Bosch LRR4
Long and Short Range 77GHz Radar
System report by David Le Gac
April 2017
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Reverse Costing Methodology

The reverse costing analysis is conducted in several phases:

- **The initialization of the analysis**
  - Pictures of the elements to be studied.
  - Identification of the components.

- **Description of the material in the “SYScost+” software**
  - Creation of an “estimation project” of the studied board with SYScost+ software.
  - Construction of the Bill of Material (BOM).

- **Assessing the material**
  - Searching for the price of each reference among distributors and manufacturers.
  - Assessing the cost of the PCB and of the unaccounted references (unknown by distributors)
  - The BOM is valued with SYScost+: price simulation according to the requested quantities.

- **Assessing the assembling and test phases**
  - Assembly and test lines are modeled with the SYScost+ software.
  - The assembly and tests costs are estimated.

- **Production cost & selling price**
  - Estimation of the production cost & selling price.

- **Report**
  - A report is edited.

SYS.cost+©, is a software tool developed by SYSTEM PLUS CONSULTING to calculate the cost of electronic boards. More information on the software can be found at www.systemplus.fr.
Global View of the Radar

Global view of the LRR4 Radar.

Total Weight: 218g
Part Collection

Overview / Introduction
Company Profile & Main Features

Physical Analysis
- Views & Dimensions
  - Radar Opening
- Electronic Boards
- RF Chipset
- Comparison

Cost Analysis
Manufacturing Price
About System Plus

Part Collection

Housing
MCU Board
RF Board
RF Board Holding Part
Radar Dome
Bottom Cover
Closing Clips (x3)
MCU Board – Top Side – Global View

PCB Characteristics:
- Material: FR4
- Total Thickness: [mm]
- Finishing:

Layers number:
- External copper thickness: [µm]
- Drilling holes number:

Dimensions: [mm x mm]
- Internal copper thickness: [µm]
- Diameter: [µm]
MCU Board – Top Side – Main Components Identification

- Diode Switching Ultrafast
- Capacitor Electrolytic
- ON Semiconductor
RF Board – Bottom Side – Main Components Markings
Receiver Package

The Radar Receiver die is packaged.

- The package is a
- Pin pitch:
- The package marking includes the logo of and :

Top view

Die

Back view
Receiver Die

Marking on die:
• The die marking includes the logo of Bosch and:

Silicon die in
## Comparison with Continental ARS4-A and Bosch MMR1Plus

<table>
<thead>
<tr>
<th></th>
<th>Bosch LRR4</th>
<th>Continental ARS4-A</th>
<th>Bosch MRR1Plus</th>
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<tr>
<td><strong>Overview / Introduction</strong></td>
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<td><strong>Company Profile &amp; Main Features</strong></td>
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<td><strong>Physical Analysis</strong></td>
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<td>· RF Chipset</td>
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<tr>
<td><strong>Comparison</strong></td>
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</tbody>
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- The LRR4 (Bosch)
  - In the LRR4, the transmitter has one
  - The LRR4 configuration offers wider range of

- The ARS4-A (Continental) contains two
  - In the ARS4-A, the transmitter has
  - The ARS4-A configuration thanks to the array of

- The MRR1Plus (BOSCH) contain one
  - In the MRR1Plus, the transmitter has
  - The MRR1Plus configuration seems to
# Overview / Introduction

- Company Profile & Main Features
- Physical Analysis
- Cost Analysis
  - Accessing the BOM
  - PCB Costs
  - BOM Cost – Electronics
  - Housing Parts Estimation
  - BOM Cost - Housing
  - Material Cost Breakdown
  - Added-Value Cost
  - Manufacturing Cost

# Manufacturing Price

<table>
<thead>
<tr>
<th>Part reference</th>
<th>Article qty</th>
<th>Description</th>
<th>Package</th>
<th>Pin nb</th>
<th>Manufacturer</th>
<th>Side Unit cost</th>
<th>Total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB of MCU Board</td>
<td>1 unit FR4</td>
<td>unit Radar ASIC QFP100</td>
<td>QFP100</td>
<td>200</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**SAMPLE**
## Manufacturing Cost Breakdown

<table>
<thead>
<tr>
<th>Bosch LLR4 77GHz Radar</th>
<th>ASSEMBLY COST</th>
<th>MATERIAL COST</th>
<th>MANUFACTURING COST without scrap &amp; supplying costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Article Qty</td>
<td>Added Value</td>
<td>Manufacturing Duration (s)</td>
</tr>
<tr>
<td>Housing</td>
<td>1</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>MCU Board</td>
<td>1</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>RF Board</td>
<td>1</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>$</td>
<td>$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bosch LLR4 77GHz Radar</th>
<th>ASSEMBLY COST</th>
<th>MATERIAL COST</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>-%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>MCU Board</td>
<td>-%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>RF Board</td>
<td>-%</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>-%</td>
<td>10%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The Total Manufacturing Cost is estimated to $, including $ for Material Cost (3%) and $ for Added Value Cost (3%).

©2017 by System Plus Consulting | Bosch LLR4 Radar
Estimation of the Manufacturing Price

The bill of material (BOM) cost is estimated to $[X] for the Radar.

To this, we must add some scrap costs and component supplying costs to obtain the total material cost of $[X].

The assembly cost is estimated to $[X], so the manufacturing cost is $[X].

With estimated costs of R&D, G&A and Profit, the average manufacturing price of Bosch can be estimated at $[X] when using the estimated economic parameters of Bosch.
Related Reports

- Continental ARS4-A 77GHz Radar
- Autoliv 77GHz Multi Mode Radar
- Infineon RRN7745P & RTN7735P eWLB Fan-Out Package – 77GHz Radar Dies

- Imaging Technologies for Automotive 2016
- Sensors and Data Management for Autonomous Vehicles report 2015
Contact

Reverse costing analysis represents the best cost/price evaluation given the publically available data, and estimates completed by industry experts.

Given the hypothesis presented in this analysis, the major sources of correction would lead to a +/- 30% correction on the manufacturing cost (if all parameters are cumulated).

These results are open for discussion. We can reevaluate this circuit with your information. Please contact us:

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- **General**
  - Email: info@yole.fr
The LLR4 is a monostatic multimodal radar in a very compact and elegant housing and uses, like its predecessors, the 77 gigahertz (GHz) frequency band. The main innovation in this fourth generation is the number of radar beams used, with six fixed radar antennas instead of four for the third generation. The LLR4 can detect other vehicles at a distance of roughly 250 meters. It enables Adaptive Cruise Control (ACC) at speeds of more than 160km/h, which can make up for large differences in speed without any intervention by the driver. The radar is equipped with a heated lens which ensures full sensor availability, even in poor weather conditions, such as snow and ice.

The system integrates two electronic boards, including NXP Semiconductor and STMicroelectronics microcontrollers and Bosch power management ICs. The radio-frequency (RF) board is manufactured with an asymmetric structure using a hybrid PTFE/FR4 substrate and is equipped with planar antennas.

Infineon 77GHz SiGe Monolithic Microwave Integrated Circuits (MMICs) are used as high-frequency transmitter and receiver. The two RF dies are packaged in the latest version of the eWLB Fan-Out Wafer Level Package developed and manufactured by Infineon.

Based on a complete teardown analysis of the Bosch radar, the report provides the bill-of-material (BOM) and the manufacturing cost of the radar sensor as well as a comparison with Continental’s ARS4-A and Bosch’s MRR1Plus modules.

A complete physical analysis and manufacturing cost estimation of the Infineon MMICs is available in a separate report.
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- Estimation of the Manufacturing Price

ANALYSIS PERFORMED WITH OUR COSTING TOOLS SYSCOST+ AND IC PRICE+

System Plus Consulting offers powerful costing tools to evaluate the production cost & selling price from single chip to complex structures.

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It provides all component costs estimation including PCB, housing and connectors, and a simulation of the assembly cost and test process at the board and system level, in order to help you defining the cost of an electronic system.

**IC Price+**
This tool performs the necessary cost simulation of any Integrated Circuit: ASICs, microcontrollers, memories, DSP, smartpower...

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- **David Le Gac**
  David is in charge of reverse costing with a focus on boards and systems. He worked for Lacroix Electronics where he was in charge its components database

- **Stéphane Elisabeth**
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- **Véronique Le Trooadec (Lab)**
  Véronique is in charge of structure analysis of semiconductors. She has deep knowledge of chemical and physical technical analyses. She previously worked for 20 years at Atmel’s Nantes Laboratory.
The ARS4-A is a 77 GHz radar sensor offering simultaneous long and short range detection. A compact, cost-effective and high-performance driving assistance system combining medium- and long-range detection. New receiver & transmitter components with a SiGe:C HBT technology from Infineon.
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Email: ................................................................. Phone: .................................................................

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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 Mailing of the Products shall have to be sent 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 have no responsibility for any delay in respect of article 2.2 above, and including in case 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 the product.

2.3 All the Products remain the property of the Seller, in accordance with the terms 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/passport. If the Product’s electronic delivery format is defective, the Seller undertakes to replace the Product at no charge to the Buyer, provided that it is informed of the defective formatting within 90 days from the date of release (the orignaldownload format 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 shall produce sufficient evidence of the resultant defects, the Buyer, the Seller, and the Analyst (in the case of an Analyst report) shall have exclusive jurisdiction upon such issues.

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 prior information to the Seller as required under article 2.5 shall remain at the Buyer’s risk.

3. Product Price

3.1 Product’s prices are fixed in euros. They are exclusive of all taxes, which may be reevaluated from time to time at the Buyer’s request.

3.2 All the provisions of these Terms and Conditions are for the benefit of the Seller itself, but also for its licensors, employees and agents which, by virtue of these Terms and Conditions, are entitled to invoice interest in arrears based on the annual rate

4. Payment

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 interpretation makes him of the Products, of the purchases he obtains, and of the acts and decisions it deduces therefrom.

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:

- damages resulting from 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; or
- any claim attributable to errors, omissions or other inaccuracies in the Product or interpretations thereof.

4.4 The Seller shall not be liable for any costs, losses or expenses which the Buyer incurs in connection with or as a result of the Buyer’s use of the Products, or any actions undertaken by the Buyer.

4.5 In no event shall the Seller be liable for any loss caused to the Buyer by the use or misuse of the Products, or any actions undertaken by the Buyer.

4.6 If the Seller shall become aware of a breach of the warranty of the Seller, the Buyer shall be entitled to ask for a reimbursement of the price paid or to cancel the contract. Any replacement is excluded for any event as set out in Article 4.5 above.

4.7 The warranty is limited to the repair or, in case of failure, to the replacement of the Products. The Seller shall not be liable for any loss caused by the Buyer’s delay in notifying the Seller of the defect.

5. Liability

5.1 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, notwithstanding the fact that they have been registered or not, and including any pending registration of one of the above mentioned rights.

5.2 The Seller will 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, notwithstanding the fact that they have been registered or not, and including any pending registration of one of the above mentioned rights.

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6.3 Any Product or any result obtained upon use by the Buyer of the Product may not be disclosed to third parties unless the Buyer obtains the Buyer’s written authorization. The Seller will guarantee that the Products are not disseminated out of the company.

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 the Product. The Buyer agrees to produce sufficient evidence of the resultant defects, the Buyer, the Seller, and the Analyst (in the case of an Analyst report) shall have exclusive jurisdiction upon such issues.

6.5 The Buyer is entitled to invoice interest in arrears based on the annual rate

7. Term and 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 Party 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 the product. The effective price is deemed to be the one applicable at the time of the order.

7.3 Any notice 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.

7.4 Governing law and jurisdiction

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.