ON Semiconductor FDMS86181
100V 124A PowerTrench Mosfet
Power Semiconductor report by Elena Barbarini
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Executive Summary

This full reverse costing study has been conducted to provide insight on technology data, manufacturing cost and selling price of the **ON Semiconductor FDMS86181 PowerTrench MOSFET**.

The Power Trench 100V MOSFET is the latest MOSFET specifically designed for automotive applications by ON Semiconductor/Fairchild. The FDMS86181 is driving 124A with an Rdson of 4.2 mΩ and a current density of 11.8 A/mm².

The MOSFET is designed with the typical PowerTrench structure of Fairchild where the shield electrode is connected to the source. The shield electrode provides charge balance for drift region. This enables the use of higher doping in the drift region, resulting in reduced drift resistance. Fairchild new medium voltage MOSFETs are optimized to improve the diode characteristics as well as the output capacitance. The specific resistance has been significantly improved while improving the switching characteristic.

Another important innovation is present in the packaging; the Power56 is not yet standard so Fairchild proposes a copper lead frame connection both for the source and the gate.

The two lead frames can be connected to the metal contact with a specific Ni layer deposited during front end process.

Based on a complete teardown analysis, the report also provides an estimation of the production cost of the IGBT, Diode and package.

The report shows the impact of the technical innovations on final MOSFET cost breakdown.
Synthesis of the Physical Analysis

Package Power 56:
- Package size: xxxmm xxxxtmm xxxxmm
- Number of Pins: 8 pin
- Pitch: xxx

MOSFET:
- Dimension: xxxxx=xxx mm2
- Electrical Connection: xxx
  - Leadframe for Source and gate
- Placement in the package: xxxxxx on copper lead frame.
Package characteristics

- The package type is a Power 56
- Package size: xxxmm xxxxmm xxxxmm
- Pin pitch: xxxmm
- The package markings include the following markings:

  - Fairchild logo
  - 0G19AB
  - FOMS
  - 86181
Cross section #3
It is visible, from the specific shape of the packaging, how the upper leadframe has been xxxxxxxx.
Package Cross-Section

Package cross section
MOSFET die Dimensions

- Die dimensions: xxx mm² (xxxxxxx)
- There is no marking on the die.
Die process
Die cross section

- Die thickness: xxxx µm
Die cross section

- Epitaxy thickness: xxx µm
Die cross section

- Al contact thickness: xxx µm
- W contact thickness: xxx µm
- Polyimide thickness: xxx µm
Die cross section

- Ti layer thickness: xxx µm
- Oxyde thickness: xxx µm
Description of the Wafer Fabrication Units - MOSFET

In our calculation, we simulate a production unit using xxxxmm wafers.

MOSFET wafer fab unit:

Name: Fairchild xxxxx
Wafer diameter: xxxxmm
Capacity: xxxx wafers / month
Year of start: xxxx
Most advanced process: Power transistors
Products: Power, transistors, Mosfet, IGBT
Location: xxxxxx

The clean room is supposed not to be totally depreciated in xxxx.
Equipment are supposed not to be totally depreciated in xxxxx.
MOSFET Process Flow

MOSFET Wafer Process:

- The manufacturing of the MOSFET begins with the implantation and the trench etching. Then the oxide layers and the polysilicon are deposited and patterned. Then the tungsten and aluminum layer is deposited. Finally a Ni layer for copper connection is deposited.

- The wafer is thinned to have a final thickness of xxxxµm. The implantation on the backside are performed. Finally, the metal layers on the backside are deposited.

- A polyimide protection layer is deposited on the guard ring and on the gate supply line.
MOSFET Process Flow

Si wafer
- Shield Electrode

Si wafer
- Gate

Si Wafer
- Metal contact

MOSFET Structure Schematic
Description of the Component Packaging Units

The power module packaging Process:
- The package type is a Power 56
- Package size: xxxxmm xxxxxmm xxxxxmm

In our calculation, we simulate an assembly unit using Fairchild plant in xxxx.

Assembly unit:

Name: Fairchild xxxx
Products: Assembly, Test
Location: xxxx

This assembly line has been created in xxxx.

Most of the equipment are certainly fully depreciated.

We estimate that a residual depreciation of 25% is existing on both equipment and clean room to maintain the efficiency of the line.
MOSFET Front-End Cost
## MOSFET Wafer Cost per process steps

<table>
<thead>
<tr>
<th>Process Step</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthesis</td>
<td>100</td>
</tr>
<tr>
<td>Die Cost</td>
<td>200</td>
</tr>
<tr>
<td>Packaging Cost</td>
<td>150</td>
</tr>
<tr>
<td>Component Cost</td>
<td>120</td>
</tr>
<tr>
<td>Cost Evolution</td>
<td>50</td>
</tr>
</tbody>
</table>
The MOSFET Component cost ranges from $xxx to $xxxx according to yield variations.

The Front end manufacturing represents xxx% of the component cost, medium yield.

Probe test, dicing and scrap account for xxxx% of the component cost.
The Component cost ranges from $xxx to $xxx according to yield variations.

The MOSFET die manufacturing represents xxx% of the component cost.

The packaging represents xxxx% of the component cost.

Final test and yield losses account for xxx% of the component cost.
Estimated Manufacturer Price

The component manufacturing cost ranges from $xxx to $xxx according to yield variations.

The component selling price ranges from $xxx to $xxxx according to yield variations.
Related Reports

REVERSE COSTING ANALYSES - SYSTEM PLUS CONSULTING

Power Semiconductors & Compound
- Cree CMF20120 SiC MOSFET
- Rohm SCH2080KE SiC MOSFET with SiC-SBD
- Cree 1200V SiC MOSFET Module
- Rohm 1200V Trench SiC MOSFET
- 1200V SiC MOSFET vs Silicon IGBT: Technology and cost comparison

Si IGBT
- Mitsubishi 6th gen CSTBT 1200V CM450DY-24S IGBT Power Module
- Infineon FS600R07A2E3 HybridPACK2 100KW 3-phase
- Infineon EconoPACK4™ 1200V IGBT4 Module
- Semikron SKiM306GD12E4

MARKET AND TECHNOLOGY REPORTS - YOLE SÉVELOPPEMENT

Power Semiconductors & Compound
- Power MOSFET 2017: Market and Technology Trends
- Power GaN 2016: Epitaxy and Devices, Applications, and Technology Trends
Business Models Fields of Expertise

Custom Analyses
(>130 analyses per year)

Reports
(>40 reports per year)

Costing Tools

Trainings

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Manufacturing Process Flow
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