Energy Harvesting

A thorough treatment of energy harvesting technologies, highlighting radio frequency (RF) and hybrid-multiple technology harvesting. The authors explain the principles of solar, thermal, kinetic, and electromagnetic energy harvesting, address design challenges, and describe applications. The volume features an introduction to switched mode power converters and energy storage and summarizes the challenges of different system implementations, from wireless transceivers to backscatter communication systems and ambient backscattering. This practical resource is essential for researchers and graduate students in the field of communications and sensor technology, in addition to practitioners working in these fields.

Apostolos Georgiadis is Honorary Associate Professor at Heriot-Watt University, Edinburgh, UK. He is a former editor-in-chief of *Wireless Power Transfer* (Cambridge). He is an EU Marie Curie Fellow, an URSI Fellow, chair of URSI Commission D Electronics and Photonics, and a distinguished lecturer of the IEEE Council on RFID.

Ana Collado was Assistant Professor at Heriot-Watt University, Edinburgh, UK. She is an EU Marie Curie Fellow.

Manos M. Tentzeris is Ken Byers Professor in Flexible Electronics with the School of Electrical and Computer Engineering (ECE), Georgia Tech. He is a Fellow of IEEE, a Fellow of the Electromagnetics Academy, and a member of URSI Commission D Electronics and Photonics and of the Technical Chamber of Greece.

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Technologies, Systems, and Challenges

APOSTOLOS GEORGIADIS
Heriot-Watt University, Edinburgh

ANA COLLADO
Formerly Heriot-Watt University, Edinburgh

MANOS M. TENTZERIS
Georgia Institute of Technology

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To our daughters Ariadne, Markella-Renata, and Christina-Apostolia

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Preface

This book discusses energy harvesting technologies for low-power wireless sensing platforms. This is a multidisciplinary topic requiring background from different physics-related disciplines such as thermodynamics and mechanics but also electrical engineering, optimization, and signal processing. In addition, material science and additive manufacturing has further helped develop low-cost sensors and circuits that enable form and cost reduction of such platforms and their ubiquitous application.

Our involvement in the field began around 2009. Apostolos and Ana had already been collaborating since 2004 in Spain in the context of a different research field, and around 2009 we decided to begin working on radio frequency (RF) energy harvesting. At this time, we were introduced to Manos during a meeting of the European Union (EU) European Cooperation in Science and Technology (COST) IC0803 project that we were running. From this moment, our collaboration in the field began, and over the last ten years we have produced numerous publications related to different aspects of energy harvesting.

Chapter 1 is an introductory chapter providing a brief overview and a perspective to the research and industrial possibilities related to such a multidisciplinary field of energy harvesting. Chapter 2 is devoted to 2D-3D integration of energy autonomous sensors using inkjet printing fabrication. Chapters 3–5 discuss solar, kinetic and thermal energy harvesting. Chapters 6 and 7 are devoted to wireless power transmission and RF energy harvesting. Chapter 8 discusses dc voltage conversion and power storage, and finally, Chapter 9 is devoted to a system overview of wireless sensing platforms with energy harvesting capability. As part of a course, one could begin with Chapter 1, follow with Chapter 2, and then cover the chapters related to the different energy harvesting technologies. Chapters 3 through 5 and the combined set of Chapters 6 and 7 could be taught in any order. Chapter 2 may also be offered after Chapters 3 through 7. One could then cover the final Chapters 8 and 9.

We would like to thank our numerous former students who have contributed to our work on energy harvesting. First and foremost, Sangkil Kim, now assistant professor at Pusan National University, South Korea, has contributed to a great number of publications and provided the main draft of Chapter 2 based on his expertise in inkjet printing. Special thanks go to Dr. Spyros Daskalakis, Heriot-Watt University, for his help with the book editing. Our thanks also go

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We hope that the book can provide a starting point for our readers to the world of energy harvesting, and we welcome any comments and feedback!