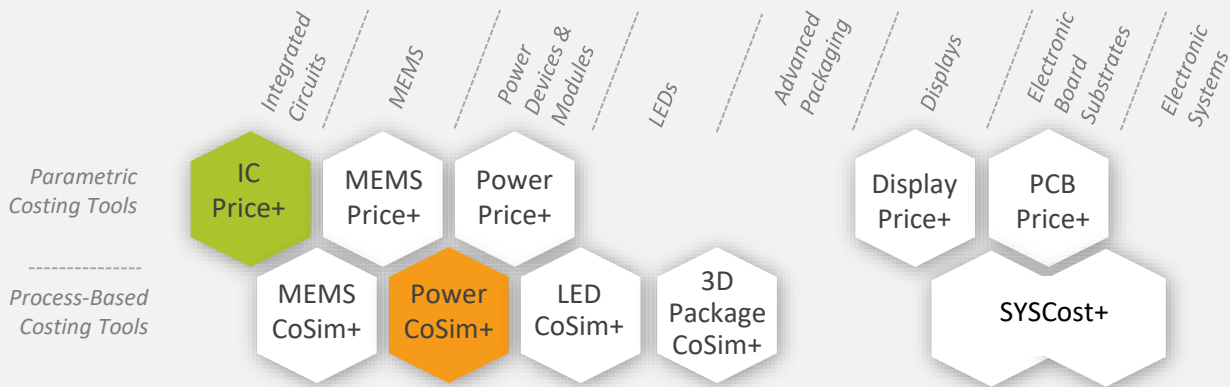


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"Seller": Based in Lyon (France headquarters), Yole Développement is a market research and business development consultancy company, facilitating market access for advanced technology industrial projects. With more than 20 market analysts, Yole works worldwide with the key industrial companies, R&D institutes and investors to help them understand the markets and technology trends.

1. **Scope**
1.1 The Contracting Parties undertake to observe the following general conditions when agreed by the Buyer and the Seller. ANY ADDITIONAL, DIFFERENT, OR CONFLICTING TERMS AND CONDITIONS IN ANY OTHER DOCUMENTS ISSUED BY THE BUYER AT ANY TIME ARE HEREBY OBJECTED TO BY THE SELLER, SHALL BE WHOLLY INAPPLICABLE TO ANY SALE MADE HEREUNDER AND SHALL NOT BE BINDING IN ANY WAY ON THE SELLER.

1.2 This agreement becomes valid and enforceable between the Contracting Parties after clear and non-equivocal consent by any duly authorized person representing the Buyer. For these purposes, the Buyer accepts these conditions of sales when signing the purchase order which mentions "I hereby accept Yole's Terms and Conditions of Sale". This results in acceptance by the Buyer.

1.3 Orders are deemed to be accepted only upon written acceptance and confirmation by the Seller, within [7 days] from the date of order, to be sent either by email or to the Buyer's address. In the absence of any confirmation in writing, orders shall be deemed to have been accepted.

2. **Mailing of the Products**

2.1 Products are sent by email to the Buyer:

- within [1] month from the order for Products already released; or

- within a reasonable time for Products ordered prior to their effective release. In this case, the Seller shall use its best endeavours to inform the Buyer of an indicative release date and the evolution of the work in progress.

2.2 Some weeks prior to the release date the Seller can propose a pre-release discount to the Buyer

The Seller shall by no means be responsible for any delay in respect of article 2.2 above, and including incases where a new event or access to new contradictory information would require for the analyst extra time to compute or compare the data in order to enable the Seller to deliver a high quality Products.

2.3 The mailing of the Product will occur only upon payment by the Buyer, in accordance with the conditions contained in article 3.

2.4 The mailing is operated through electronic means either by email via the sales department or automatically online via an email/password. If the Product's electronic delivery format is defective, the Seller undertakes to replace it at no charge to the Buyer provided that it is informed of the defective formatting within 90 days from the date of the original download or receipt of the Product.

2.5 The person receiving the Products on behalf of the Buyer shall immediately verify the quality of the Products and their conformity to the order. Any claim for apparent defects or for non-conformity shall be sent in writing to the Seller within 8 days of receipt of the Products. For this purpose, the Buyer agrees to produce sufficient evidence of such defects.

2.6 No return of Products shall be accepted without prior information to the Seller, even in case of delayed delivery. Any Product returned to the Seller without providing prior information to the Seller as required under article 2.5 shall remain at the Buyer's risk.

3. **Price, invoicing and payment**

3.1 Prices are given in the orders corresponding to each Product sold on a unit basis or corresponding to annual subscriptions. They are expressed to be inclusive of all taxes. The prices may be reevaluated from time to time. The effective price is deemed to be the one applicable at the time of the order.

3.2 Yole may offer a pre release discount for the companies willing to acquire in the future the specific report and agreeing on the fact that the report may be release later than the anticipated release date. In exchange to this uncertainty, the company will get a discount that can vary from 15% to 10%.

3.3 Payments due by the Buyer shall be sent by cheque payable to Yole Développement, credit card or by electronic transfer to the following account:

HSBC, 1 place de la Bourse 69002 Lyon France

Bank code: 30056

Branch code: 00170

Account n°: 0170 200 1565 87

BIC or SWIFT code: CCFRFRPP

IBAN: FR76 3005 6001 7001 7020 0156 587

To ensure the payments, the Seller reserves the right to request down payments from the Buyer. In this case, the need of down payments will be mentioned on the order.

3.4 Payment is due by the Buyer to the Seller within 30 days from invoice date, except in the case of a particular written agreement. If the Buyer fails to pay within this time and fails to contact the Seller, the latter shall be entitled to invoice interest in arrears based on the annual rate Refi of the «BCE» + 7 points, in accordance with article L. 441-6 of the French Commercial Code. Our publications (report, database, tool...) are delivered only after reception of the payment.

3.5 In the event of termination of the contract, or of misconduct, during the contract, the Seller will have the right to invoice at the stage in progress, and to take legal action for damages.

4. **Liabilities**

4.1 The Buyer or any other individual or legal person acting on its behalf, being a business user buying the Products for its business activities, shall be solely responsible for choosing the Products and for the use and interpretations he makes of the documents it purchases, of the results he obtains, and of the advice and acts it deduces thereof.

4.2 The Seller shall only be liable for (i) direct and (ii) foreseeable pecuniary loss, caused by the Products or arising from a material breach of this agreement

4.3 In no event shall the Seller be liable for:

a) damages of any kind, including without limitation, incidental or consequential damages (including, but not limited to, damages for loss of profits, business interruption and loss of programs or information) arising out of the use of or inability to use the Seller's website or the Products, or any information provided on the website, or in the Products;

b) any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 All the information contained in the Products has been obtained from sources believed to be reliable. The Seller does not warrant the accuracy, completeness adequacy or reliability of such information, which cannot be guaranteed to be free from errors.

4.5 All the Products that the Seller sells may, upon prior notice to the Buyer from time to time be modified by or substituted with similar Products meeting the needs of the Buyer. This modification shall not lead to the liability of the Seller, provided that the Seller ensures the substituted Product is similar to the Product initially ordered.

4.6 In the case where, after inspection, it is acknowledged that the Products contain defects, the Seller undertakes to replace the defective products as far as the supplies allow and without indemnities or compensation of any kind for labor costs, delays, loss caused or any other reason. The replacement is guaranteed for a maximum of two months starting from the delivery date. Any replacement is excluded for any event as set out in article 5 below.

4.7 The deadlines that the Seller is asked to state for the mailing of the Products are given for information only and are not guaranteed. If such deadlines are not met, it shall not lead to any damages or cancellation of the orders, except for non acceptable delays exceeding [4] months from the stated deadline, without information from the Seller. In such case only, the Buyer shall be entitled to ask for a reimbursement of its first down payment to the exclusion of any further damages.

4.8 The Seller does not make any warranties, express or implied, including, without limitation, those of sale ability and fitness for a particular purpose, with respect to the Products. Although the Seller shall take reasonable steps to screen Products for infection of viruses, worms, Trojan horses or other codes containing contaminating or destructive properties before making the Products available, the Seller cannot guarantee that any Product will be free from infection.

5. **Force majeure**

The Seller shall not be liable for any delay in performance directly or indirectly caused by or resulting from acts of nature, fire, flood, accident, riot, war, government intervention, embargoes, strikes, labor difficulties, equipment failure, late deliveries by suppliers or other difficulties which are beyond the control, and not the fault of the Seller.

6. **Protection of the Seller's IPR**

6.1 All the IPR attached to the Products are and remain the property of the Seller and are protected under French and international copyright law and conventions.

6.2 The Buyer agreed not to disclose, copy, reproduce, redistribute, resell or publish the Product, or any part of it to any other party other than employees of its company. The Buyer shall have the right to use the Products solely for its own internal information purposes. In particular, the Buyer shall therefore not use the Product for purposes such as:

- Information storage and retrieval systems;
- Recordings and re-transmittals over any network (including any local area network);
- Use in any timesharing, service bureau, bulletin board or similar arrangement or public display;
- Posting any Product to any other online service (including bulletin boards or the Internet);
- Licensing, leasing, selling, offering for sale or assigning the Product.

6.3 The Buyer shall be solely responsible towards the Seller of all infringements of this obligation, whether this infringement comes from its employees or any person to whom the Buyer has sent the Products and shall personally take care of any related proceedings, and the Buyer shall bear related financial consequences in their entirety.

6.4 The Buyer shall define within its company point of contact for the needs of the contract. This person will be the recipient of each new report in PDF format. This person shall also be responsible for respect of the copyrights and will guaranty that the Products are not disseminated out of the company.

6.5 In the context of annual subscriptions, the person of contact shall decide who within the Buyer, shall be entitled to access on line the reports on I-micronews.com. In this respect, the Seller will give the Buyer a maximum of 10 password, unless the multiple sites organization of the Buyer requires more passwords. The Seller reserves the right to check from time to time the correct use of this password.

6.6 In the case of a multisite, multi license, only the employee of the buyer can access the report or the employee of the companies in which the buyer have 100% shares. As a matter of fact the investor of a company, the joint venture done with a third party etc...cannot access the report and should pay a full license price.

7. **Termination**

7.1 If the Buyer cancels the order in whole or in part or postpones the date of mailing, the Buyer shall indemnify the Seller for the entire costs that have been incurred as at the date of notification by the Buyer of such delay or cancellation. This may also apply for any other direct or indirect consequential loss that may be borne by the Seller, following this decision.

7.2 In the event of breach by one Party under these conditions or the order, the non-breaching Party may send a notification to the other by recorded delivery letter upon which, after a period of thirty (30) days without solving the problem, the non-breaching Party shall be entitled to terminate all the pending orders, without being liable for any compensation.

8. **Miscellaneous**

All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents. Each of them is entitled to assert and enforce those provisions against the Buyer.

Any notices under these Terms and Conditions shall be given in writing. They shall be effective upon receipt by the other Party.

The Seller may, from time to time, update these Terms and Conditions and the Buyer, is deemed to have accepted the latest version of these terms and conditions, provided they have been communicated to him in due time.

9. **Governing law and jurisdiction**

9.1 Any dispute arising out or linked to these Terms and Conditions or to any contract (orders) entered into in application of these Terms and Conditions shall be settled by the French Commercial Courts of Lyon, which shall have exclusive jurisdiction upon such issues.

9.2 French law shall govern the relation between the Buyer and the Seller, in accordance with these Terms and Conditions.



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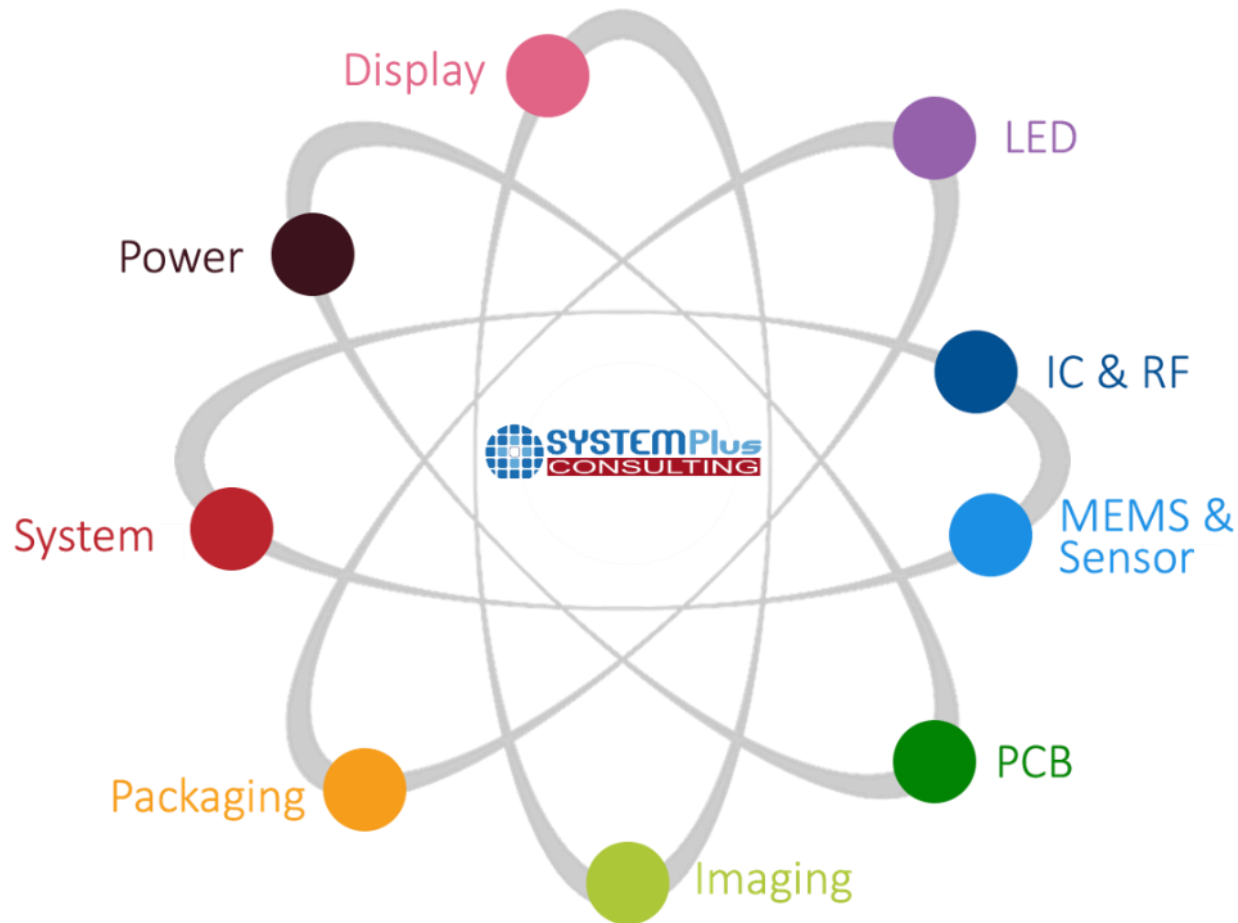
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