Melexis MLX75023
Automotive 3D ToF

Imaging report by Stéphane ELISABETH
July 2017

Tel: 02-713-9574  http://www.oic.co.kr / info@oic.co.kr
SOMMAIRE

Overview / Introduction 3
  - Executive Summary
  - Reverse Costing Methodology

Company Profile 6
  - Melexis
  - Business Model
  - Softkinetic PortFolio
  - Melexis ToF Solution
  - 3D Imaging & Sensing Market

Physical Analysis 13
  - Synthesis of the Physical Analysis
    - Package 15
      - Package Views: Dimensions, Marking, Block Diagram
      - Package Opening: RDL, Line/Space Width, Optical Filter
      - Package Cross-Section : RDL, Bumps, Optical Filter
    - Die 28
      - Die View & Dimensions
      - Delayering & main Blocs
      - Die Process: Transistor, Pixels technology
      - Die Cross-Section: Transistor, Metal Layers, Pixels
      - Die Process Characteristic

Physical Comparison 45
  - Infineon 3D ToF Image Sensor
  - STMicroelectronics SPAD technology
  - Texas Instruments OPT8241

Manufacturing Process 51
  - Synthesis of the main parts
  - Image Sensor Die Front-End Process & Fabrication Unit
  - Glass BGA Packaging Process Flow

Cost Analysis 58
  - Synthesis of the cost analysis
  - Yields Explanation & Hypotheses 61
  - Image Sensor die 63
    - Die Front-End Cost
    - Die Wafer Cost
    - Die Cost
  - Packaging 66
    - Packaging Cost
    - Packaging Cost per steps
  - Component Cost 69

Estimated Manufactured Price 71

Company services 75
Executive Summary

This full reverse costing study has been conducted to provide insight on technology data, manufacturing cost and selling price of the Melexis MLX75023.

The MLX75023 is an automotive 3D ToF Sensor already integrated in gesture recognition system from OEMs like BMW.

The 3D ToF sensor is packaged using Glass BGA. The device is an integrated sub-system comprising the die sensor and the glass filter in the same component in a thin packaging (0.7 mm). The sensor is based on CPAD technology from Softkinetic.

In this report, the complete subsystem is analyzed from the glass filter which is a NIR band pass filter to the collector based on the CPAD developed by Softkinetic and improved by Melexis. The report includes a complete cost analysis and price estimation of the device based on a detailed description of the package, and the ToF detector.

It also features a complete technology comparison with the Infineon ToF Image sensor, STMicroelectronics ToF technology and the Texas Instrument Industrial ToF image sensor also based on CPAD technology.
Package View & Dimensions

- Package:
- Dimensions:
- Pin Pitch:

Package Top View – Optical View
©2017 by System Plus Consulting

Package Bottom View – Optical View
©2017 by System Plus Consulting

Package Back View – Side View
©2017 by System Plus Consulting
Image Sensor Die Dimensions

- Die Area:
- Nb of PGDW per wafer:
- Pad number:

Pixel array:
CIS resolution:
- Pixel area:
- Pixel size:

Die Overview – Optical View
©2017 by System Plus Consulting

SAMPLE

PGDW: Potential Good Dies per Wafer
Image Sensor Die – Pixels

Overview / Introduction
Company Profile & Supply Chain
Physical Analysis
  - Synthesis
  - Package
  - Package Opening
  - Package Cross-Section
  - Image Sensor Die
  - Image Sensor Cross-Section
Physical Comparison
Manufacturing Process Flow
Cost Analysis
Selling Price Analysis
Image sensor Die Cross-Section – Pixels

Die Process – Pixels – SEM View
©2017 by System Plus Consulting

Die Cross-Section – NIR CIS – Schematic View
©2017 by System Plus Consulting
Comparison with Infineon CIS

Overview / Introduction

Company Profile & Supply Chain

Physical Analysis

Physical Comparison
- Infineon CIS
- STMicro. SPAD
- TI OPT8241

Manufacturing Process Flow

Cost Analysis

Selling Price Analysis
Global Overview

Overview / Introduction
Company Profile & Supply Chain
Physical Analysis
Physical Comparison
Manufacturing Process Flow
  - Synthesis
    - Front-End Process & Fabrication Unit
    - Packaging Process Flow
Cost Analysis
Selling Price Analysis
## 3D ToF Imager Front-End Cost

<table>
<thead>
<tr>
<th></th>
<th>Low Yield</th>
<th>Medium Yield</th>
<th>High Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
</tr>
<tr>
<td>Raw wafer Cost (Si)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean Room Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumable Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield losses Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CIS Front-End Cost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross margin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masks Set Depreciation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CIS Front-End Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Packaging Cost

<table>
<thead>
<tr>
<th>Package Manufacturing</th>
<th>Low Yield</th>
<th>Medium Yield</th>
<th>High Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
</tr>
<tr>
<td>Glass Wafer Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean Room Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumable Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield losses Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The **Packaging cost** for the ToF ranges from [ ] according to yield variations.

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

<table>
<thead>
<tr>
<th></th>
<th>Low Yield</th>
<th>Medium Yield</th>
<th>High Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reconstituted Wafer Cost</strong></td>
<td>Cost</td>
<td>Breakdown</td>
<td>Cost</td>
</tr>
<tr>
<td>Packaging Manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Wafer Cost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nb of potential dies per wafer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nb of good dies per wafer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CIS Die Price</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaging Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BE : Yield losses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Die Cost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By adding the final test cost, the **Component cost** ranges from [ ] according to yield variations.

- The **CIS die** represents [ ] of the component cost.
- The **packaging** represent [ ] of the component cost.
- **Final test and yield losses** represent [ ] of the component cost.
## Estimated Manufacturer Price

<table>
<thead>
<tr>
<th>Component</th>
<th>Low Yield</th>
<th>Medium Yield</th>
<th>High Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melexis Gross Profit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Component price</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This corresponds to the selling price for large volume to OEMs.