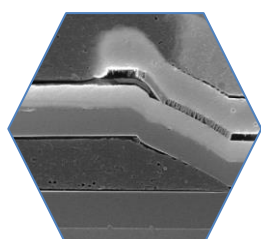
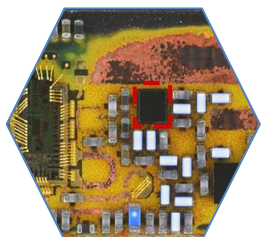




Skyworks' FBAR-BAW Filter Technology in 2G/UHB PAMiD SKY78221

First High-Volume Manufacturing (HVM) BAW filter on the market from Skyworks, integrated in the Apple iPhone 11 Pro Max and iPad Pro second generation.



Title: Skyworks' FBAR-BAW Filter Technology in 2G/UHB PAMiD SKY78221

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In the smartphone market Apple is one of the most profitable companies, with around a 40% share of the market in 2018. The overall smartphone market is worth more than \$400 billion. Module and filter manufacturers must be reliable and highly innovative to match Apple's spirit if they want to be a supplier. Until 2019, Skyworks was known for its high-performance Surface Acoustic Wave (SAW) filters and Low-Band/Mid-Band modules. Today, with its newly developed Bulk Acoustic Wave (BAW) filter in High Volume Manufacturing (HVM), the company is embracing the 5G Sub-6GHz wave by offering an Ultra High Band (UHB) module. By doing so, Skyworks is now able to compete with Qorvo or Broadcom in these frequencies.

In 2019 and 2020, Skyworks is supplying Apple with Power Amplifier Modules (PAMs) that feature 2G connectivity and UHB Front-End in the same package. The module is integrated in the Apple iPhone Series 11, 11 Pro and 11 Pro Max, but also in the latest Apple iPad Pro second generation, as the SKY78201 model. Depending on the version, the module features several dies: a Power Amplifier (PA), Silicon-on-insulator (SOI) Switch and Low-Noise Amplifier (LNA), Integrated Passive Device (IPD), SAW Filter and Film Bulk Acoustic Resonator (FBAR) filters.

This report will only focus on the FBAR filters. The component is using an innovative silicon cap bonded wafer Chip-Scale Packaging (CSP) technology with Through-Silicon Vias (TSVs) enabling electrical contacts and scandium doped Aluminum Nitride (ScAlN) as a piezoelectric material. This newly developed device implements a simple ladder structure with a density comparable to its major competitor. To seal the internal structure, the packaging uses eutectic bonding with Au-Sn solder.

The report contains a deep analysis of the filter die with a complete cost analysis of the component. It also integrates a comparison with the Broadcom's FBAR and Qorvo's Solidly Mounted Resonator (SMR) BAW filter technology also integrated in the Apple iPhone series.

COMPLETE TEARDOWN WITH

- Detailed photos
- Precise measurements
- Materials analysis
- Manufacturing process flow
- Supply chain evaluation
- Manufacturing cost analysis
- Estimated sales price
- Technical and cost comparison with Broadcom's FBAR-BAW and Qorvo's SMR

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AUTHORS

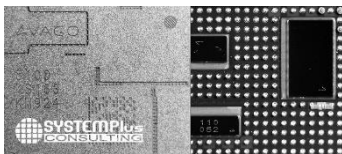


Stéphane Elisabeth, PhD has joined System Plus Consulting's team in 2016. Stéphane is Expert Cost Analyst in RF, Sensors and Advanced Packaging. He has a deep knowledge of materials characterizations and electronics systems. He holds an Engineering Degree in Electronics and Numerical Technology, and a PhD in Materials for Microelectronics.



Guillaume Chevalier has joined System Plus Consulting in early 2018 to perform physical analyses. He holds a two-year university degree in technology of physical measurements and instrumentation technics, and previously worked for four years for chemistry, mechanical and mass-metrology laboratories.

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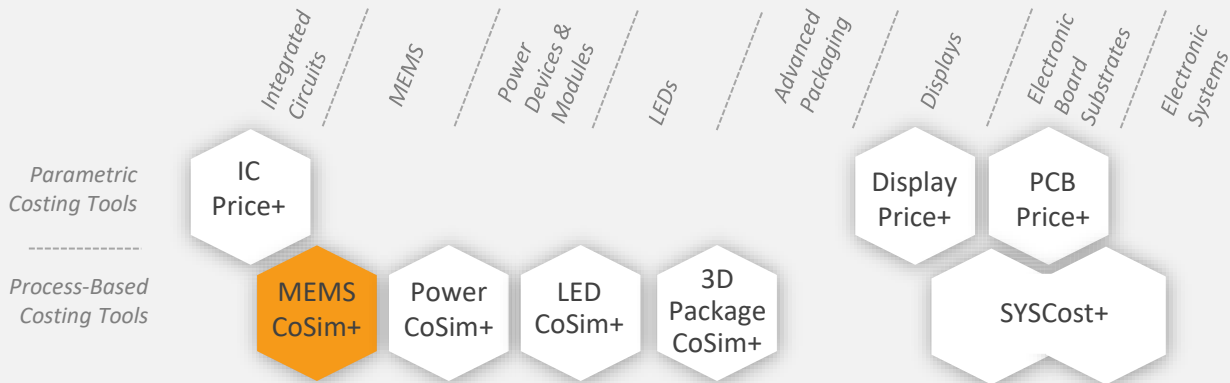


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WHAT IS A REVERSE COSTING®?

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