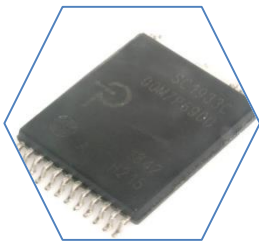




GaN-on-Sapphire HEMT Power IC by Power Integrations

The unique device with GaN-on-Sapphire technology in the Anker's PowerPort Atom PD 1 wall charger.



After long expectation, the first GaN-on-Sapphire die has been integrated in a commercially available device!

In this report, System Plus Consulting unveils Power Integrations' technical choices; from the device design up to the packaging.

The first GaN on Sapphire based Power IC die has been found in the Wall-Charger PowerPort Atom PD1: A2017, from Anker. The die is co-packaged with three ICs constituting primary-side and secondary-side controllers, in the device SC1933C.

To our great surprise, the power GaN HEMT was processed on a sapphire substrate which is a major breakthrough that we did not observe before in other power GaN HEMTs. The latter being generally processed on Silicon substrates.

In this report, System Plus Consulting presents a deep teardown analysis of the SC1933C. Detailed optical and SEM pictures and cross-sections with EDX analysis are included to reveal Power Integrations' technical choices till the microscopic level of the ICs and HEMT's designs.

The report provides an estimation of the production costs of the ICs, the HEMT and the package as well as the estimated selling price of the component.

Finally, the report shows a comparison with the GaN-on-Si HEMT from Navitas. This comparison highlights the differences in GaN dies' design and manufacturing costs.

A system-oriented analysis of the PowerPort Atom PD1: A2017 from Anker, can be found in our report "GaN Chargers Comparison"; a report which focus on the impact of the GaN dies adoption in the latest wall chargers design and performances.

COMPLETE TEARDOWN WITH

- Detailed optical and SEM photos
- Precise measurements
- Materials EDX analysis
- Supply chain evaluation
- Manufacturing cost analysis
- Estimated selling price
- Technology and cost comparisons with GaN-on-Si HEMT from Navitas.

Title: GaN-on-Sapphire HEMT Power IC by Power Integrations

Pages: 156

Date: July 2019

Format: PDF & Excel file

TABLE OF CONTENTS

Overview/Introduction

- Executive Summary
- Market
- Reverse Costing Methodology

Company Profile

- Power Integrations

Physical Analysis

- Summary of the Physical Analysis
- Power IC in Wall-Charger Anker PowerPort Atom PD 1
- Package Analysis
 - Package opening, package cross-sections
- HEMT Die
 - HEMT die view and dimensions
 - HEMT die process, cross-section, and process characteristics
- Primary and Secondary Control ICs
 - IC die views and dimensions
 - IC die processes, cross-sections, process characteristics

Manufacturing Process

- HEMT Die Front-End Process and Fabrication Unit
- IC Die Front-End Processes and Fabrication Units
- Packaging Process Flow

Cost Analysis

- Summary of the Cost Analysis
- Yield Explanations and Hypotheses
- HEMT Die
 - HEMT wafer front-end cost and front-end cost per process step.
 - HEMT back-end cost: Die probe test, thinning and dicing
 - HEMT die cost
- IC dies
 - IC front-end cost
 - IC back-end cost : Die probe test, thinning and dicing
 - IC die cost
- Packaging Assembly Cost
- Component Cost
 - Back-end: Final test cost
 - Component cost

Price Analysis

- Definition of Prices
- Estimation of Selling Price

Price Analysis

- Technology and Cost Comparison Between Power Integrations and Navitas GaN HEMT Dies

AUTHORS



Amine Allouche is part of System Plus Consulting's Power Electronics and Compound Semiconductors team. Amine holds a Master's degree focused on Micro and Nano-technologies for integrated Systems.



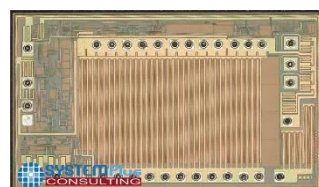
Véronique Le Troadec has joined System Plus Consulting as a laboratory engineer. She holds a Master degree in Micro-electronics from the University of Nantes.

RELATED REPORTS



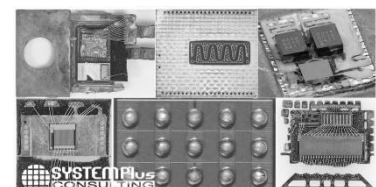
GaN-Based Wall Charger Comparison 2019

The first wall-chargers based on GaN technology from RAVPower, Aukey, Made in Mind, and Anker.
July 2019



Navitas 650V GaNFast Power IC Family

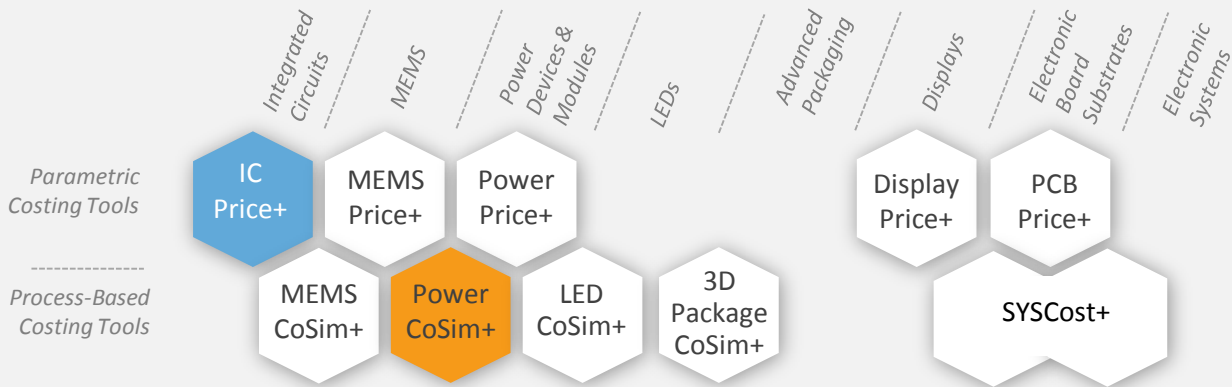
The first GaN monolithic devices from Navitas for fast charging.
May 2019



GaN-on-Silicon Transistor Comparison 2018

Dive deep into the technology and cost of GaN-on-silicon HEMTs from EPC, Transphorm, GaN Systems, Panasonic and Texas Instruments.
April 2018

COSTING TOOLS



Our analysis is performed with our costing tools Power CoSim+ and IC Price+.

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

IC Price+

The tool performs the necessary cost simulation of any Integrated Circuit: ASICs, microcontrollers, memories, DSP, smartpower...

Power CoSim+

Cost simulation tool to evaluate the cost of any Power Electronics process or device: from single chip to complex structures.

ABOUT SYSTEM PLUS CONSULTING

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.



CONTACTS

Headquarters

22, bd Benoni Goullin
Nantes Biotech
44200 Nantes
France
+33 2 40 18 09 16
sales@systemplus.fr

Europe Sales Office

Lizzie LEVENEZ
Frankfurt am Main
Germany
+49 151 23 54 41 82
llevenez@systemplus.fr

America Sales Office

Steven LAFERRIERE
Western USA & Canada
+1 310-600-8267
laferriere@yole.fr

Chris YOUMAN
Eastern USA & Canada
+1 919-607-9839
chris.youman@yole.fr

Asia Sales Office

Takashi ONOZAWA
Japan & Rest of Asia
+81 80 4371 4887
onozawa@yole.fr

Mavis WANG
Greater China
+886 979 336 809
wang@yole.fr

Peter OK
Korea
+82 10 4089 0233
peter.ok@yole.fr

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
- TEARDOWNS
- CUSTOM ANALYSES
- COSTING SERVICES
- COSTING TOOLS
- TRAININGS

www.systemplus.fr
sales@systemplus.fr

ORDER FORM

Please process my order for “GaN-on-Sapphire HEMT Power IC by Power Integrations” Reverse Costing® – Structure, Process & Cost Report

Ref: SP19480

- Full Structure, Process & Cost Report
- 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

Return order by:

FAX: +33 2 53 55 10 59

MAIL: SYSTEM PLUS CONSULTING

22, bd Benoni Goullin

Nantes Biotech

44200 Nantes – France

EMAIL: sales@systemplus.fr

**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 2019

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):

- **MEMS & Sensors:** Accelerometer – Environment - Fingerprint - Gas - Gyroscope - IMU/Combo - Microphone - Optics - Oscillator - Pressure
- **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

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.