



HAL
open science

Test and Dependability of Microsystems

Serge Bernard, Philippe Cauvet

► **To cite this version:**

Serge Bernard, Philippe Cauvet. Test and Dependability of Microsystems. DTC'10: European Nanoelectronics Design Technology Conference, Jun 2010, grenoble, France. pp.210-216. lirmm-00506495

HAL Id: lirmm-00506495

<https://hal-lirmm.ccsd.cnrs.fr/lirmm-00506495>

Submitted on 28 Jul 2010

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Tutorial DTC 2010

Test and Dependability of
Microsystems

LIRMM
Serge
BERNARD

2010, June 22nd

ophthalmia
Philippe
CAUVET

Outline

- Introduction
- Implications for Integrated Systems
- Test Challenges
- Some Test Solutions
- From Test to Dependability
- Conclusion

2

Introduction

TOETS Project: Towards One European Test Solution application, chip and transistor levels
NXP, ST, INFINEON, PHILIPS, Q-STAR, D4T, TEMETO, ATMEL, E2V, JTAG, CEA, TIMA, UT...

- **LIRMM (Laboratoire d'Informatique Robotique Microélectronique de Montpellier)**: cross-faculty research entity CNRS-UM2. 350 people, including 160 researchers, 150 PhD students.
- **Ophthalmia**: SME, development, fabrication, and sales of innovative electronic solutions dedicated to diagnostics and treatment of eye pathologies, and to measuring *intra-body* physiological parameters

3

Introduction

Context

- More functionalities
- Shorter time to market
- Higher quality

4

Outline

- Introduction
- Implications for Integrated Systems
- Test Challenges
- Some Test Solutions
- From Test to Dependability
- Conclusion

5

Implications for Integrated Systems

Complexity: "More Moore"

ASIC
"Function on Chip"
+ VHDL
+ System C
+ Mask

Complexity: "More Moore"
RAM/ROM, Logic, IP, μC, DSP

SoC (System on Chip): combinations of IPs into an integrated circuit

6

Implications for Integrated Systems

Complexity and Heterogeneous: "More than Moore"

Bare dies

SiP

SiP (System in Package): any combination of semiconductors, passives, and interconnects into a single package

7

Implications for Integrated Systems

Complex and Heterogeneous: Several MS/RF blocks

Set-top box (PNX8327)
2 ADC, 6 DAC, TX/Rx

- Video decoder: 12 ADC, 2 DAC, ...
- Cell phone: GSM +TVoM+ WiFi+ Bluetooth+ GPS= 5 transceivers or Rx

8

Implications for Integrated Systems

Complex and Heterogeneous: Packaging and 3D

Integration Trend

- Discretes Solutions
- MCM Solutions
- Laminate + SMDs Solutions
- Laminate + SMDs + Passive die
- Double Flip Chip assembly
- Wafer Level Packaging
- 3D WLP SiPs

Legend:
 Active Die
 Passive/Interconnect die
 SMDs / Components

9

Implications for Integrated Systems

High Performances: Software Radio Example

10

Implications for Integrated Systems

Low Yield

High Performances + Short Time to Market

Tight Design Margin

11

Implications for Integrated Systems

Low Yield

High Performances + Short Time to Market + **high Quality**

Tight Design Margin

12

ATRENE **TOETS**

Outline

- Introduction
- Implications for Integrated Systems
- Test Challenges
- Some Test Solutions
- From Test to Dependability
- Conclusion

13

ATRENE **TOETS**

Test Challenges

Test vs. Manufacturing Costs

Price of the Chip

100%

50%

0%

2010 2020

Cost for Design and Manufacturing

Test Cost

14

ATRENE **TOETS**

Test Challenges

Complexity, Heterogeneous, Performances

2005 2010 2015 2020

- Expensive Test equipment
 - ATE : 1M\$
 - MS/RF option: 300k\$
- Long testing time

Test Challenges

- Test equipment
- Test time

15

ATRENE **TOETS**

Test Challenges

Complexity, Heterogeneous, Performances

2005 2010 2015 2020

- Access
 - Few primary I/O
 - Complex system
 - Signal Integrity

Test Challenges

- Test equipment
- Test time
- Test access

16

ATRENE **TOETS**

Test Challenges

[NXP Semiconductors]

SIP wafer

SIP

- Acceptable Yield
 - Known Good Die
- Recursive test
 - Missing dies
 - Scrubbing effect

Test Challenges

- Test equipment
- Test time
- Test access
- KGD
- Recursive test

17

ATRENE **TOETS**

Outline

- Introduction
- Implications for Integrated Systems
- Test Challenges
- Some Test Solutions
- From Test to Dependability
- Conclusion

18

Test solutions

Access + Recursive Test → Sip-TAP

Solution for end-user: SIP-TAP
Fide Jang, A. Biewenga ITC 2006

Star Configuration (Intermediate Test) Ring Configuration (End-user test)

19

Test solutions

Recursive Test → Wireless Test

ATE Wafer under tested

- A tester with a radio interface
- Integrating a "wireless module" in each DUT

20

Test solutions

Equipment + Time + Access → Built-in-Self Test

- Low-cost (no?) Test Equipment
- At Speed Test
- Up-to-date Technology

21

Test solutions

Equipment + Time + Access → Indirect Test

"Classical" "Indirect"

DUT#100 Spec1 Spec2 Spec3

22 [azal906]

Test solutions

Equipment + Time + Access → Loopback Test 1/2

- Low-cost Test Equipment
- Test simulation
- Easier BIST implementation
- Close to the application conditions

23

Test solutions

Equipment + Time + Access → Loopback Test 2/2

Using DSP-based methods / algorithms, the contribution of the non-linearity of each converter is discriminated.
 The converters may be re-used as embedded instruments in the loop!

24

ATRENE **TOETS**

Outline

- Introduction
- Implications for Integrated Systems
- Test Challenges
- Some Test Solutions
- From Test to Dependability
- Conclusion

25

ATRENE **TOETS**

From Test to Dependability

From production test to in situ repair

26

ATRENE **TOETS**

From Test to Dependability

General concepts 1/2

- **Dependability:** "a measure of the degree to which an item is operable and capable of performing its required function throughout the lifespan of the contract"

| | | |
|---------------|------------|--|
| DEPENDABILITY | ATTRIBUTES | <ul style="list-style-type: none"> AVAILABILITY RELIABILITY SAFETY CONFIDENTIALITY INTEGRITY MAINTAINABILITY |
| | MEANS | <ul style="list-style-type: none"> FAULT PREVENTION FAULT TOLERANCE FAULT REMOVAL FAULT FORECASTING |
| | THREATS | <ul style="list-style-type: none"> FAULTS ERRORS FAILURES |

27

ATRENE **TOETS**

From Test to Dependability

General concepts 2/2

- **Correct service:** when the service implements the system function
- **Failure:** an event that occurs when the delivered service deviates from correct service
- **Error:** part of the system state that may cause a subsequent failure
- **Fault:** adjudged or hypothesized cause of an error

28

ATRENE **TOETS**

From Test to Dependability

How to attain dependability?

By...

- Fault prevention: design and manufacturing
- Fault tolerance: **error detection** and recovery
- Fault removal: design (verification) and operational life time (**maintenance**)
- Fault forecasting: qualitative and quantitative evaluation

29

ATRENE **TOETS**

From Test to Dependability

How to attain dependability for miniaturized systems?

By implementing / improving...

- **Error detection :**
 - BIST (built-in-self-test)
 - BISR (built-in-self-diagnosis)
- **Maintenance :**
 - BISR (built-in-self-repair)
 - BISC (built-in-self-calibration)

Easy to tell, but not easy in practice, especially for heterogeneous micro-systems!!!

30

From Test to Dependability

Example 1: automotive

Source : Bosch

31

From Test to Dependability

Example 2: Medical

System life time

Human beings !!

- Strategy for risk handling
- System level management to avoid any real failure

32

From Test to Dependability

(Advanced) Examples

Phase 1 : acquisition & recording

Phase 2 : download

Intraocular pressure recording system (Class 2a)

- Dependability issues:
 - Too high RF power transmitted to the eye → control circuitry
 - Poor contact between sensor and cornea → reference

33

From Test to Dependability

(Advanced) Examples

The temperature information is transmitted continuously to the reader (acquisition and recording)

Reader

Capsule (Class 2a)

- Autonomy of 10-15 days continuous after activation
- Size : 17.2x8.2mm

The reader is interfaced to a computer to store and analyze the data (download)

- Dependability issues:
 - Power drop down during transit → management circuitry
 - Temperature measurement error → calibration + in-situ checks

34

From Test to Dependability

Two major items

In Class 2 electronic medical devices, dependability mainly focuses on:

- The safety and the security of the patient:
 - Hardware + software monitors / controllers are embedded, re-using functional and DFT resources
- The accuracy of the practitioner diagnosis:
 - Built-in functions are provided for in-situ test, diagnosis and repair

35

Conclusion

- Test Challenges (for production test)
 - Test equipment
 - Testing time
 - Test access
 - KGD
 - Recursive Testing
- Test solutions (at research level)
 - BIST
 - SiP-TAP
 - ANC
 - Wireless Test
 - Loopback
 - ...
- New Challenge = Dependability
 - BIST, BISR, BISR
 - At System level

36