

## Chapter 2

# MEMS Accelerometers: Testing and Practical Approach for Smart Sensing and Machinery Diagnostics

A. Albarbar and S.H. Teay

**Abstract** Micro-Electro Mechanical Systems (MEMS)-based sensing elements are gaining wider acceptance and adoption for static and dynamic (mobile) applications. Recent increase in demands for reliable wireless sensing nodes has necessitated seeking alternatives to expensive conventional accelerometers to perform multi-control and monitoring tasks. Owing to their size and cost, MEMS accelerometers is one of the alternative options.

This chapter provides insight into the fundamental design, working principles and practical guidance to MEMS accelerometers. Details of experimental set-ups, signal conditioning and data processing are also provided to construct integrated performance assessment system. Performance assessments are carried out using sinusoidal excitations, impulsive (hammer testing) and random excitations. Subsequently, calculations and comments on frequency response functions, signal-to-noise ratios and phase distortions are outlined. Finally, guidelines to practical adoption of MEMS accelerometers such as packaging, establishing smart vibration sensing nodes and extraction of condition-related information are given.

**Keywords** MEMS accelerometers design and testing • Performance assessment of MEMS accelerometers • Vibration measurement using MEMS sensors • Smart sensor design and implementation • Machinery-condition monitoring

## 1 Introduction

Vibration analysis is one of the most usable methods in machinery-condition monitoring. It plays a significant role in the dynamic qualification of newly designed structural components, prediction of faults and structural aging-related problems, and several other structural dynamics studies and diagnosis [1–3]. One reason for

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# Chapter 2 Mems Accelerometers Testing And Practical

**Henry Baltes**



## **Chapter 2 Mems Accelerometers Testing And Practical:**

Advanced Mechatronics and MEMS Devices II Dan Zhang, Bin Wei, 2016-10-18 This book introduces the state of the art technologies in mechatronics robotics and MEMS devices in order to improve their methodologies It provides a follow up to Advanced Mechatronics and MEMS Devices 2013 with an exploration of the most up to date technologies and their applications shown through examples that give readers insights and lessons learned from actual projects Researchers on mechatronics robotics and MEMS as well as graduate students in mechanical engineering will find chapters on Fundamental design and working principles on MEMS accelerometers Innovative mobile technologies Force tactile sensors development Control schemes for reconfigurable robotic systems Inertial microfluidics Piezoelectric force sensors and dynamic calibration techniques And more Authors explore applications in the areas of agriculture biomedicine advanced manufacturing and space Micro assembly for current and future industries is also considered as well as the design and development of micro and intelligent manufacturing

*Failure Analysis* Marius Bazu, Titu Bajenescu, 2011-03-08 Failure analysis is the preferred method to investigate product or process reliability and to ensure optimum performance of electrical components and systems The physics of failure approach is the only internationally accepted solution for continuously improving the reliability of materials devices and processes The models have been developed from the physical and chemical phenomena that are responsible for degradation or failure of electronic components and materials and now replace popular distribution models for failure mechanisms such as Weibull or lognormal Reliability engineers need practical orientation around the complex procedures involved in failure analysis This guide acts as a tool for all advanced techniques their benefits and vital aspects of their use in a reliability programme Using twelve complex case studies the authors explain why failure analysis should be used with electronic components when implementation is appropriate and methods for its successful use Inside you will find detailed coverage on a synergistic approach to failure modes and mechanisms along with reliability physics and the failure analysis of materials emphasizing the vital importance of cooperation between a product development team involved the reasons why failure analysis is an important tool for improving yield and reliability by corrective actions the design stage highlighting the concurrent engineering approach and DfR Design for Reliability failure analysis during fabrication covering reliability monitoring process monitors and package reliability reliability resting after fabrication including reliability assessment at this stage and corrective actions a large variety of methods such as electrical methods thermal methods optical methods electron microscopy mechanical methods X Ray methods spectroscopic acoustical and laser methods new challenges in reliability testing such as its use in microsystems and nanostructures This practical yet comprehensive reference is useful for manufacturers and engineers involved in the design fabrication and testing of electronic components devices ICs and electronic systems as well as for users of components in complex systems wanting to discover the roots of the reliability flaws for their products

**Handbook of Structural Life Assessment** Raouf A. Ibrahim, 2017-04-17 This

important self contained reference deals with structural life assessment SLA and structural health monitoring SHM in a combined form SLA periodically evaluates the state and condition of a structural system and provides recommendations for possible maintenance actions or the end of structural service life It is a diversified field and relies on the theories of fracture mechanics fatigue damage process and reliability theory For common structures their life assessment is not only governed by the theory of fracture mechanics and fatigue damage process but by other factors such as corrosion grounding and sudden collision On the other hand SHM deals with the detection prediction and location of crack development online Both SLA and SHM are combined in a unified and coherent treatment

Advanced MEMS Packaging John H. Lau, Cheng Kuo Lee, C. S. Premachandran, Yu Aibin, 2009-10-22 A comprehensive guide to 3D MEMS packaging methods and solutions Written by experts in the field Advanced MEMS Packaging serves as a valuable reference for those faced with the challenges created by the ever increasing interest in MEMS devices and packaging This authoritative guide presents cutting edge MEMS microelectromechanical systems packaging techniques such as low temperature C2W and W2W bonding and 3D packaging This definitive resource helps you select reliable creative high performance robust and cost effective packaging techniques for MEMS devices The book will also aid in stimulating further research and development in electrical optical mechanical and thermal designs as well as materials processes manufacturing testing and reliability Among the topics explored Advanced IC and MEMS packaging trends MEMS devices commercial applications and markets More than 360 MEMS packaging patents and 10 3D MEMS packaging designs TSV for 3D MEMS packaging MEMS wafer thinning dicing and handling Low temperature C2C C2W and W2W bonding Reliability of RoHS compliant MEMS packaging Micromachining and water bonding techniques Actuation mechanisms and integrated micromachining Bubble switch optical switch and VOA MEMS packaging Bolometer and accelerameter MEMS packaging Bio MEMS and biosensor MEMS packaging RF MEMS switches tunable circuits and packaging

IEEE VLSI Test Symposium ,2005 Case-based Reasoning for MEMS Design Synthesis Corie Lynn Cobb, 2008 *Proceedings of the Fourteenth Biennial University/Government/Industry Microelectronics Symposium* ,2001 **International Aerospace Abstracts** ,1999 **Microlithography and Metrology in Micromachining** ,1997 **Enabling Technology for MEMS and Nanodevices** Henry Baltes, 2004-08-06

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## **Table of Contents Chapter 2 Mems Accelerometers Testing And Practical**

1. Understanding the eBook Chapter 2 Mems Accelerometers Testing And Practical
  - The Rise of Digital Reading Chapter 2 Mems Accelerometers Testing And Practical
  - Advantages of eBooks Over Traditional Books
2. Identifying Chapter 2 Mems Accelerometers Testing And Practical
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Chapter 2 Mems Accelerometers Testing And Practical
  - User-Friendly Interface

4. Exploring eBook Recommendations from Chapter 2 Mems Accelerometers Testing And Practical
  - Personalized Recommendations
  - Chapter 2 Mems Accelerometers Testing And Practical User Reviews and Ratings
  - Chapter 2 Mems Accelerometers Testing And Practical and Bestseller Lists
5. Accessing Chapter 2 Mems Accelerometers Testing And Practical Free and Paid eBooks
  - Chapter 2 Mems Accelerometers Testing And Practical Public Domain eBooks
  - Chapter 2 Mems Accelerometers Testing And Practical eBook Subscription Services
  - Chapter 2 Mems Accelerometers Testing And Practical Budget-Friendly Options
6. Navigating Chapter 2 Mems Accelerometers Testing And Practical eBook Formats
  - ePub, PDF, MOBI, and More
  - Chapter 2 Mems Accelerometers Testing And Practical Compatibility with Devices
  - Chapter 2 Mems Accelerometers Testing And Practical Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Chapter 2 Mems Accelerometers Testing And Practical
  - Highlighting and Note-Taking Chapter 2 Mems Accelerometers Testing And Practical
  - Interactive Elements Chapter 2 Mems Accelerometers Testing And Practical
8. Staying Engaged with Chapter 2 Mems Accelerometers Testing And Practical
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Chapter 2 Mems Accelerometers Testing And Practical
9. Balancing eBooks and Physical Books Chapter 2 Mems Accelerometers Testing And Practical
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Chapter 2 Mems Accelerometers Testing And Practical
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Chapter 2 Mems Accelerometers Testing And Practical
  - Setting Reading Goals Chapter 2 Mems Accelerometers Testing And Practical
  - Carving Out Dedicated Reading Time

12. Sourcing Reliable Information of Chapter 2 Mems Accelerometers Testing And Practical
  - Fact-Checking eBook Content of Chapter 2 Mems Accelerometers Testing And Practical
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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