Discrete Packages Comparison
A Cost Oriented Trend Analysis
Power Semiconductor report by Farid Hamrani
May 2018
SUMMARY

Overview
- Executive Summary
- Reverse Costing Methodology
- Analyzed devices

Introductions
- Discrete Market

Physical and Manufacturing Cost Analysis
- 3x1.3mm²
  - SOT23
- 3x1.6mm²
  - TSOP6
- 3x3mm²
  - SON3x3
  - TSMT8
- 4.5x2.5mm²
  - SOT89
  - SOIC-8
- 5x6mm²
  - PowerFLAT 5x6
  - PowerFLAT 5x6 Double Island
  - PowerFLAT 5x6 Dual Side Cooling
  - SOP Advance
  - DSOP Advance
- 6x6mm²
  - DPAK
  - DPAK-5

Comparison
- 10x10mm²
  - D2PAK7
  - H2PAK
  - PSOFA-008
  - TO-220
- 15x20mm²
  - TO-247

Company services
Executive Summary

In recent years the packaging market industry has been stabilizing around some standards formats and footprint. But the ever-going race for optimization is far from being over.

The fast-moving evolutions of the EV/HEV markets, the electrification of transportation, and more generally the of the power electronic market growth have induced a contested competition between power electronic components manufacturers.

And the race to innovation and efficiency, the semiconductor die itself isn’t the only key of success. In fact, when chasing after the optimum configuration for electrical, thermal and mechanical performances, the manufacturers also must battle with the mechanical reliability and cost of the packaging. More than a simple “shell” the packaging surrounding the dies can make or break a design.

To satisfy an industry where standardization and return of experience and key points of success, seemingly small but smart tweaks around common packages can turn out to be highly differentiating.

Through physical analysis (chemical opening, cross-section, measurements and so on) this report try to overview the state of the art of packaging power semiconductor at a discrete level. With a cost oriented point of view, we are revealing the hidden details that makes the differences between over 20 types of packages ranging from mW to kW sustaining designs.
Reverse methodology

The report contains the following analysis:

Teardown analysis

- Packages are externally analyzed and measured. Then the molding is removed through chemical opening. Finally a cross-section on the components is realized for internal measurements purposes

Costing analysis

- Setup of the manufacturing environment
- Cost simulation of the process steps
Introduction & Market
This Market forecast by Yole Development is showing the rise of the global power market devices. It also shows that the market for the Discrete devices will follow that trend with an estimated XXX increase in the next five years.
PHYSICAL ANALYSIS
5x6mm²
Overview

Introduction

Physical Analysis
- 5x6mm
  - PowerFLAT 5x6
  - PowerFLAT Double Island
  - PowerFLAT Double Dual Side
  - SOP Advance
  - DSOP Advance
  - Power 56
  - DualCool TM 56
  - So-8FL
  - TDSON-8
  - Direct FET

About System Plus

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- The SOP packaging enables current output up to 40 A, an improvement on Toshiba’s standard SOP-8 MOSFETs. Toshiba’s SOP Advance packaging is only 1 mm in height, approximately a 37 percent reduction in thickness compared to Toshiba’s standard SOP-8 packaging.
Overview

Introduction

Physical Analysis
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- SOP Advance
- DSOP Advance
- Power 56
- DualCool TM 56
- So-8FL
- TDSON-8
- Direct FET1

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SOP Advance – Views and Dimensions

- Total Pad area: 17.5mm²
Overview

Introduction

Physical Analysis

- 5x6mm²
  - PowerFLAT 5x6
  - PowerFLAT Double Island
  - PowerFLAT Double Dual Side
- SOP Advance
- DSOP Advance
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- So-BFL
- TDSON-8
- Direct FET1

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SOP Advance – Opening and Cross-Section

Top View After Chemical Opening

Cross-section View
Overview

Introduction

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  - So-8FL
  - TDSON-8
  - Direct FET1

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**SOP Advance – Cost Simulation**

### Packaging Total Cost Per Step

<table>
<thead>
<tr>
<th>Process Operation</th>
<th>TOTAL COST (USD / Unit)</th>
<th>Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solder Paste Deposition</td>
<td>$2.06</td>
<td>2.06%</td>
</tr>
<tr>
<td>Die Placement</td>
<td>$1.54</td>
<td>1.54%</td>
</tr>
<tr>
<td>Solder Reflow</td>
<td>$1.68</td>
<td>1.68%</td>
</tr>
<tr>
<td>Cleaning</td>
<td>$1.28</td>
<td>1.28%</td>
</tr>
<tr>
<td></td>
<td>$1.28</td>
<td>1.28%</td>
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<tr>
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<td>$1.28</td>
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<tr>
<td></td>
<td>$1.28</td>
<td>1.28%</td>
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<tr>
<td>Lead Plating</td>
<td>$2.64</td>
<td>2.64%</td>
</tr>
<tr>
<td>Deflash/Trim/Form/Singulate</td>
<td>$0.86</td>
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<tr>
<td>Total Cost</td>
<td>$10.00</td>
<td>100.0%</td>
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</tbody>
</table>

### Package Manufacturing Cost Breakdown

<table>
<thead>
<tr>
<th>Low Yield</th>
<th>Cost</th>
<th>Breakdown</th>
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</thead>
<tbody>
<tr>
<td>Leafframe</td>
<td>$68.94</td>
<td>68.94%</td>
</tr>
<tr>
<td>Clean Room Cost</td>
<td>$31.94</td>
<td>31.94%</td>
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<tr>
<td>Equipment Cost</td>
<td>$20.61</td>
<td>20.61%</td>
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<tr>
<td>Consumable Cost</td>
<td>$16.06</td>
<td>16.06%</td>
</tr>
<tr>
<td>Labor Cost</td>
<td>$8.03</td>
<td>8.03%</td>
</tr>
<tr>
<td>Yield Losses (Y= 99.74%)</td>
<td>$0.04</td>
<td>0.04%</td>
</tr>
</tbody>
</table>

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COMPARISON
This graph above compares the cost breakdown of each of the studied packages.
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