Industrial Power Module Packaging Comparison 2020

10 Power Modules from Infineon, Mitsubishi, IXYS, Vincotech, ABB, Wolfspeed

SP20474 - POWER SEMICONDUCTOR REPORT by Amine ALLOUCHE
PHYSICAL ANALYSIS by Véronique LE TROADEC
June 2020 – SAMPLE
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- Company profile and products catalog

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- Examples of System Integration of Industrial Power Modules
- Summary of the Physical Analysis

Physical Analysis (Dimension, module opening and package cross-sections) of each module:

  - **Infineon**
    - ✓ EasyPACK™ FSS0R07W1E3_B11A
    - ✓ EconoPACK™ 4 FS100R12PT4
    - ✓ PrimePACK™ 2 FF1200R12IE5

  - **Mitsubishi**
    - ✓ Std Type CM450DY-24S
    - ✓ Six-Pack CM600HG-130H

  - **Vincotech**
    - ✓ flow90PIM 1 V23990-P632-A-PM

  - **IXYS**
    - ✓ E3-Pack MIXG240W1200PZTEH

  - **ABB**
    - ✓ LinPak 5SN 1000X170300

  - **Wolfspeed**
    - ✓ High Performance 62mm CAS325M12HM2
    - ✓ XM3 CAB450M12XM3

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- For each module:
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  - ✓ Packaging Fabrication Unit

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- Summary of the cost analysis
- Yields Explanation & Hypotheses
- For each module:
  - ✓ Package Assembly Cost Per Process Step
  - ✓ Package External Parts Cost
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- Package Cost Comparison breakdown
- Package Cost Comparison per Commutation Cell
- Package Cost Comparison per kVA
- Package Cost Comparison per Surface
- Package Cost Comparison per Volume

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**SystemPlus Consulting Services**
Executive Summary

Power Module packaging currently faces several challenges: from housing aspect till die attach and connections. It must combine good thermal and electrical efficiency while keeping low mass and volume. Also, to remain competitive, power module makers must deliver high reliability while remaining cost efficient.

In this dynamic context of the power modules packaging market, System Plus Consulting provides a deep comparative review of packaging technology and cost, of 10 Industrial Power Modules from the main suppliers on the market: Infineon, Mitsubishi, IXYS, Vincotech, ABB, and Wolfspeed.

System Plus Consulting analyzes the several technologies of packaging to provide an insight on their structure, processes and costs. We look at their external housing (case, cover), baseplate (if present), and their internal structure (substrates, internal assembly of the substrates and of the complete module: dies and substrate attach, connections...). The physical analysis includes optical and SEM images of top and cross-section views. Some EDX material analysis are included as well.

The cost of each power module packaging was detailed: External parts cost (substrates, baseplate, etc.), Assembly cost per process step (substrate assembly and module assembly), with yield losses cost.

The industrial power modules packaging have been compared in terms of: Packaging structure (type of substrate, baseplate, dimensions), assembly (die attach, connections), electrical performances (commutation cells, electric power).

The industrial power modules packaging have been finally compared in terms of packaging cost: cost breakdown, cost per commutation cell, cost per power, cost per package surface, and cost per package volume.
Market Overview – Industrial Package Family By Manufacturer

Overview / Introduction
- Executive Summary
  - Reverse Costing Methodology
  - Glossary

Company Profile & Supply Chain

Physical Analysis

Physical Comparison

Manufacturing Process Flow

Cost Analysis

Cost Comparison

Feedbacks

Related Reports

About System Plus

Non-exhaustive list - Package drawings not to scale
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Examples of System Integration of Industrial Power Modules (1/2)

- In this section we will present two examples of integrating Power Modules in industrial systems.
- This first example shows the integration of xxx the Solar Inverter xxx supplied by xxx.
- The power modules are located in xxx.
Summary of the Physical Analysis

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Module Name</th>
<th>Industrial Application Includes</th>
<th>Package Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infineon</td>
<td>FSP0607-V1.3, D24A</td>
<td></td>
<td>EasyPACK™</td>
</tr>
<tr>
<td>Infineon</td>
<td>FHR6010-1172G</td>
<td></td>
<td>EconoPACK™ 4</td>
</tr>
<tr>
<td>Infineon</td>
<td>FFL200R-1288S</td>
<td></td>
<td>PrimePAK™ 2</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>CUI400V-245</td>
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<td>Std Type</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>CUI400W-1350</td>
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<td>Six-Pack</td>
</tr>
<tr>
<td>Vincotech</td>
<td>VP5930-P532-6-PRM</td>
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<td>Flow90PIM 1</td>
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<tr>
<td>IXYS</td>
<td>M1KX240W1200PF16B</td>
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<td>E3-Pack</td>
</tr>
<tr>
<td>ABB</td>
<td>SW3M333D110200</td>
<td></td>
<td>Lin Pak</td>
</tr>
<tr>
<td>Wolfspeed 8</td>
<td>CAG2Z91H22MV</td>
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<td>High Performance 62mm</td>
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<td>Wolfspeed</td>
<td>CAG2Z91H233B4</td>
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<td>PWM</td>
</tr>
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Manufacturing Process Flow
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EconoPACK™ 4 FS100R12PT4 – Views and Dimensions

Top Side – Optical View
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Bottom Side – Optical View
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EconoPACK™ 4 FS100R12PT4 – Opening (1/2)

[Image of an industrial power module showing various components and labels, such as "Case," "Module Opening – Optical View," etc.]
PrimePACK™ 2 FF1200R12IE5 – Cross-Section

Overview / Introduction
Company Profile & Supply Chain
Physical Analysis
  - Examples of Industrial Power Modules Integration
  - Methodology
  - Summary
  - Infineon
    - EasyPACK™ FS50R07W1E3_B11A
    - EconoPACK™ 4 FS100R12PT4
    - PrimePACK™ 2 FF1200R12IE5
  - Mitsubishi
  - Vincotech
  - IXYS
  - ABB
  - Wolfspeed
Physical Comparison
Manufacturing Process Flow
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Package Cross-section – SEM View
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### Physical Comparison

<table>
<thead>
<tr>
<th>Module Reference</th>
<th>Manufacturer</th>
<th>Package Name</th>
<th>Package</th>
<th>Substrate</th>
<th>Baseplate</th>
<th>Dres attach</th>
<th>Wire bonding</th>
<th>Total no of dies</th>
<th>Commutation cells</th>
<th>Voltage (V)</th>
<th>Nominal Current (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F550R07W1E6-EL1A</td>
<td>Infineon</td>
<td>EasyPACK™</td>
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<td>650</td>
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<td></td>
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<td>1200</td>
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<td>FF1200P12/ES</td>
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<td>Std Type</td>
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<tr>
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<td>MJXG240W1200P2TEH</td>
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<td>1200</td>
<td></td>
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<tr>
<td>CAS325M12HM2</td>
<td>Wolfspeed</td>
<td>High Performance</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>1200</td>
<td>62mm</td>
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<tr>
<td>CAB/50M12XM3</td>
<td>Wolfspeed</td>
<td>XM3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1200</td>
<td></td>
</tr>
</tbody>
</table>
EasyPACK™ FS50R07W1E3_B11A – Assembly Process Flow

Packaging assembly process:

✓ Solder is xxxxxxxx
✓ The dies xxxxx are placed on substrate.
✓ xxx and NTC thermistor are soldered on DBC.
✓ xxx wire bonding between the xxxxxx
✓ Xxxxxxx
✓ xxxxxx
✓ Silicone gel is deposited.
✓ Xxxxxxxxx
✓ xxxxxxxxxx

Module Opening – Optical View
Synthesis of the cost analysis

- The table below summarizes the packaging cost breakdown for each module: External Parts cost, Assembly cost and yield losses cost.
- Infineon has the highest packaging cost.
- Vincotech baseplates.

<table>
<thead>
<tr>
<th>Package Name</th>
<th>Substrates Cost</th>
<th>Baseplate Cost</th>
<th>Remaining external parts Cost</th>
<th>External Parts Total Cost</th>
<th>Assembly Cost</th>
<th>Yield Losses Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>EasyPACK™ FS5D07W1E3_B11A</td>
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<tr>
<td>EconoPACK™ FS100R12PT4</td>
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</tr>
<tr>
<td>PrimePACK™ FF1200R12IES</td>
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</tr>
</tbody>
</table>

Cost Comparison

- Mitsubishi
- Vincotech
- IXYS
- ABB
- Wolfspeed
### EasyPACK™ FS50R07W1E3_B11A – Assembly Cost Per Process Step

<table>
<thead>
<tr>
<th>Process Operation</th>
<th>TOTAL COST</th>
<th>Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODULE ASSEMBLY</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

#### EasyPACK™ FS50R07W1E3_B11A
- EconoPACK™ 4
  - FS100R12PT4
- PrimePACK™ 2
  - FF1200R12IE5

#### Mitsubishi
- Vincotech
- IXYS
- ABB
- Wolfspeed

#### DBC Assembly Cost

**Total (per DBC)**
**EasyPACK™ FS50R07W1E3_B11A – Packaging Total Cost**

**Cost Analysis**
- Cost Analysis Summary
- Yields Explanation & Hypotheses
- Infineon
  - EasyPACK™ FS50R07W1E3_B11A
  - EconoPACK™ 4 FS100R12PT4
  - PrimePACK™ 2 FF1200R122E5
- Mitsubishi
- Vincotech
- IXYS
- ABB
- Wolfspeed

The **packaging cost** of the module is estimated at

The largest portion of the packaging cost is due to the
Cost Comparison – Package Cost Breakdown

In the graph below we compare the packaging cost breakdown of the modules.
Cost Comparison – Package Cost per kVA

- In this graph we compare the cost per kVA for each module. The kVA is the product of the nominal voltage between emitter and collector (Vce) and the nominal collector current (ICN) (1kVA=1000VA).
Related Reports

**POWER**
- Infineon PrimePACK™2 1200V Power Module with IGBT5 and ECS Diode
- Wolfspeed All-SiC Module CAB450M12XM3
- Wolfspeed CAS325M12HM2 All-SiC 1200V Power Module
- ABB LinPak 1700V 2x1000A Power Module
- SiC MOSFET Comparison 2019

**MARKET & TECHNOLOGY REPORTS – YOLE DÉVELOPPEMENT**

Power Electronics
- Status of the Power Module Packaging Industry 2019
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