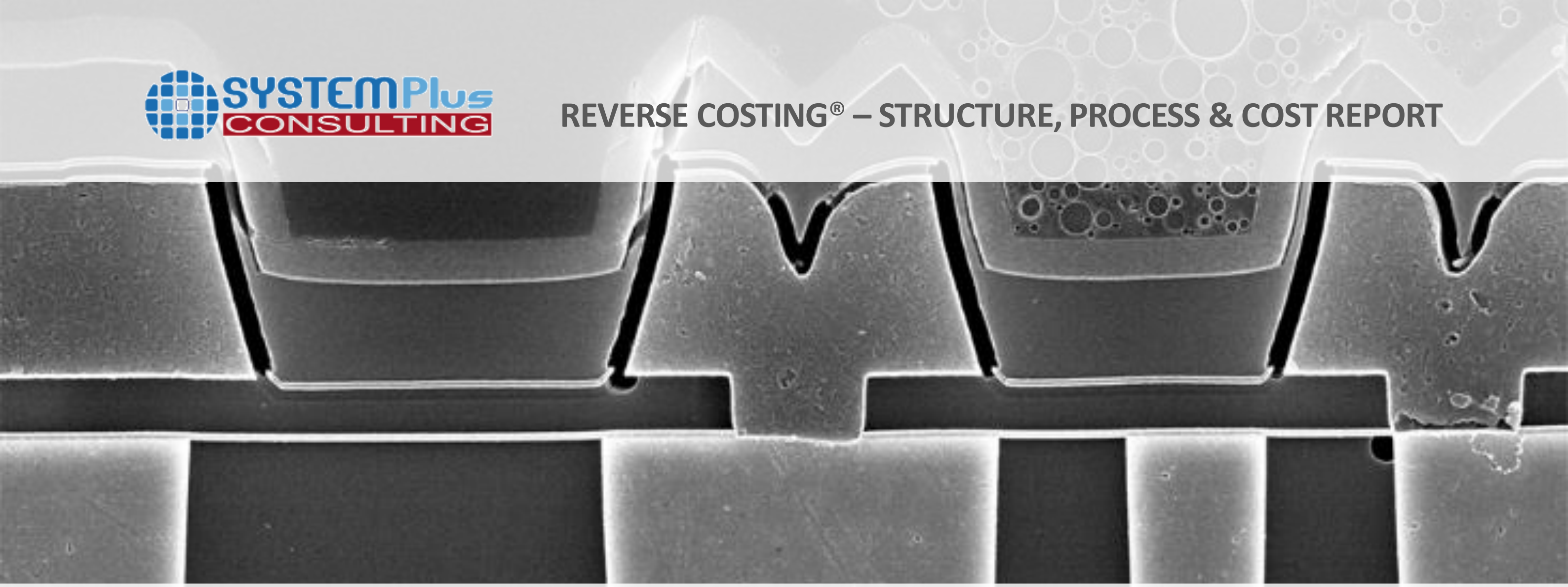
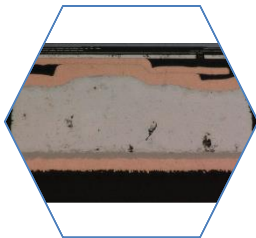


Advanced System-in-Package Technology in Apple's AirPods Pro

Analysis of Apple's first SiP found in the latest AirPods, featuring a fully integrated SiP for audio codec and Bluetooth connectivity.



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The System-in-Package (SiP) market delivered huge revenue – $13.4 billion – in 2019, and is expected to reach approximately $18.8 billion in 2025. The market is mainly driven by increased need for advanced architectures in electronic devices, mostly in mobile and consumer products. Advanced technology asks for higher levels of die and functionality integration in a single package at lower cost. Since 2015, Apple has integrated several generations of SiP in its smartwatch. This year, for the first time, the company has chosen the same type of solution for its earbuds. This came in two different SiPs, one for the Bluetooth connectivity and one for the audio codec.

In the latest AirPods Pro, the SiPs influence device compactness and size reduction of the wireless headsets. The AirPods Pro, designed and manufactured by Apple, comprise several SiPs assembled together: two Inertial Measurement Units (IMUs), one Bluetooth module and one audio codec module. The IMUs are standard Land Grid Array (LGA) SiPs from STMicroelectronics.

The Bluetooth H1-Module is packaged using double side molding technology in order to integrate a memory under the System-on-Chip (SoC). This structure enables a wireless connection, drives Apple's voice-enabled Siri assistance and allows real time noise cancellation. The audio codec integrates up to eight dies and 80 passive components with a density of 0.96 components per mm². The module has a special shape that is designed to meet the mechanical constraints of the earbuds to minimize the lost area in the system. Both SiPs are designed in order to have better power management, higher performance and high cost effectiveness.

The report includes all the packaging details from the substrate to the dies from both modules. The report focuses on the packaging processes of the two SiP modules and the final assembly. High resolution images of the package cross section at different positions and angles enable full package and assembly process analyses. It also includes a full description of the process and the manufacturing cost of the dies and the packaging. Finally, a physical comparison of the two SiP Modules is included.

COMPLETE TEARDOWN WITH

- Detailed photos
- Precise measurements
- Material analysis
- Manufacturing process flow
- Supply-chain evaluation
- Manufacturing cost analysis
- Estimated sales price

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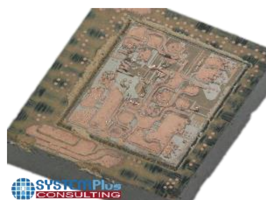
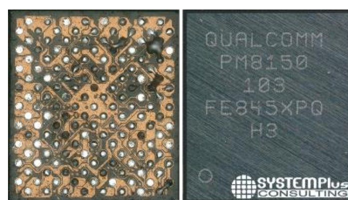


Qualcomm QET5100M Envelope Tracker Module with SEMCO's Embedded Die Packaging Technology

The first device featuring six-layer embedded die packaging technology found in the consumer market from SEMCO and Amkor.

November 2019



ASE/Deca M-Series Fan-Out Process

ASE/Deca's patented fan-out technology has penetrated a new commercially available device, the Qualcomm PM8150 PMIC.

September 2019

Advanced packaging technology in the Apple Watch Series 4's System-in-Package

Four major packaging technologies: ASE's SiP & modified SESUB, TSMC's inFO-ePoP, Skyworks' Double Side BGA.

January 2019

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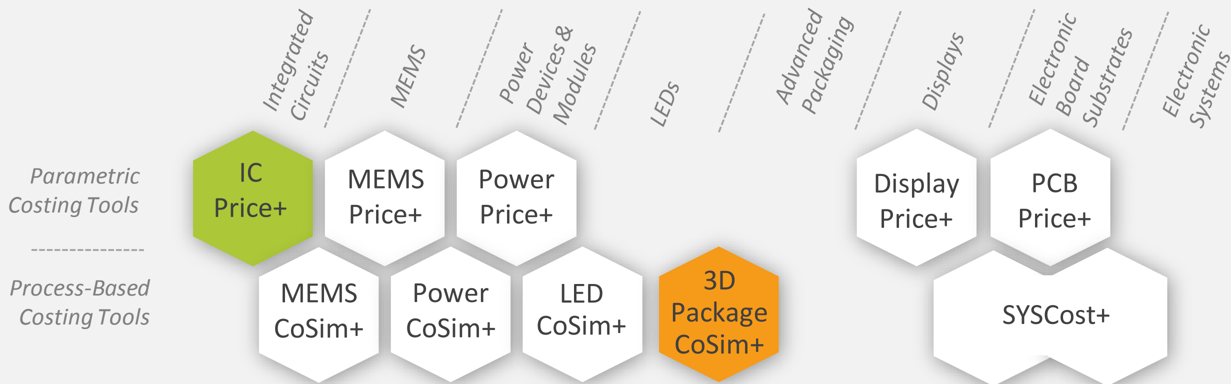
COSTING TOOLS



Our analysis is performed with our costing tools 3D Packaging CoSim+ and IC Price+.

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

3D Packaging CoSim+
Cost simulation tool to evaluate the cost of any Packaging process: Wafer-level packaging, TSV, 3D integration…

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WHAT IS A REVERSE COSTING®?

Reverse Costing® is the process of disassembling a device (or a system) in order to identify its technology and calculate its manufacturing cost, using in-house models and tools.

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System Plus Consulting is specialized in the cost analysis of electronics from semiconductor devices to electronic systems.
A complete range of services and costing tools to provide in-depth production cost studies and to estimate the objective selling price of a product is available.

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SYSTEMPlus CONSULTING

TERMS AND CONDITIONS OF SALES

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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.

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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.

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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.

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

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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?

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As a rule, all information handed by customers to system Plus Consulting are considered as strictly confidential.

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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

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