

# Infineon FF400R07A01E3 Double Side Cooled IGBT Module

## Discover Infineon's first double sided cooling power module for automotive



Pushed by aggressive legislation, CO2 emission reduction is one of the key challenges in the 21st century. Therefore, carmakers need to develop cleaner vehicles. To achieve these ambitious targets, the best solution currently available is the electrification of vehicles, with different levels of electrification depending on the strategies of different car manufacturers. The full hybrid electric vehicle (HEV) segment will drive the IGBT power module market in the automotive industry, with IGBT power modules used for electric vehicles and hybrid electric vehicles (EV/HEV), competing with superjunction (SJ) MOSFETs. The IGBT market for EV/HEV reached \$845M in 2016, making it the biggest IGBT market by value. However the market for IGBTs in the EV/HEV sector is expected to be worth almost \$2.1B by 2022, representing over 41% of the whole IGBT market's value.

In a compact car the maximum power of the motor is 60kW, while the hybrid systems used in medium and large vehicles have inverter power exceeding 160kW. But when converting an existing petrol vehicle to a hybrid version, the available space in the engine compartment is often so limited that it is difficult to accommodate a Power Control Unit (PCU). Thus, it is necessary that the PCU, which controls the traction motors of HEVs, get smaller, with higher power density.

To achieve these targets, manufacturers have developed different solutions, such as reducing wire bonding or using a double-sided cooling (DSC) structure to efficiently cool the power semiconductor chips.

The HybridPACK Double Sided Cooled (DSC) power module is the first DSC IGBT module from Infineon specifically designed for automotive inverters. The FF400R07A01E3 drives 700A and uses a molded structure optimized for cooling, thus improving its thermal cycling capability and extending the lifetime of the power module.

The terminals are connected directly on the DBC with wire bonding and the dies are dissipated on the front side by alloy spacers.

The IGBT is manufactured with the standard TrenchStop technology design, which reduces losses in conduction and switching. The module uses an EMCON PN diode.

Based on a complete teardown analysis, the report also provides an estimation of the production cost of the IGBT, diode and package. The report also contains a technical and cost comparison between Infineon's design and the Toyota Prius inverter's DSC power module. It highlights the differences in design of the packaging and the material solutions adopted by the two companies.

**Title:** Infineon FF400R07A01E3 Double Side Cooled IGBT Module

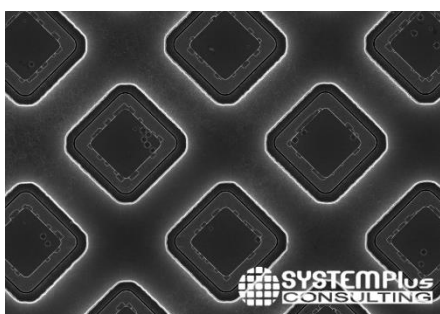
**Pages:** 115

**Date:** January 2018

**Format:** PDF & Excel file

### COMPLETE TEARDOWN WITH:

- Detailed photos
- Precise measurements
- Material analysis
- Manufacturing process flow
- Supply chain evaluation
- Manufacturing cost analysis
- Selling price estimation
- Comparison with Toyota Prius power module



## TABLE OF CONTENTS

### Overview/Introduction

- Executive Summary
- Reverse Costing Methodology

### Company Profile

- Infineon

### Physical Analysis

- Overview of the Physical Analysis
- Package Analysis
  - ✓ Package opening and cross-section
- IGBT Die
  - ✓ IGBT die view and dimensions, process, cross-section and process characteristic
- Diode Die
  - ✓ Diode die view and dimensions, process, cross-section and process characteristic

### Manufacturing Process

- IGBT die front-end process
- IGBT die fabrication unit
- Diode die front-end process
- Diode die fabrication unit
- Final test and packaging fabrication unit

### Cost Analysis

- Overview of the Cost Analysis
- Yield Explanations and Hypotheses
- IGBT Die
  - ✓ IGBT die front-end cost
  - ✓ IGBT die probe test, thinning and dicing
  - ✓ IGBT die wafer cost
  - ✓ IGBT die cost
- Diode Die
  - ✓ Diode die front-end cost
  - ✓ Diode die probe test, thinning and dicing
  - ✓ Diode die wafer cost
  - ✓ Diode die cost
- Complete Device
  - ✓ Packaging cost
  - ✓ Final test cost
  - ✓ Component cost

### Price Analysis

- Overview of the Cost

### Comparison

- Comparison with Toyota Prius Power Module

### AUTHORS:



**Elena Barbarini**

Elena is in charge of costing analyses for Power Electronics and Compound Semiconductors. She has a deep knowledge of Electronics R&D and Manufacturing environment. Elena holds a Master in Nanotechnologies and a PhD in Power Electronics.



**Véronique Le Troadec (Lab)**

Véronique is in charge of structure analysis of semi-conductors. She has deep knowledge of chemical and physical technical analyses. She previously worked for 20 years at Atmel's Nantes Laboratory.

## ANALYSIS PERFORMED WITH OUR COSTING TOOLS POWER COSIM+ AND POWER PRICE+

	Process-Based Costing Tools	Parametric Costing Tools
Integrated Circuits		IC Price+
MEMS	MEMS CoSim+	MEMS Price+
Power Devices & Modules	<b>Power CoSim+</b>	<b>Power Price+</b>
LEDs	LED CoSim+	
Advanced Packaging	3D-Package CoSim+	
Electronic Boards Substrates		PCB Price+
Electronic Systems	SYScost+	
Displays		Display Price+

System Plus Consulting offers powerful costing tools to evaluate the production cost & selling price from single chip to complex structures.

**POWER CoSim+** is a process based costing tool used to evaluate the manufacturing cost per wafer using your own inputs or using the pre-defined parameters included in the tool.

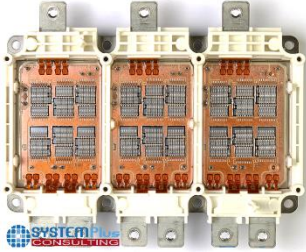
**POWER Price+** is a parametric costing tool used to evaluate the manufacturing cost of devices using few process related inputs.

Performed by

## RELATED REPORTS

### Infineon FS820R08A6P2B HybridPACK Drive IGBT Module

The newest HybridPACK Drive power module from Infineon with EDT2 IGBT technology. The HybridPACK Drive power module is the latest power packaging specifically designed for automotive applications.



Pages: 90  
Date: April 2017

### Toyota Prius 4 PCU Power Modules

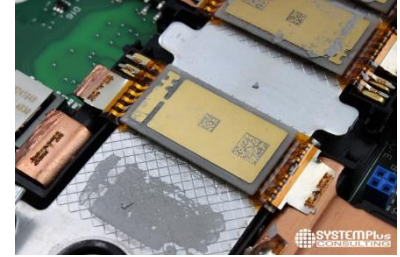
They integrate IGBT and free-wheeling diodes onto innovative double side cooling packaging for hybrid electric vehicles, allowing better thermal dissipation, modularity and scalability of the system.



Pages: 135  
Date: September 2016

### Infineon CooliR<sup>2</sup>Die™ Power Module

Infineon power module integrating an IGBT and diode into innovative packaging for electric vehicles. The innovative packaging shrinks the power module and enables better thermal dissipation.



Pages: 80  
Date: September 2016

## ANNUAL SUBSCRIPTION OFFER

Each year System Plus Consulting releases a comprehensive collection of new reverse engineering & 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):

- MEMS & Sensors:  
*Accelerometer - Environment - Fingerprint - Gas - Gyroscope - IMU/Combo - Microphone - Optics - Oscillator - Pressure*
- Power:  
*GaN - IGBT - MOSFET - Si Diode - SiC*
- Imaging: *Camera - Spectrometer*
- LED & 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*

# ORDER FORM

Please process my order for "Infineon FF400R07A01E3 Double Side Cooled IGBT" Report

Ref.: SP18375

\*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](http://www.systemplus.fr). The present document is valid 6 months after its publishing date: January 2018

## 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:.....

## ABOUT 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:

**TECHNOLOGY ANALYSIS - COSTING SERVICES - COSTING TOOLS - TRAININGS**

[www.systemplus.fr](http://www.systemplus.fr) - [sales@systemplus.fr](mailto:sales@systemplus.fr)

## PAYMENT

**DELIVERY on receipt of 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

### Return order by:

FAX: +33 2 53 55 10 59  
MAIL: SYSTEM PLUS CONSULTING  
21 rue La Nouë Bras de Fer  
44200 Nantes – France

### Contact:

EMAIL: [sales@systemplus.fr](mailto:sales@systemplus.fr)  
TEL: +33 2 40 18 09 16

# TERMS AND CONDITIONS OF SALES

## 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. RESPONSABILITY 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.

If the dispute cannot be settled out-of-court, the competent Court will be the Tribunal de Commerce de Nantes.