Confidential

ICT-2009.3.2-248603-**IP**

Modelling, Control and Management of Thermal Effects in Circuits of the Future

therminator	WP no.	Deliverable no.	Lead participant
	WP8	**D8.3.3**	**BME**

First report on the organization and the execution of the courses

Prepared by	**G. Nagy (BME)**
Issued by	**THERMINATOR Project Office**
Document Number	**THERMINATOR/D8.3.3/v0.1**
Dissemination Level	**Public**
Date	**8/02/2011**

Document

Title	First report on the organization and the execution of the courses
Type	Deliverable Report Public
Ref	D8.3.3
Target version	V0_1
Current issue	V1
Status	
File	
Author(s)	Gergely Nagy (BME)
Reviewer(s)	Marta Rencz (BME), Steve Stoffels (IMEC), Alexander Burenkov (FHG)
Approver(s)	Giuliana Gangemi (ST), Francesco Moschella (ST)
Approval date	
Release date	

Distribution of the release

Dissemination level	PU
Distribution list	

History

Rev.	DATE	Comment
0.1	8-01-2011	Initial version
0.9		Input of all partners
1.0		Revised version, approved by all partners
1.1	8-2-2011	Check and ship out

References

IPCA – Therminator Consortium Agreement

This page was intentionally left blank.

Contents

Document ii

Distribution of the release iii

References iii

Introduction 6

The course materials 7

Courses organized in 2011 8

Therminator Workshop organized by Intel 8

Special Session 1: Low-Power and Thermal-Aware Design and Test 8

Therminic 2011, Therminator Special Sessions organized by BME 9

Therminator courses organized by POLITO 9

Courses planned in 2012 12

Conclusion 13

Introduction

The dissemination of the knowledge gathered and created by FP7 projects is an important task. The purpose of this task is to make it possible for engineers, scientists and everyone who is interested in the areas the project is concerned with to get acquainted with the work done in the frames of the THERMINATOR project.

Two different level of courses are organized to allow everyone to choose the depth and scope of his or her needs. The introductory course will address interested designers and researchers having low or no experience in thermal-aware design. This course will have an extended theoretical background section and a state-of-the-art presentation section. New design techniques originating from the R&D work in the THERMINATOR project will be embedded into the latter section. EDA methodologies, tools and flows will be only briefly reviewed. The advanced course will focus on designers with thermal design experience rather than on researchers. After a short introduction, consisting of theoretical background and state-of-the-art design techniques, the design solutions and technologies developed within the project will be covered in details. Also, the thermal-aware EDA tools and flows, as well as their potential integration into existing design flows will be discussed deeply.

This deliverable describes the following:

- state of the course materials created in the frames of the THERMINATOR project throughout its second year,
- the courses organized in 2011,
- the courses planned in the third year of the project.

The course materials

The set of course materials prepared during the first year of the project was amended in 2011 by the presentations of the following courses: Intel's course in Munich (6) and Polito's course in Torino (7) – these are described in detail among the course descriptions. A further new course material is the presentation on electro-thermal simulation created by Synopsys (8).

Thus the list of the materials available for trainings in the project is the following:

1. Synopsys design flow (advanced)
2. High-level thermal estimation flow by Offis (advanced)
3. Introductory Course: Modeling and Characterization of Thermal Effects in Si-LDMOSTs by NXP (introductory)
4. Introduction to electro-thermal simulation (methods, tools, examples) by BME (introductory)
5. WiCkeD 6.3 Training by MunEDA (advanced)
6. Tutorials of the Intel course (23. Sept. 2010. Munich) (advanced)
7. Tutorials of the Polito course (6-7. Dec. 2010. Torino) (introductory and advanced)
8. Thermal and Electro-Thermal Simulation: Achievements and Trends by Synopsys (advanced)

The materials can be downloaded from the project's website (http://www.fp7-therminator.org/). They can be found under WP8, the title of the entry is “D8.3.2 - Course materials in electronic form”.

Courses organized in 2011

Therminator Workshop organized by Intel

Advanced course, Munich, 23. September 2011.

- Internal advanced course for employees and project partners
- 25 participants:
  - engineers (department heads and technical group leaders among them)
  - 2 PhD students (from Intel and Fraunhofer)
- Technical talks:

1. *Digital CMOS Circuit Scaling Challenges for Future Mobile Communication IC's* (Intel – Christian Pacha, Thomas Baumann, Karl Hofmann)
2. *PSP modelling* (Infineon – Joachim Assenmacher)
3. *TCAD Simulations of Nano-CMOS Including Self-Heating* (Fraunhofer – Alex Burenkov)
4. *Simulation of electro-thermal interaction effects in electronic circuits* (Fraunhofer – Roland Jancke, Christoph Sohrmann)
5. *Thermal Effects in Digital CMOS Circuits* (Intel – Klaus von Armin)
6. *TCAD: Modeling of CMOS Degradation Mechanisms and Modeling/Calibration of FinFET Devices including Thermal Effects* (Synopsys – Chan-Su Yun, Tommaso Cilento, Guenther Zandler)

Special Session 1: Low-Power and Thermal-Aware Design and Test

Advanced course, Porto de Galinhas, Brazil, March 27th - 30th, 2011
Organizer: Enrico MACII, Politecnico di Torino, Italy

1. *Low-Power and Thermal-Aware Design and Test: Behavioral-Level Thermal- and Aging-Estimation Flow* (Sven ROSINGER*, Malte METZDORF*, Domenik HELMS*, Wolfgang H. NEBEL**)
   * OFFIS - Institute for Information Technology Oldenburg, Germany
   ** University of Oldenburg Oldenburg, Germany
2. *A New Built-In Current Sensor Scheme to Detect Dynamic Faults in Nano-Scale SRAMs* (Felipe LAVRATTI*, Andrea CALIMERA**, Letícia Maria BOLZANI POEHLS*, Fabian VARGAS*, Enrico MACII**)
   * Catholic University – PUCRS, Brazil
   ** Politecnico di Torino
3. *Studying the influence of chip temperatures on timing integrity* (András TIMAR, Márta RENCZ – Budapest University of Technology and Economics)
4. NBTI-Aware Data Allocation Strategies for Scrathpad Based Embedded Systems (Cesare FERRI*, Dimitra PAPAGIANNOPOULOU*, Andrea CALIMERA**, Ruth

BAHAR*)
* Brown University, USA
** Politecnico di Torino, Italy

Therminic 2011, Therminator Special Sessions organized by BME

Advanced course, Paris, 27-29. September 2011. – participants: 80

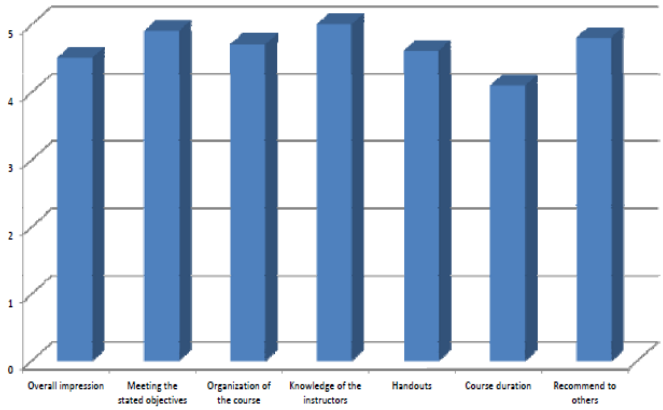
- **Therminator Special Session I.**
  1. *An Analog Behavioral Thermal Macro-model Aimed at Representing an Elementary Portion of a Discrete IGBT Power Device* (Gaetano Bazzano, Daniela Grazia Cavallaro, Giuseppe Greco)
  2. *Self-heating Effects in Nano-scaled MOSFETs and Thermal Aware Compact Models* (Alex Burenkov, Jürgen Lorenz)
  3. *3D Electro-Thermal Simulations of Analog ICs carried out with Standard CAD tools and Verilog-A* (Jean-Christophe Krencker, Jean-Baptiste Kammerer, Yannick Hervé and Luc Hébrard)
  4. *Modeling of Thermally Induced Skew Variations in Clock Distribution Network* (Alessandro Sassone, Wei Liu, Andrea Calimera, Alberto Macii, Enrico Macii and Massimo Poncino)
- **Therminator Special Session II.**
  1. *Improved power modeling in logi-thermal simulation* (András Timár, György Bognár, Márta Rencz)
  2. *A Novel Simulation Environment Enabling Multilevel Power Estimation of Digital Systems* (Gergely Nagy, András Poppe)
  3. *Thermal Modeling of 3D Stacks for Floorplanning* (Sven Reitz, Andy Heinig, Roland Martin, Jörn Stolle, Andreas Wilde)
  4. *High Temperature Calibration of a Compact Model for GaN-on-Si Power Switches* (Steve Stoffels, Denis Marcon, Karen Geens, Xuanwu Kang, Geert Van Der Plas, Marleen Van Hove, Stefaan Decoutere)
  5. *Single-Chip Cloud Computer Thermal Model* (Mohammad Sadegh Sadri, Andrea Bartolini, Luca Benini)

Therminator courses organized by POLITO

Torino, 6-7. December 2011.

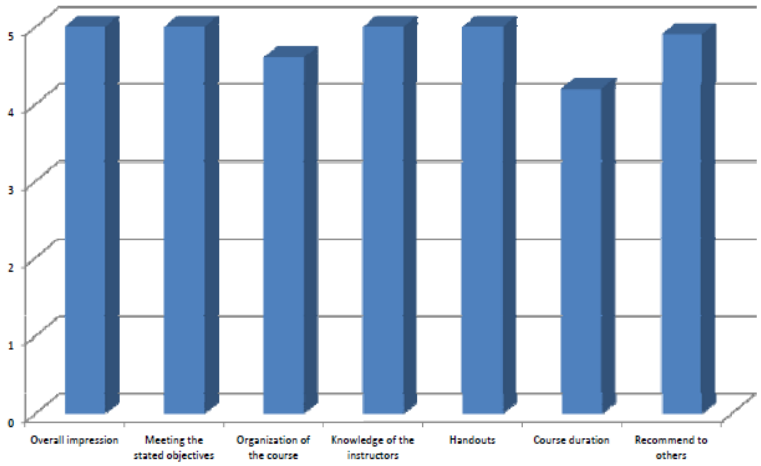
1. *Thermal Aware Design Techniques for Digital ICs*
   - Public introductory course
   - Date: 6. 12. 2011.
   - Participants:
     - 25 students (18 PhD students, 7 undergraduates)

- 7 postdocs
- 6 professors
- 4 engineers from the industry



Evaluation results of the introductory course

2. *Circuit and Physical Level Thermal Aware Design Techniques for Digital ICs* – Advanced course (7. 12. 2011.)
   - Public advanced course
   - Date: 7. 12. 2011.
   - Participants:
     - 21 students (18 PhD students, 3 undergraduates)
     - 6 postdocs
     - 6 professors
     - 4 engineers from the industry



Evaluation results of the advanced course

Courses planned in 2012

The following courses are foreseen in 2012 at the time of writing:

1. Therminator training course at the IMEC headquarters (introductory & advanced)
2. Two public, introductory courses on the theory and practice of electro-thermal simulation by BME (one in the frames of Therminic 2012 at Budapest)
3. Therminator workshop at Therminic 2012 organized by BME
4. Therminator special session at LATW 2012 (Quito, Ecuador) organized by BME
5. Advanced, internal course by NXP
6. An introductory and an advanced public course by POLITO
7. Two introductory and two advanced internal courses for employees organized by ST
8. Internal introductory and advanced courses on TCAD organized by Synopsys at its Zurich office for project partners and employees:
    - *Electro-thermal 2D and 3D TCAD simulation*
        - introductory course
        - The presentation shows how to use TCAD tools for the simulation of electro-thermal problems in semiconductor devices. The lecture starts from the generation and meshing of the 2D or 3D structure, introduces and discusses the device models, and ends with the discussion of simulation results.
    - *Temperature effects in device models - separation and extraction of temperature effects*
        - advanced course
        - The presentation presents and discusses the state of the art device simulation models with respect to their temperature dependence. Ways to calibrate model parameters and to extract temperature dependence of compact model parameters from device simulation are discussed.

Conclusion

According to the plans outlined in the Description of Work (DoW) for the task, introductory and advanced courses were organised, advertised and held by the partners participating in the project at various premises.

Courses were held by academic and industry partners as well both at an introductory level which aims engineers and researchers having little experience in these fields, and at advanced level for research partners and other specialized professionals.

The Therminator project partners also undertook to organize special sessions and workshops at major design and EDA conferences. In 2011 two such events were held, one at the LATW conference and the other in the frames of the THERMINIC conference.

In the third year of the project further courses and special sessions are planned in accordance with the DoW.

Planned in the DoW						
Year	2010		2011		2012	
Course type	introductory	advanced	introductory	advanced	introductory	advanced
Therminic			1		1	
Other workshops						
NXP						1
IMC						1
ST			1	1	1	1
public editions			2	1	2	1

Done in 2011 and foreseen for 2012						
Year	2010		2011		2012	
Course type	introductory	advanced	introductory	advanced	introductory	advanced
Therminic			1		1	
Other workshops (name)			1 (LATW)		1 (LATW)	
NXP						1
IMC				1		
ST					2	2
IMEC					1	1
Synopsys					1	1
POLITO			1	1	1	1
BME					2	
Public editions[1] (premises)			1 (POLITO)	1 (POLITO)	4 (IMEC, BME,POLITO)	2 (IMEC, POLITO)

[1] The numbers in the „Public editions" line are not additional courses, they show the number of the courses in the lines above that were made public.