Rf Mems Switches And Switch Matrices Ursi Home

Microelectromechanical Systems (MEMS) stand poised for the next major breakthrough in the silicon revolution that began with the transistor in the 1960s and has revolutionized microelectronics. MEMS allow one to not only observe and process information of all types from small scale systems, but also to affect changes in systems and the environment at that scale. “RF MEMS Switches and Integrated Switching Circuits” builds on the extensive body of literature that exists in research papers on analytical and numerical modeling and design based on RF MEMS switches and micromachined switching circuits, and presents a unified framework of coverage. This volume includes, but is not limited to, RF MEMS approaches, developments from RF MEMS switches to RF switching circuits, and MEMS switch components in circuit systems. This book also: -Presents RF Switches and switching circuit MEMS devices in a unified framework covering all aspects of engineering innovation, design, modeling, fabrication, control and experimental implementation -Discusses RF switch devices in detail, with both system and component-level circuit integration using micro- and nano-fabrication techniques -Includes an emphasis on design innovation and experimental relevance rather than basic electromagnetic theory and device physics “RF MEMS Switches and Integrated Switching Circuits” is perfect for engineers, researchers and students working in the fields of MEMS, circuits and systems and RFs.

With its unique promise to revolutionize science, engineering, technology, and other fields, nanotechnology continues to profoundly impact associated materials, components, and systems, particularly those used in telecommunications. These developments are leading to easier convergence of related technologies, massive storage data, compact storage devices, and higher-performance computing. Nanotechnology for Telecommunications presents vital technical scientific information to help readers grasp issues and challenges associated with nanoscale telecommunication system development and commercialization—and then avail themselves of the many opportunities to be gleaned. This book provides technical information and research ideas regarding the use of nanotechnology in telecommunications and information processing, reflecting the continuing trend toward the use of optoelectronics. Nanotech will eventually lead to a technology cluster that offers a complete range of functionalities for systems used in domains including information, energy, construction, environmental, and biomedical. Describing current and future developments that hold promise for significant innovations in telecommunications, this book is organized to provide a progressive understanding of topics including: Background information on nanoscience and nanotechnology Specific applications of nanotechnology in telecommunications Nanostructured optoelectronic materials MEMS, NEMS, and their applications in communication systems Quantum dot Cellular Automata (QCA) and its applications in telecommunication systems How nonohmic nonlinear behavior affects both digital and analog signal processing Concepts regarding quantum switching and its applications in quantum networks The scale of the physical systems that use nanoscale electronic devices is still large, and that presents serious challenges to the establishment of interconnections between nanoscale devices and the outside world. Also addressing consequent social implications of nanotech, this book reviews a broad range of the nano concepts and their influence on every aspect of telecommunications. It describes the different levels of interconnections in systems and details the standardized assembly process for a broad specrum of micro-, nano-, bio-, fiber-optic, and optoelectronic components and functions. This book is a powerful tool for understanding how to harness the power of nanotech through integration of materials, processes, devices, and applications.

This exciting new book focuses on the analysis and design of reconfigurable antennas for modern wireless communications, sensing, and radar. It presents the definitions of basic antenna parameters, an overview of RF switches and explains how to characterize their insertion loss, isolation, and power handling issues. Basic reconfigurable antenna building blocks, such as dipoles, monopoles, patches and slots are described, followed by presentations on frequency reconfigurable antennas, pattern reconfigurable antennas, and basic scanning antenna arrays. Switch biasing in an electromagnetic environment is discussed, as well as simulation strategies of reconfigurable antennas, and MIMO (Multiple Input Multiple Output) reconfigurable antennas. Performance characterization of reconfigurable antennas is also presented. The book provides information for the technical professional to design frequency reconfigurable, pattern reconfigurable, and MIMO antennas all relevant for modern wireless communication systems. Readers learn how to select switching devices, bias them properly, and understand their role in the overall reconfigurable antenna design. The book presents practical experimental implementation issues, including losses due to switches, materials, and EMI (Electromagnetic Interference) and shows how to address those.

This book presents select peer-reviewed proceedings of the International Conference on Frontiers in Smart Systems Technologies (ICFSST 2019). It focuses on latest research and cutting-edge technologies in smart systems and intelligent autonomous systems with advanced functionality. Comprising topics related to diverse aspects of smart technologies such as high security, reliability, miniaturization, energy consumption, and intelligent data processing, the book contains contributions from academics as well as industry. Given the range of the topics covered, this book will prove useful for students, researchers, and professionals alike.

This book includes high impact papers presented at the International Conference on Communication, Computing and Electronics Systems 2019, held at the PPG Institute of Technology, Coimbatore, India, on 15-16 November, 2019. Discussing recent trends in cloud computing, mobile computing, and advancements of electronics systems, the book covers topics such as automation, VLSI, embedded systems, integrated device technology, satellite communication, optical communication, RF communication, microwave engineering, artificial intelligence, deep learning, pattern recognition, Internet of Things, precision models, bioinformatics, and healthcare informatics.

An up-to-date guide to the theory and applications of RF MEMS. With detailed information about RF MEMS technology as well as its reliability and applications, this is a comprehensive resource for professionals, researchers, and students alike. • Reviews RF MEMS technologies • Illustrates new techniques that solve long-standing problems associated with reliability and packaging • Provides the information needed to incorporate RF MEMS into commercial products • Describes current and future trends in RF MEMS, providing perspective on industry growth • Ideal for those studying or working in RF and microwave circuits, systems, microfabrication and manufacturing, production management and metrology, and performance evaluation

This practically-oriented, all-inclusive guide covers all the major enabling techniques for current and next-generation cellular communications and wireless networking systems. Technologies covered include CDMA, OFDM, UWB, turbo and LDPC coding, smart antennas, wireless ad hoc and sensor networks, MIMO, and cognitive radios, providing readers with everything they need to master wireless systems design in a single volume. Uniquely, a detailed introduction to the properties, design, and selection of RF subsystems and antennas is provided, giving readers a clear overview of the whole wireless system. It is also the first textbook to include a complete introduction to speech coders and video coders used in wireless systems. Richly illustrated with over 400 figures, and with a unique emphasis on practical and state-of-the-art techniques in system design, rather than on the mathematical foundations, this book is ideal for graduate students and researchers in wireless communications, as well as for wireless and telecom engineers.

This paper presents a study of the behaviour of electrically actuated RF-MEMS switches with ohmic contact. We will discuss about the relationship between the actuation voltage, displacement and the corresponding contact force experienced by the switch. We will demonstrate the linear behaviour of the switch when factors such as width or length of the switch arm are varied. Experimental results for DC actuation are also presented.

Radio frequency microelectromechanical system (RF-MEMS) switches have demonstrated superior electrical performance (lower loss and higher isolation) compared to semiconductor-based devices to implement reconfigurable microwave and millimeter (mm)-wave circuits. In this chapter, electrostatically actuated RF-MEMS switch configurations that can be easily integrated in uniplanar circuits are presented. The design procedure and fabrication process of RF-MEMS switch topologies able to control the propagating modes of multimodal uniplanar structures (those based on a combination of coplanar waveguide (CPW), coplanar stripline (CPS), and slotline) will be described in detail. Generalized electrical (multimodal) and mechanical models will be presented and applied to the switch design and simulation. The switch-simulated results are compared to measurements, confirming the expected performances. Using an integrated RF-MEMS surface micromachining process, high-performance multimodal reconfigurable circuits, such as phase switches and filters, are developed with the proposed switch configurations. The design and optimization of these circuits are discussed and the simulated results compared to measurements.

Radio Frequency Micromachined Switches, Switching Networks, and Phase Shifters discusses radio frequency microelectromechanical systems (RF MEMS)-based control components and will be useful for researchers and R&D engineers. It offers an in-depth study, performance analysis, and extensive characterization on micromachined switches and phase shifters. The reader will

learn about basic design methodology and techniques to carry out extensive measurements on MEMS switches and phase shifters which include electrical, mechanical, power handling, linearity, temperature stability, reliability, and radio frequency performance. Practical examples included in the book will help readers to build high performance systems/subsystems using micromachined circuits. Key Features Provides simple design methodology of MEMS switches and switching networks including SPST to SP16T switches Gives an in-depth performance study of micromachined phase shifters. Detailed study on reliability and power handling capability of RF MEMS switches and phase shifters presented Proposes reconfigurable micromachined phase shifters Verifies a variety of MEMS switches and phase shifters experimentally
Microelectromechanical systems (MEMS) refer to a collection of micro-sensors and actuators, which can react to environmental change under micro- circuit control. The integration of MEMS into traditional Radio Frequency (RF) circuits has resulted in systems with superior performance levels and lower manufacturing costs. The incorporation of MEMS based fabrication technologies into micro and millimeter wave systems offers viable routes to ICs with MEMS actuators, antennas, switches and transmission lines. The resultant systems operate with an increased bandwidth and increased radiation efficiency and have

considerable scope for implementation within the expanding area of wireless personal communication devices. This text provides leading edge coverage of this increasingly important area and highlights the overlapping information requirements of the RF and MEMS research and development communities. * Provides an introduction to micromachining techniques and their use in the fabrication of micro switches, capacitors and inductors * Includes coverage of MEMS devices for wireless and Bluetooth enabled systems Essential reading for RF Circuit design practitioners and researchers requiring an introduction to MEMS technologies, as well as practitioners and researchers in MEMS and silicon technology requiring an introduction to RF circuit design.

Discover this comprehensive yet concise reference including the definitions, requirements, and available options for multifunctional antennas Multifunctional Antennas and Arrays for Wireless Communication Systems delivers an exploration of the state-of-the-art in multifunctional antennas and arrays for efficient frequency spectrum management. The book covers a range of topics related to multiple radiating modes in reconfigurable phased arrays, anti-jamming antennas, and polarization reconfigurability. The distinguished authors also describe current approaches to achieving reconfigurable antennas.The book discusses electrically small reconfigurable antennas, massive MIMO antennas for simultaneous multiple generation, beam peak, and null forming, as well as reconfigurable antennas for 4G and 5G. Finally, Massive MIMO applications, the use of metamaterial and metasurfaces, and recent developments in reconfigurable antennas appropriate for 5G networks are covered. Multifunctional Antennas and Arrays for Wireless Communication Systems shows readers how to understand, design, and work with compact, light, and inexpensive antenna technology. Readers will also benefit from the inclusion of: A thorough introduction to multiple radiating modes-based pattern reconfigurable phased arrays and anti-jamming antennas A presentation of several approaches to realizing reconfigurable antennas, including Liquid Crystal Polymer, liquid metal, and RF-MEMS reconfigurable antennas Coverage of special topics, including multiple input multiple output (MIMO) reconfigurable antennas and massive MIMO antennas for simultaneous multiple generation and beam peak and null forming A discussion of electrically small reconfigurable antennas Perfect for students, engineers, and researchers studying and working on wireless communications technology, Multifunctional Antennas and Arrays for Wireless Communication Systems will also earn a place in the libraries of engineers in related fields, like RF devices, who seek a one-stop reference for this essential technology.

This book (CCIS 839) constitutes the refereed proceedings of the First International Conference on Communication, Networks and Computings, CNC 2018, held in Gwalior, India, in March 2018. The 70 full papers were carefully reviewed and selected from 182 submissions. The papers are organized in topical sections on wired and wireless communication systems, high dimensional data representation and processing, networks and information security, computing techniques for efficient networks design, electronic circuits for communication system.

Advances in Imaging and Electron Physics merges two long-running serials--Advances in Electronics and Electron Physics and Advances in Optical and Electron Microscopy. This series features extended articles on the physics of electron devices (especially semiconductor devices), particle optics at high and low energies, microlithography, image science and digital image processing, electromagnetic wave propagation, electron microscopy, and the computing methods used in all these domains. Contributions from leading authorities Informs and updates on all the latest developments in the field

In order to incorporate the RF MEMS technology with the 3D MMICs technology, a novel RF MEMS switch was designed and implemented in a 3D MMIC circuit environment. RF MEMS switches possess many advantages compared to traditional solid-state switches, such as high electromechanical isolation, and ultra-low power consumption. The novelty of this switch was that it was based on low temperature processing techniques. Design equations for a shielded coplanar waveguide were derived for the switch. Traditional lumped element capacitor model and this newly developed distributed transmission line models were compared against measured data to verify their validity. While measurement results show good agreement with both models, the distributed model consistently demonstrated better match than its lumped element counterpart. Test and measurement results showed that a typical RF MEMS switch was capable of delivering less than 0.2dB insertion loss and more than 14.1dB isolation between input and output ports at X-band (8GHz-12GHz). This RF MEMS switch required only 12V actuation voltage while it was capable of handling 2.88W RF power before "hot-switching" occurs. Hysteretic phenomenon of RF MEMS switches was observed; release voltage threshold was found to be around 2V 4V, much lower than the one required for pulling down the structure. Switching speeds of RF MEMS switches with different beam strength were measured using a novel experimental setup utilizing couplers as bias networks. The fastest switches demonstrated maximum switching speed of 3.571 kHz and more than 10,800,000 life cycles. As the application of RF MEMS switches, a

4-bit digital phase shifter was designed and fabricated. 180? bit and 90? bits were realized using reflection type phase shifters, while the 45? and 22.5? bits were achieved using loaded-line type phase shifters. A novel reflection type phase shifter loaded with multiple switch pairs was developed and was capable of delivering multiple phase shift angles within one circuit stage. Phase shifter measurement results were consistent with simulated results.

The successful launch of viable MEMs product hinges on MEMS reliability, the reliability and qualification for MEMs based products is not widely understood. Companies that have a deep understanding of MEMs reliability view the information as a competitive advantage and are reluctant to share it. MEMs Reliability, focuses on the reliability and manufacturability of MEMS at a fundamental level by addressing process development and characterization, material property characterization, failure mechanisms and physics of failure (POF), design strategies for improving yield, design for reliability (DFR), packaging and testing.

RF MEMS capacitive switches capable of order of-magnitude impedance changes have demonstrated operating lifetimes exceeding 100 billion switching cycles without failure. In situ monitoring of switch characteristics demonstrates no significant degradation in performance and quantifies the charging properties of the switch silicon dioxide film. This demonstration lends credence to the mechanical robustness of RF MEMS switches.

The integration of microelectromechanical systems (MEMS) and nanotechnology (NT) in sensors and devices significantly reduces their weight, size, power consumption, and production costs. These sensors and devices can then play greater roles in defense operations, wireless communication, the diagnosis and treatment of disease, and many more applications. MEMS and Nanotechnology-Based Sensors and Devices for Communications, Medical and Aerospace Applications presents the latest performance parameters and experimental data of state-of-the-art sensors and devices. It describes packaging details, materials and their properties, and fabrication requirements vital for design, development, and testing. Some of the cutting-edge materials covered include quantum dots, nanoparticles, photonic crystals, and carbon nanotubes (CNTs). This comprehensive work encompasses various types of MEMS- and NT-based sensors and devices, such as micropumps, accelerometers, photonic bandgap devices, acoustic sensors, CNT-based transistors, photovoltaic cells, and smart sensors. It also discusses how these sensors and devices are used in a number of applications, including weapons' health, battlefield monitoring, cancer research, stealth technology, chemical detection, and drug delivery.

This dissertation presents designs, fabrication processes and measurements of a series of high performance RF MEMS switches. Chapter 2 presents a miniature RF MEMS metal contact switch based on a tethered-cantilever structure. The miniature size and the use of tethers result in an excellent biaxial residual stress and stress gradient tolerance. The switch is built using thin metal process with a large biaxial stress and a high stress gradient (50 MPa and -105 MPa/um), and works well under these conditions. In the up-state, the switch capacitance is 9.4 fF and results in an isolation of 20 dB at 20 GHz. In the down-state, the switch resistance is 3.6 ohm for a gold-gold contact under 30 V actuation voltage. The switch is compatible with CMOS back-end processing. With its miniature size, the switch could be placed in arrays to achieve lower contact resistance and higher power handling. Chapter 3 presents a multi-contact mN-force RF MEMS metal-contact switch with a pull-down voltage (Vp) of 45 V-50 V and an operation voltage of 60V-65V. The switch gets a contact force of s 2.0 mN under 65 V actuation voltage and a release force of s 1.2 mN (simulated). The switch gets an on-state resistance of s 1.8 with Ru-Au contact and an off-state capacitance of 13.5 fF, which results in a figure of merit of 24 fs. In the temperature stability measurement, the switch shows a change of 4V in pull-down voltage and a change of 2V in release voltage from 25 C to 125 C. In the high power handling measurement, the switch demonstrates a reliability of > 10 million cold switching cycles with 5 W RF power. Chapter 4 first presents a high capacitance ratio (Cr) capacitive switch with continuous tuning capability after pull-down. The measured up-state capacitance is 74 fF. The pull-down voltage of the switch is 30V -32V and there is an 8.4% linear tuning range from 33V to 40V actuation voltage. The measured down-state capacitance is 1296 fF under 40V actuation voltage, resulting in a Cr of 17.5. Next, a back-to-back switch using the high Cr switch is designed to improve IP2 without extra power supply. The back-to-back switch shows an up-state capacitance of 31fF, a Cr of 19.7 and a 6.8% continuous tuning range from 34V to 40V. The back-to-back switch shows a 14 dB higher OIP2 than the single switch does.

Ultrasmall Radio Frequency and Micro-wave Microelectromechanical systems (RF MEMs), such as switches, varactors, and phase shifters, exhibit nearly zero power consumption or loss. For this reason, they are being developed intensively by corporations worldwide for use in telecommunications equipment. This book acquaints readers with the basics of RF MEMs and describes how to design practical circuits and devices with them. The author, an acknowledged expert in the field, presents a range of real-world applications and shares many valuable tricks of the trade.

This thesis presents the design, fabrication and measurements of a new metal-contact RF MEMS switch with low sensitivity to stress gradients and temperature variations. The switch is based on a circular geometry with arc type springs, and results in high contact force, fast switching time, and excellent microwave performance of up to> 40 GHz. This thesis also presents the design, fabrication and measurements of a new metal-contact RF MEMS single-pole double-throw (SPDT) switch with low sensitivity to stress gradients. The switch is based on a circular geometry with arc type springs, and results in high contact force, fast switching time, and excellent microwave performance of up to> 30 GHz. To our knowledge, this is the smallest high-performance SPDT switch to-date (0.04 mm2). Furthermore, the design, fabrication and measurements of a novel metal-contact RF MEMS switch with variable spring constant and high contact and release forces are demonstrated. The spring constant of the switch dramatically increases when the applied voltage is larger than the threshold voltage (Vt), defined as the voltage obtained when the tip touches a dielectric block. This design shows a total contact force and restoring force of 0.6 - 1.1 mN and a 0.5 mN, respectively, for an actuation voltage of 75-90 V. The measured switching time is

The recent shift in focus from defense and government work to commercial wireless efforts has caused the job of the typical microwave engineer to change dramatically. The modern microwave and RF engineer is expected to know customer expectations, market trends, manufacturing technologies, and factory models to a degree that is unprecedented in the

The latest developments in chemical and biological sensor research and development. Topics include: 1. new selective species recognition surfaces and materials; 2. molecular recognition materials and approaches to minimize non-specific binding; 3. semi-selective species recognition materials; 4. novel methods for signal processing, signal amplification, and detection; 5. detection systems for multiple analytes in complex samples; 6. sensor arrays; and 7. analytical systems and approaches.

This dissertation presents the design and measurement of high performance RF MEMS metal contact switches capable of achieving mN-level contact and release forces. The switches are designed and demonstrated to be tolerant to a wide range stress effect and temperature. Chapter 2 presents an electrostatic RF MEMS metal contact switch based on a tethered cantilever topology. The use of tethers results in a design that has low sensitivity to stress gradients, biaxial stresses, and temperature. A switch with a footprint of 160x190 [mu]m2 and based on a surface-micromachined 8-[mu]m thick gold cantilever with a Au/Ru contact is implemented on a high-resistivity silicon substrate and results in a total contact force of 0.8-1.2 mN at 80-90 V, a restoring force of 0.5 mN, a pull-in voltage of 61 V, an up-state capacitance of 24 fF, and an actuation time of 6.4 [mu]s. The device achieves a switch resistance of 2.4±1.4 Ohms to 1.8±0.6 Ohms at 90-100 V in open laboratory environments (unpackaged). Chapter 3 presents a temperature stable metal-contact RF MEMS switch capable of handling>5W of RF power (a second generation of the tethered cantilever topology). The device achieves 0.7 - 1.5 mN of contact force for actuation voltages of 80 - 90 V, with a restoring force of 0.63 mN. Furthermore, the device is insensitive to stress effects and temperature. Temperature measurements showed excellent thermal stability - no deflection in the beam, and a change in pull-in voltage of only 4 V from 25-125°C. The switch was tested under prolonged (>24 hrs) high-power RF conditions with excellent reliability. Chapter 4 presents a compact RF MEMS metal-contact switch based on a tethered cantilever topology and orthogonal anchors. The switch is a "medium-force" design capable of achieving 0.38-0.72 mN of contact force for actuation voltages of 90-100 V and a restoring force of 0.46 mN (simulated) in a 120160 um^2 area. The pull-in and release voltages are 75 V and 70 V, respectively. In the down-state, the switch resistance is 1-2 with a Au/Ru hybrid contact. In the up-state, the capacitance is 16 fF, resulting in an isolation of 20 dB at 10 GHz and 9 dB at 40 GHz for an SPST configuration. Furthermore, the switch demonstrated a reliability of>10 million cycles (1 W, cold switching) and a power handling of>5 W. For a series/shunt configuration, the switch achieves an isolation of 55 dB at 10 GHz and 35 dB at 40 GHz. Compact SP4T and SP6T switching networks are also implemented. The SP4T is 850x530 [mu]m2 (850x650 [mu]m2 with bias pads); the SP6T is 850x730 [mu]m2 (850x855 [mu]m2 with bias pads). Both designs achieve an isolation ~36 dB and insertion loss 0.3 dB at 3 GHz. Chapter 5 presents a mN-level contact and restoring force RF MEMS metal-contact switch exhibiting high reliability, high linearity, and high power handing for DC-40 GHz applications. The device, which is insensitive to stress and temperature effects, achieves 1.2-1.5 mN of contact force (per contact) from 80-90 V and 1.0 mN of restoring force (per contact). The up-state capacitance is 8 fF, resulting in an isolation of -46, -31, and -14 dB at 1, 6, and 40 GHz, respectively. Measured results show switch resistances of 1-2 Ohms and a reliability of100 million cycles at 2-5Wunder cold-switching at 100 mW under hot-switching conditions, in an unpackaged and standard laboratory environment. Furthermore, the device was tested under prolonged hold-down conditions and demonstrated excellent RF power handling (>10 W) and DC current handling (>1 A) capability. Finally, SP4T and SP6T switching networks implemented with the metal-contact switch are demonstrated.

Micro-Electro-Mechanical (MEM) devices like switches, varactors and oscillators have shown great potential for use in communication devices, sensors and actuators. Electrostatically actuated switches in particular have been shown to have superior performance characteristics over traditional semiconductor switches. However, their widespread insertion in integrated electronics is critically dependent on a thorough understanding of two broad issues - manufacturing process variations and failure mechanisms. Variations during fabrication lead to uncertain material and/or geometric parameters causing a significant impact on device performance. Such uncertainties need to be accounted for during the robust design of these switches. In terms of failure mechanisms limiting the lifetime of MEMS switches, dielectric charging is considered to be the most critical. It can cause the switch to either remain stuck after removal of the actuation voltage or to fail to contact under application of voltage. There is a need for accurate and computationally efficient, multi-physics CAD tools for incorporating the effect of dielectric charging. In this work, we have attempted to address some of the aforementioned challenges. We have come up with new algorithms for improving the effciency of coupled electro-mechanical simulations done in existing commercially available software like ANSYS. The gains in efficiency are accomplished through eliminating the need for repeated mesh update or re-meshing during finite element electrostatic modeling. This is achieved through the development of a `map' between the deformed and un-deformed geometries. Thus only one finite element discretization on the original undeformed geometry is needed for performing electrostatic analysis on all subsequent deformed geometries. We have generalized this concept of `mapping' to perform stochastic electrostatic analysis in the presence of geometric uncertainties. The different random realizations of geometry are considered as deformed geometries. The electrostatic problem on each of these random samples is then obtained using the `mapping' and the finite element simulation on the mean geometry. Statistics such as the mean and standard deviation of the desired system response such as capacitance and vertical force are efficiently computed. This approach has been shown to be orders of magnitude faster than standard Monte Carlo approaches. Next, we have developed a methodology for the model order reduction of MEMS devices under random input conditions to facilitate fast time and frequency domain analyses. In this approach, the system matrices are represented in terms of polynomial expansions of input random variables. The coefficients of these polynomials are obtained by deterministic model order reduction for specific values of the input random variables. These values are chosen `smartly' using a Smolyak algorithm. The stochastic reduced order model is cast in the form of an augmented, deterministic system. The proposed method provides significant efficiency over standard Monte Carlo. Finally, we have developed a physics based, one dimensional macroscopic model for the quantitative description of the process of dielectric charging. The fidelity of the model relies upon the utilization of experimentally-obtained data to assign values to model parameters that capture the non-linear behavior of the dielectric charging process. The proposed model can be easily cast in the form of a simple SPICE circuit. Its compact, physics-based form enables its seamless insertion in non-linear, SPICE-like, circuit simulators and makes it compatible with system-level MEMS computer-aided analysis and design tools. The model enables the efficient simulation of dielectric charging under different, complex control voltage waveforms. In addition, it provides the means for expedient simulation of the impact of dielectric charging on switch performance degradation. It is used to demonstrate failure of a switch in Architect. We conclude with a description of how this one dimensional model can be combined in a detailed two dimensional coupled electro-mechanical framework.

The book presents select proceedings of the International Conference on Micro and Nanoelectronics Devices, Circuits and Systems (MNDCS-2021). The volume includes cutting-edge research papers in the emerging fields of micro and nanoelectronics devices, circuits, and systems from experts working in these fields over the last decade. The book is a unique collection of chapters from different areas with a common theme and will be immensely useful to academic researchers and practitioners in the industry who work in this field.

Small, low power devices for manipulation of high frequency (above 10 GHz) signals are an enabling technology for improved communications and remote sensing equipment. MEMS devices for switching of microwave or millimetre wave signals show promise for applications in areas such as agile radio systems, reconfigurable tuning and matching networks, and phased arrays. The mechanical operating principle of MEMS switches allows these devices to achieve electrical performance (including linearity, isolation, and insertion loss) competitive with or in some cases exceeding that possible with semiconductor technology, in combination with small size and low power consumption. In applications where fast (microsecond) switching times are not required, at frequencies sufficiently high that semiconductor switches are challenging to design or lossy, MEMS technology has excellent potential. The technology of

MEMS switches using electrostatic actuation and metal-to-metal or metal-to-dielectric contact has been extensively developed. Unfortunately, practical difficulties such as high actuation voltage, poor reliability, or poor power handling have proven hard to resolve, and the wider adoption of these devices has been delayed. It is therefore worthwhile to develop novel device designs that may be able to comprehensively avoid these issues. The aim of this project was to investigate and validate a concept for a piezoelectric contact-less MEMS switch. The device uses a variable capacitance principle, avoiding the need for contact during switching. Piezoelectric actuation allows high power handling to be achieved with a reasonable (predicted sub 25 V) actuation voltage. A comprehensive model for the mechanical and electrical behaviour of the device was developed. In order to inform the design of a high performance device, the effects of the structure, materials, and applied RF power were considered. Predictions from this model were compared with the results of finite element analysis. Static test structures were designed to validate the electrical performance model and fabricated on glass wafers. S-parameter measurements made on these validation structures were compared with the expected results from the model. Finally, a fabrication process was developed to produce a device in silicon. Additional electrical measurements were carried out on a prototype version of this silicon structure (fabricated without piezoelectric material) to further study the performance of this contact-less RF MEMS switch design. Closes the gap between hardcore-theoretical and purely experimental RF-MEMS books. The book covers, from a practical viewpoint, the most critical steps that have to be taken in order to develop novel RF-MEMS device concepts. Prototypical RF-MEMS devices, both including lumped components and complex networks, are presented at the beginning of the book as reference examples, and these are then discussed from different perspectives with regard to design, simulation, packaging, testing, and post-fabrication modeling. Theoretical concepts are introduced when necessary to complement the practical hints given for all RF-MEMS development stages. Provides researchers and engineers with invaluable practical hints on how to develop novel RF-MEMS device concepts Covers all critical steps, dealing with design, simulation, optimization, characterization and fabrication of MEMS for radio-frequency applications Addresses frequently disregarded issues, explicitly treating the hard to predict interplay between the three-dimensional device structure and its electromagnetic functionality Bridges theory and experiment, fundamental concepts are introduced with the application in mind, and simulation results are validated against experimental results Appeals to the practice-oriented R&D reader: design and simulation examples are based on widely known software packages such as ANSYS and the hardware description language Verilog.

"This work presents a novel approach to modeling and control of an RF- MEMS switch. The model presented in this work is comprehensive and generic in nature such that it takes into account the effect of squeeze film damping, impact force and electrostatic force effects on the dynamic behavior of the switch during pull-in and release of its membrane. This model makes it adaptable to any similar switch regardless of the form and/or dimensions. Simulation results of the switch dynamics is validated against experimental data for an identical switch. Model response to electrostatic voltage shows very good agreement with experiments. The proposed model is then used to construct a feedback controller capable of improving response parameters of the membrane during operation. Due to micro-dimensions of the switch, real time displacement measurement of the membrane is not readily available. Therefore, the proposed controller utilizes measurement of switch capacitors current as a platform for real time estimates of the membrane position. Membrane Current measurement was not available for control purposes due to the lack of the fabricated RF MEMS switch. Consequently, approximate model for current-displacement relationship is constructed from numerical solution of the nonlinear model data and system identification techniques using Simulink."--Abstract.

In the past decades, the mainstream of microelectronics progression was mainly powered by Moore's law focusing on IC miniaturization down to nano scale. However, there is a fast increasing need for "More than Moore" (MtM) products and technology that are based upon or derived from silicon technologies, but do not simply scale with Moore’s law. This book provides new vision, strategy and guidance for the future technology and business development of micro/nanoelectronics.

RF MEMS Switches and Phase Shifters for 3D MMIC Phased Array Antenna Systems

In the high frequency world, the passive technologies required to realize RF and microwave functionality present distinctive challenges. SAW filters, dielectric resonators, MEMS, and waveguide do not have counterparts in the low frequency or digital environment. Even when conventional lumped components can be used in high frequency applications, their behavior does not resemble that observed at lower frequencies. RF and Microwave Passive and Active Technologies provides detailed information about a wide range of component technologies used in modern RF and microwave systems. Updated chapters include new material on such technologies as MEMS, device packaging, surface acoustic wave (SAW) filters, bipolar junction and heterojunction transistors, and high mobility electron transistors (HMETs). The book also features a completely rewritten section on wide bandgap transistors.

Modern electronics testing has a legacy of more than 40 years. The introduction of new technologies, especially nanometer technologies with 90nm or smaller geometry, has allowed the semiconductor industry to keep pace with the increased performancecapacity demands from consumers. As a result, semiconductor test costs have been growing steadily and typically amount to 40% of today's overall product cost. This book is a comprehensive guide to new VLSI Testing and Design-for-Testability techniques that will allow students, researchers, DFT practitioners, and VLSI designers to master quickly System-on-Chip Test architectures, for test debug and diagnosis of digital, memory, and analog/mixed-signal designs. Emphasizes VLSI Test principles and Design for Testability architectures, with numerous illustrations/examples. Most up-to-date coverage available, including Fault Tolerance, Low-Power Testing, Defect and Error Tolerance, Network-on-Chip (NOC) Testing, Software-Based Self-Testing, FPGA Testing, MEMS Testing, and System-In-Package (SIP) Testing, which are not yet available in any testing book. Covers the entire spectrum of VLSI testing and DFT architectures, from digital and analog, to memory circuits, and fault diagnosis and self-repair from digital to memory circuits. Discusses future nanotechnology test trends and challenges facing the nanometer design era; promising nanotechnology test techniques, including Quantum-Dots, Cellular Automata, Carbon-Nanotubes, and Hybrid Semiconductor/Nanowire/Molecular Computing. Practical problems at the end of each chapter for students.

This is the first comprehensive book to address the design of RF MEMS-based circuits for use in high performance wireless systems. A groundbreaking research and reference tool, the book enables you to understand the realm of applications of RF

MEMS technology; become knowledgeable of the wide variety and performance levels of RF MEMS devices; and partition the architecture of wireless systems to achieve greater levels of performance. This innovative resource also guides you through the design process of RF MEMS-based circuits, and establishes a practical knowledge base for the design of high-yield RF MEMS-based circuits. The book features exercises and detailed case studies on working RF MEMS circuits that help you decide what approaches best fit your design constraints. This unified treatment of RF MEMS-based circuit technology opens up a new world of solutions for meeting the unique challenges of low power/portable wireless products.

This book contains the best papers of the International Conference on Advances in Power Electronics and Instrumentation Engineering, PEIE 2010, organized by the Association of Computer Electronics and Electrical Engineers (ACEEE), during September 7–9, 2010 in Kochi, Kerala, India. PEIE is an international conference integrating two major areas of electrical en- neering – power electronics and instrumentation. Thus this conference reflects a c- tinuing effort to increase the dissemination of recent research results among prof- sionals who work in the areas of power electronics, instrumentation and electrical engineering The program of this joint conference included several outstanding keynote lectures presented by internationally renowned distinguished researchers who are experts in the various PEIE areas. Their keynote speeches have contributed to heightening the ov- all quality of the program and significance of the theme of the conference. I hope that you will find this collection of the best PEIE 2010 papers an excellent source of inspiration as well as a helpful reference for research in the aforementioned areas. Organizing a conference like this one is not possible without the assistance and continuous support of many people and institutions. I thank Stefan Goeller, Janahanlal Stephen, R Vijay Kumar, and Nessy Thankachan for their constant support and gu- ance. I would like to express my gratitude to Springer's LNCS-CCIS editorial team, especially Leonie Kunz, for producing such a wonderful proceedings book.