Fan-Out Packaging Processes Comparison 2020

In-depth technical and cost overview of key Fan-Out processes technologies form Infineon, nepes, TSMC, SEMCO and

SP20479 - PACKAGING report by Stéphane ELISABETH
January 2020 – Sample
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Executive Summary

• Back in 2015, only Outsourced Semiconductor Assembly and Test (OSAT) players were involved in Fan-Out (FO) packaging. In 2016, TSMC led the entry of foundries into this market with its integrated FO (inFO) packaging technology. Next, Integrated Device Manufacturers (IDMs) like Samsung joined the race with new in-house technology at the panel level. The result is that in 2019 OSATs have only a third of the market. Even with this reduced share, they are still developing and enhancing their portfolio in this segment. Recently ASE, in partnership with Deca Technologies, has entered the core market with its M-Series technology. Next, nepes bought the technology from Deca. As the market is continuously moving, System Plus Consulting offers an overview of the technologies on the market, providing the original equipment manufacturers’ (OEMs’) technical and cost choices of fan-out packaging.

• This report provides insights on technology data for FO packaging for different application segments. It includes a comparative study of eight components from power management integrated circuits (PMICs) to processors to radar Monolithic Microwave Integrated Circuits (MMICs) using Fan-Out technology from different suppliers.

• Physical data of several components has been compared in term of process flow, cost and integration to provide a largepanel of OEM technical and economic choices from the market such as:
  • embedded Wafer Level Ball (eWLB) grid array from Infineon, Amkor and STATSChipPAC
  • Redistributed Chip Package (RCP) from nepes
  • M-Series from ASE/Deca Technologies
  • Integrated Fan-Out (inFO) from TSMC
  • Enhanced Panel Level Packaging (ePLP) from SEMCO

• The report includes a description of each process flow for the five major fan-out technologies on the market. It also contains a complete cost analysis of the packaging and tries to explain OEM choices.
Denso DNMWR009 – 77 GHz Radar

- The radar features two receivers, one transmitter and one power amplifier MMIC.
- These four components are all packaged using eWLB technology.
Components with Fan-Out from 2011 to 2019

- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019

Device Teardown
- Denso DNMWR009
- Continental ARS4-A
- Apple Watch Series 4
- Samsung Galaxy Watch
- Samsung Galaxy S10 5G
- Samsung Galaxy S7 Edge
- FitBit Charge 3
- Smartphone Evolution

Market Analysis

Physical Analysis

Manufacturing Process Flow

Cost Analysis

Cost Comparison

Feedbacks

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Fan-Out Packaging Technology – Smartphones Evolution – 2019

Overview / Introduction
Company Profile & Supply Chain

Device Teardown
- Denso DNMWR009
- Continental ARS4-A
- Apple Watch Series 4
- Samsung Galaxy Watch
- Samsung Galaxy S10 5G
- Samsung Galaxy S7 Edge
- FitBit Charge 3

Market Analysis
Physical Analysis
Manufacturing Process Flow
Cost Analysis
Cost Comparison
Feedbacks
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Summary of the Physical Analysis

Thermal Dissipation

- Infineon RXN77XX:
  - Process:
  - Features:
  - Substrate:

- NXP MR2001XXX:

High I/O

- Apple A12:

Side Wall Protection

- Qualcomm WCD9335:

- Qualcomm PM8150:

- Samsung Exynos 9110:

- Cypress CYSTM200-PM-BLE:

Manufacturing Process Flow

Cost Analysis

Cost Comparison

Feedbacks

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Package View & Dimensions

- Package:
- Dimensions:
- Pitch:
Package Overview

- Min. L/S: XX / XX µm
- Min. Line Pitch: XX µm
- Min. Line to Pad: XX µm
- Pad Dimensions: Ø XX µm (Outer), Ø XX µm (Inner)
- BGA Pad Dimensions: Ø XX µm (Outer)

Package Bottom View
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Process Structure

- Wafer reconstitution and wafer molding
- Redistribution layer
- Ball drop, reflow and singulation

- Wafer reconstitution and wafer molding
- Redistribution layer
- Ball drop, reflow and singulation
  - Ball dropping and reflow
Amkor’s eWLB vs. ASE’s M-series Packaging Process

- Amkor’s eWLB packaging
- ASE’s M-Series packaging

- Package Process:
  - Package Type:
  - Carrier:
  - Process type:

- Test:
  - Test type:
The cost for the packaging ranges from [ ] to [ ] according to yield variations.

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

By adding a gross margin of 15% for the OSAT, the packaging price per module ranges from [ ]
inFO vs. ePLP Packaging Cost per process steps (1/2)

<table>
<thead>
<tr>
<th>Process Operation</th>
<th>TOTAL COST (USD/Unit)</th>
<th>Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDL #1: Polymerization &amp; Lithography</td>
<td></td>
<td></td>
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<tr>
<td>RDL #2: Cure</td>
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<tr>
<td>RDL #3: Cleaning</td>
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<tr>
<td>RDL #4: Backplating Copper (Cu)</td>
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</tbody>
</table>

Cost Analysis
- Cost Analysis Summary
- Yields Explanation & Hypotheses
- Front-End Cost
- Thermal Dissipation Packaging Cost
- High I/O Packaging Cost
- Side Wall Protection Packaging Cost
- SiP Packaging Cost

Cost Comparison

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Cost Comparison

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## Component Cost

### Low Yield | Medium Yield | High Yield
---|---|---
**SIP using RCP**
Dies Cost per Reconstruct Wafer
RCP Package Manufacturing Price
Total Wafer Cost

### Nb of potential dies per wafer

**SIP Die Cost**

---

### Low Yield | Medium Yield | High Yield
---|---|---
**SIP using eWLB**
Dies Cost per Reconstruct Wafer
eWLB Package Manufacturing Price
Total Wafer Cost

### Nb of potential dies per wafer

**SIP Die Cost**
Summary of Cost Analysis

<table>
<thead>
<tr>
<th>Carrier Type</th>
<th>Carrier Size</th>
<th>Package Price</th>
<th>Costly Step</th>
<th># of patterning</th>
<th>Packaging price per component</th>
<th>Price per Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Dissipation</td>
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<td>Side Wall Protection</td>
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<td>System-in-Package</td>
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</tbody>
</table>
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REVERSE COSTING ANALYSES - SYSTEM PLUS CONSULTING

ADVANCED PACKAGING
- ASE/Deca M-Series Fan-Out Process
- Advanced packaging technology in the Apple Watch Series 4’s System-in-Package
- Samsung Exynos 9110 with ePLP: First Generation of Samsung’s Fan-Out Panel Level Packaging (FO-PLP)

MARKET AND TECHNOLOGY REPORTS - YOLE DÉVELOPPEMENT

ADVANCED PACKAGING
- Fan-Out Packaging: Technologies and Market Trends 2019
- Equipment and Materials for Fan-Out Packaging 2019
- Status of the Advanced Packaging Industry 2019
Business Models Fields of Expertise

- Custom Analyses
  (>130 analyses per year)
- Reports
  (>60 reports per year)
- Costing Tools
- Trainings

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