The most recent market forecast by Yole Développement shows the global rise of power devices. The market for power module devices will follow that trend, with a 10.2% compound annual growth rate (CAGR) over the next five years. This will impact the power module packaging market, which will see a 9.5% CAGR, reaching a value of almost $1.8B.

The progress of electric and hybrid electric vehicles (EV/HEVs) is imposing new standards in terms of electrical equipment, pushing electronic components to work in non-conventional environments for longer. That poses the electronics industry new challenges regarding both performance and reliability. To meet these requirements, electronic systems have to be improved at both design and industrialization levels.

Power modules have come a long way since the early stages of car electrification. They are now playing a key role in the power modulation through all EV/HEVs, from inverters to bi-directional converters. Packaging these modules has become critical due to several technical aspects. They must combine good thermal and electrical efficiency while keeping low mass and volume. Also, to remain competitive in an open market, power module makers must deliver high reliability while remaining cost efficient.

In this report we analyzed the physical composition and cost of ten modules for automotive applications from seven different manufacturers. We reviewed the different topologies and techniques used for the module packaging in such applications. We describe opening the modules, provide measurements and cross-sections, along with scanning electron microscope (SEM) and optical pictures. We analyze and simulate the cost of manufacturing and compare it to a summary panel.

This report includes comparison of the structures and costs of the different technological choices made by key manufacturers of the automotive industry.
TABLE OF CONTENTS

Overview/Introduction

• Executive Summary
• Reverse Costing Methodology
• Analyzed Devices
• Power Module Market

Physical and Manufacturing Cost Analysis

• Bosch
  ✓ Company profile
  ✓ T-PM
• Infineon
  ✓ Company profile
  ✓ HybridPACK 2
  ✓ HybridPACK drive
  ✓ HybridPACK double side cooling
  ✓ CoolIR
• Mitsubishi
  ✓ Company profile
  ✓ J serie T-PM

• Semikron
  ✓ Company profile
  ✓ SKIM
• ST Microelectronics
  ✓ Company profile
  ✓ Tpak
• Toshiba
  ✓ Company profile
  ✓ Case module
• Toyota
  ✓ Company profile
  ✓ Molded DSC

• Module Comparison
• Cost Breakdown
• Cost by Power
• Cost by Switch
• Cost by Surface and Volume

AUTHORS

Farid Hamrani joined System Plus Consulting in 2016 as a system cost engineer. He’s in charge of systems reverse cost analysis with a focus on embedded systems. He previously worked in the high-reliability packaging field. Farid holds a master degree in microelectronics and material from the University of Nantes.

Yvon Le Goff has joined System Plus Consulting in 2011, in order to setup the laboratory of System Plus Consulting. He previously worked during 25 years in Atmel Nantes Technological Analysis Laboratory as fab support in physical analysis, and 3 years at Hirex Engineering in Toulouse, in a DPA lab.

Véronique Le Troadec has joined System Plus Consulting as a laboratory engineer. Coming from Atmel Nantes, she has extensive knowledge in failure analysis of components and in deprocessing of integrated circuits.

RELATED REPORTS

Tesla Model 3 Inverter with SiC Power Module from STMicroelectronics
The first SiC power module in commercialized electric vehicles.
June 2018 - EUR 3,490*

Infineon FF400R07A01E3 Double Side Cooled IGBT Module
Discover Infineon’s first double sided cooling power module for automotive.
January 2018 - EUR 3,490*

Infineon FS820R08A6P2B HybridPACK Drive IGBT Module
The newest HybridPACK Drive power module from Infineon with EDT2 IGBT technology.
June 2017 - EUR 3,490*
WHAT IS A REVERSE COSTING®?

Reverse Costing® is the process of disassembling a device (or a system) in order to identify its technology and calculate its manufacturing cost, using in-house models and tools.

SYSTEM PLUS CONSULTING

System Plus Consulting is specialized in the cost analysis of electronics from semiconductor devices to electronic systems.

A complete range of services and costing tools to provide in-depth production cost studies and to estimate the objective selling price of a product is available.

Our services:
- STRUCTURE & PROCESS ANALYSES
- CUSTOM ANALYSES
- COSTING SERVICES
- COSTING TOOLS
- TRAININGS

www.systemplus.fr
sales@systemplus.fr
ORDER FORM

Please process my order for “Automotive Power Module Packaging Comparison 2018” Reverse Costing® – Structure, Process & Cost Report
Ref: SP18399

☐ Full Structure, Process & Cost Report : EUR 4,490*
☐ Annual Subscription offers possible from 3 reports, including this report as the first of the year. Contact us for more information.

SHIP TO
Name (Mr/Ms/Dr/Pr): .............................................................
Job Title: .............................................................................
Company: ............................................................................
Address: ............................................................................
City: ................................................................................. State: ........................................
Postcode/Zip: ........................................................................
Country: .............................................................................
VAT ID Number for EU members: ........................................
Tel: .....................................................................................
Email: ..................................................................................
Date: ...................................................................................
Signature: ............................................................................

BILLING CONTACT
First Name : ...........................................................................
Last Name: ...........................................................................
Email: ..................................................................................
Phone: ...................................................................................

PAYMENT
By credit card:
Number: |__|__|__|__|  |__|__|__|__|  |__|__|__|__|  |__|__|__|__|
Expiration date: |__|__|/|__|__|
Card Verification Value: |__|__|__|

By bank transfer:
HSBC - CAE - Le Terminal -2 rue du Charron - 44800 St Herblain France
BIC code: CCFRFRPP
- In EUR
  Bank code : 30056 - Branch code : 00955 - Account : 09550003234
  IBAN: FR76 3005 6009 5509 5500 0323 439
- In USD
  Bank code : 30056 - Branch code : 00955 - Account : 09550003247
  IBAN: FR76 3005 6009 5509 5500 0324 797

*For price in dollars please use the day’s exchange rate
*All reports are delivered electronically in pdf format
*For French customer, add 20 % for VAT
*Our prices are subject to change. Please check our new releases and price changes on www.systemplus.fr. The present document is valid 6 months after its publishing date: July 2018

ANNUAL SUBSCRIPTIONS

Each year System Plus Consulting releases a comprehensive collection of new reverse engineering and costing analyses in various domains. You can choose to buy over 12 months a set of 3, 4, 5, 7, 10 or 15 Reverse Costing® reports.

Up to 47% discount!

More than 60 reports released each year on the following topics (considered for 2018):
- Power: GaN - IGBT - MOSFET - Si Diode - SiC
- Imaging: Camera - Spectrometer
- LED and Laser: UV LED - VCSEL - White/blue LED
- Packaging: 3D Packaging - Embedded - SIP - WLP
- Integrated Circuits: IPD – Memories – PMIC – SoC
- RF: FEM - Duplexer
- Systems: Automotive - Consumer - Energy - Telecom
1. INTRODUCTION
The present terms and conditions apply to the offers, sales and deliveries of services managed by System Plus Consulting except in the case of a particular written agreement. Buyer must note that placing an order means an agreement without any restriction with these terms and conditions.

2. PRICES
Prices of the purchased services are those which are in force on the date the order is placed. Prices are in Euros and worked out without taxes. Consequently, the taxes and possible added costs agreed when the order is placed will be charged on these initial prices.

System Plus Consulting may change its prices whenever the company thinks it necessary. However, the company commits itself in invoicing at the prices in force on the date the order is placed.

3. REBATES and DISCOUNTS
The quoted prices already include the rebates and discounts that System Plus Consulting could have granted according to the number of orders placed by the Buyer, or other specific conditions. No discount is granted in case of early payment.

4. TERMS OF PAYMENT
System Plus Consulting delivered services are to be paid within 30 days end of month by bank transfer except in the case of a particular written agreement.

If the payment does not reach System Plus Consulting on the deadline, the Buyer has to pay System Plus Consulting a penalty for late payment the amount of which is three times the legal interest rate. The legal interest rate is the current one on the delivery date. This penalty is worked out on the unpaid invoice amount, starting from the invoice deadline. This penalty is sent without previous notice.

When payment terms are over 30 days end of month, the Buyer has to pay a deposit which amount is 10% of the total invoice amount when placing his order.

5. OWNERSHIP
System Plus Consulting remains sole owner of the delivered services until total payment of the invoice.

6. DELIVERIES
The delivery schedule on the purchase order is given for information only and cannot be strictly guaranteed. Consequently any reasonable delay in the delivery of services will not allow the buyer to claim for damages or to cancel the order.

7. ENTRUSTED GOODS SHIPMENT
The transport costs and risks are fully born by the Buyer. Should the customer wish to ensure the goods against lost or damage on the base of their real value, he must imperatively point it out to System Plus Consulting when the shipment takes place. Without any specific requirement, insurance terms for the return of goods will be the carrier current ones (reimbursement based on good weight instead of the real value).

8. FORCE MAJEURE
System Plus Consulting responsibility will not be involved in non execution or late delivery of one of its duties described in the current terms and conditions if these are the result of a force majeure case. Therefore, the force majeure includes all external event unpredictable and irresistible as defined by the article 1148 of the French Code Civil?

9. CONFIDENTIALITY
As a rule, all information handed by customers to system Plus Consulting are considered as strictly confidential.
A non-disclosure agreement can be signed on demand.

10. RESPONSIBILITY LIMITATION
The Buyer is responsible for the use and interpretations he makes of the reports delivered by System Plus Consulting. Consequently, System Plus Consulting responsibility can in no case be called into question for any direct or indirect damage, financial or otherwise, that may result from the use of the results of our analysis or results obtained using one of our costing tools.

11. APPLICABLE LAW
Any dispute that may arise about the interpretation or execution of the current terms and conditions shall be resolved applying the French law.
It the dispute cannot be settled out-of-court, the competent Court will be the Tribunal de Commerce de Nantes.