

# Vincotech Power Module for Solar inverter Infineon IGBT3

Reverse Costing Analysis by System Plus Consulting  
November 2009

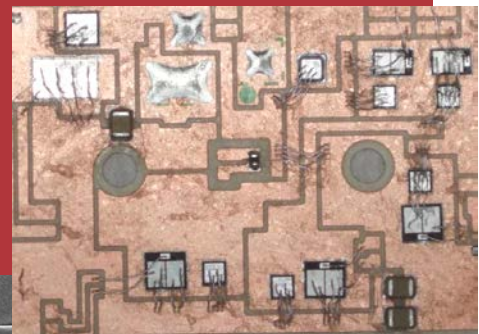
- Analyze the cost of projects at the R&D level
- Enhance the negotiation power of purchasing managers
- Benchmark competitor's products

System Plus Consulting is proud to publish the reverse costing report of the power module supplied by Vincotech for solar inverters. Five IGBT3 transistors are assembled in the power module. Based on a complete teardown process, the report provides an estimation of the production cost as well as the selling price of the power module and IGBT3 transistors.

This Vincotech power module is used to convert direct current (DC) from solar panels to alternating current (AC). This module is installed in the solar inverter Sunny Boy 3000TL from SMA. The power module integrates a H-bridge and a boost circuit (Transistors + diodes). The Power module holds 6 IGBTs and 7 diodes. 5 IGBTs are manufactured with IGBT3 technology from Infineon.

This report provides complete teardown and cost estimation of the product with :

- Detailed teardown photos
- Material analysis
- IGBT3 physical analysis
- Schematic assembly description
- Manufacturing Process Flow
- In-depth economical analysis
- Manufacturing cost breakdown
- Selling price estimation



# Vincotech Power Module – Solar inverter

## Infineon IGBT3

### Reverse Costing Analysis

by System Plus Consulting

## TABLE OF CONTENTS 1/2

### Ceramic power module

Miniskip package  
Connect the power transistors and the Main board with these press-in contacts

The IGBTs are assembled on a ceramic board. The board is directly mounted on a radiator, here the carter of the solar inverter.

The dies are protected from moisture by a silicone gel. The mechanical protection and the electrical contacts are realized by the Miniskip package.

The power transistors are assembled as bare dies

The transistors are protected by a silicone gel

### Simplified Block Diagram

Input capacitor, Boost circuit, H bridge, Smoothing Inductor, Solar panel DC current, Grid AC current, Ceramic power board

The ceramic power board integrates a H bridge with the 4 IGBTs and their free wheel diodes and a boost circuit. The magnetic components and the input capacitor are assembled directly in the solar inverter.

Vincotech is a specialist of electronic power systems. It designs and manufactures several inverter ranges which are optimized for solar inverters. It manufactures a standard

### Trench IGBT

The aluminum metal layer is the IGBT source. The source covers the whole area except the pads for the gate.

We measure a pitch of 13µm between two gates.

13µm, 6.15µm, 5.5µm, Oxide, Gate oxide, Poly-silicon filled trench, The silicon is recessed in contact area

### Wafer section

85µm, N-drift region, 75µm, wafer, P+ cathode layer 2µm, Metal backside 0.67µm

The thickness of the N drift region (85µm) allows to accept a 600V voltage. It is a characteristic value, 100V for 10µm.

The border of P+ doped layer is visible on the photo.

**Overview / Introduction** p3

- Executive Summary
- The Course of the Analysis

**Power Module Physical Analysis** p7

- Simplified Block Diagram
- Sunny Boy Disassembly
- Ceramic Power Module
- Ceramic Board
- Sunny Boy 3000TL, 4000TL and 5000TL Family
- Transistors Physical Analysis

**Transistor 1 & 2 Physical Analysis** p15

- Die Dimensions and pads – Transistor 1
- Die Dimensions and pads – Transistor 2
- Guard Ring
- Trench IGBT
- Wafer
- Well Thickness
- Synthesis : IGBT Structure

**Transistor 1 & 2 Process Flow** p25

- Front Side
- Back Side
- Wafer Fabrication Unit

**Transistor 1 & 2 Cost** p29

- Wafer Cost Data
- Wafer Cost
- Probe Yield
- Component Manufacturing Cost
- Selling Price – Transistors 1 & 2

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### Reverse Costing Analysis

by System Plus Consulting

## TABLE OF CONTENTS 2/2

### Boost Transistor

p41

- Die Dimension and Pads- Boost Transistor
- Wafer Technology
- Component Manufacturing Cost

### BOM Cost

p44

- Assessing the BOM
- Estimation of the Cost of the Ceramic board
- Ceramic Power Board
- Material Cost Breakdown

### Added Value Cost

p47

- Assessing the Added Value (AV) cost
- Assessing the Added Value (AV) cost
- Ceramic Board manufacturing flow
- Ceramic Board Hourly rates and cadencies
- Details of the Ceramic board AV Cost

### Estimation of the selling price

p52

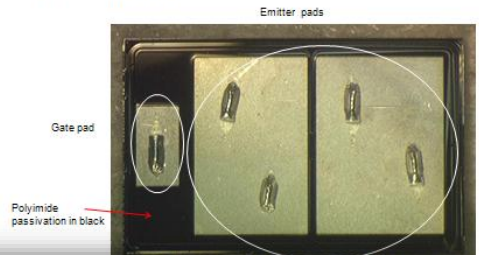
- Selling Price Hypothesis
- Estimation of the Selling Price

### Conclusion

p54

#### Die Dimensions and Pads – Transistor 1

- Die size : 6.5mm x 4.3mm = 27.95mm<sup>2</sup>
- Die thickness : 75µm
- The pads are in Aluminium
- The die is protected by a polyimide film.



#### Details of the Ceramic Board AV Cost

Operation	Unit	Time	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost	Rate	Cost
Manufacturing	1.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Scrap	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Material	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Assembly	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Storage	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Transportation	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Inventory	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Quality	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Waste	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Energy	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Water	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CO2	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Board production time	0.0000	0.0000	0.0000	0.0000	100.00%	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The total Manufacturing and Test time is close to 100 seconds.  
 The assembly is assumed to be done in Hungary and its cost is \$1.23  
 • Labor Cost : Direct Labor or Operators and line Technicians, which equals to 99.21, 99% of the Added Value.  
 • Indirect Labor : Line Managers and Engineers which equal to 0.02, 0.8% of the Added Value  
 • Equipment Cost : Equipment, consumables, floor space and energy which equals to 0.01, 0.8% of the Added Value.  
 The total cost takes into account a cumulative yield of 95%, with none rejected items.

#### Estimation of the selling price

Manufacturing Location	Price			G&A			Floor Price			Manufacturer Price		
	Unit	Rate	Cost	Unit	Rate	Cost	Unit	Rate	Cost	Unit	Rate	Cost
Hungary	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	0.0000

The Power Ceramic Board is manufactured by Vincotech in their Hungarian facility.  
 The bill of material (BOM) cost is \$18.79 for the Inverter. To this, we must add some scrap cost (\$0.19) and component supplying costs (\$1.23) to obtain the total material cost (\$20.20). The assembly cost is \$1.23, so the manufacturing cost is \$21.43 (\$18.99).  
 With estimated costs of R&D (\$2.26), G&A (\$2.54) and Profit (\$1.97), the average selling price can be estimated at \$28.19 (\$26.74) when using the estimated economic parameters of Vincotech.

#### Supply Chain Analysis

- Freescale is an IDM company which manufacture and assemble the dies.
- Two prices are calculated with our pricing models:
  - The Floor Price corresponds to a selling price with no margin, only R&D and G&A.
  - The Manufacturer Price corresponds to a selling price with a nominal margin.



Note: Taxes and delivery costs are not taken into account in this analysis

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