

## 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

**Robert R. Redfield**



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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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keterangan x rata rata kelas x jumlah seluruh skor n banyaknya siswa b ketuntasan belajar individual ketuntasan belajar individual dihitung dengan menggunakan rumus

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pola time series bagian keempat menguraikan hal hal yang berhubungan

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dalam skala interval atau rasio sering dideskripsikan dengan nilai rata rata mean atau total sementara itu dalam penentuan ukuran sampel melalui model pendekatan statistika terdapat rumus rumus yang berlainan untuk pengukuran rata rata total maupun proporsi

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sudjana 2002 66 69 menjelaskan data itu adalah menentukan rerata mean nilai sering muncul modus dan nilai tengah data median rumus data tersebut adalah rumus yang digunakan untuk mencari rata rata mean adalah sumber sudjana 2004 keterangan mean rerata jumlah nilai hasil jumlah data sampel menentukan nilai yang sering muncul

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a rata rata mean rata rata digunakan untuk mencari nilai rata rata dari keseluruhan sampel yang ada dalam keseluruhan data yang akan dianalisis □ □ □ sudjana 2013 keterangan □ rata rata j □ □ jumlah keseluruhan data x □ banyaknya data b modus

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menggunakan rumus berikut banyaknya peserta didik rumus rata rata hitung dimodifikasi dari sudjana 2005 dari 70 nilai tes hasil belajar thb dan keterangan 30 nilai pengerjaan lkpd kemudian hasil rata rata skor aktivitas peserta didik dari pengamat ke i

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distribusi sampling rata rata sudjana 2001 87 mendefinisikan distribusi sampling rata rata adalah kumpulan dari bilangan bilangan yang masing masing merupakan rata rata hitung dari sampelnya notasi dalam distribusi sampling rata rata n ukuran sampel n ukuran populasi x rata rata sampel  $\mu$  rata rata populasi

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cara menghitung rata rata hasil belajar matematika dengan rumus sudjana 2005 67 keterangan nilai rata rata hasil belajar matematika siswa banyaknya subjek jumlah nilai seluruh siswa adapun untuk menentukan varians nantinya akan disusun terlebih dahulu dalam tabel distribusi frekuensi

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rumus rata rata diadaptasi dari sudjana 1975 keterangan  $\bar{x}$  skor rata rata praktikalitas  $\bar{y}$  skor rata rata praktikalitas peserta didik ke  $\bar{z}$  banyak peserta didik 5 kemudian hasil dari skor rata rata kepraktisan yang dinilai oleh guru dan peserta didik tersebut

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sudjana 1996 metoda statistika bandung tarsito bandung banyak uji t digunakan dengan rumus seandainya ada empat rata rata n 4 maka banyak uji t dilakukan adalah sebelum uji kesamaan beberapa rata rata dilakukan maka persyaratannya haruslah dipenuhi terlebih dahulu persyaratan uji beberapa rata rata sama halnya

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yang diberikan oleh penilai kemudian rata rata perolehan skor kepraktisan oleh masing masing penilai dengan menggunakan rumus berikut k rumus rata rata hitung diadaptasi dari sudjana 2005 bengkulu yaitu ibu velysa astari s pd dan keterangan ibu alin suhermi s pd kepraktisan oleh siswa rata rata skor kepraktisan oleh

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b rata rata untuk menghitung rata rata digunakan rumus berikut  $\bar{x} = \frac{\sum f_i x_i}{\sum f_i}$  sudjana 2016 67 keterangan x mean rata rata x i jumlah nilai uji f i jumlah frekuensi untuk nilai x i yang bersesuaian c variasi untuk menghitung variasi digunakan rumus berikut  $s^2 = \frac{\sum f_i x_i^2}{n} - \bar{x}^2$  sudjana 2016 95

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 $\bar{a}$  percepatan rata rata t waktu v kecepatan benda dari rumus tersebut nantinya dapat diketahui bahwa jika percepatan positif maka benda mengalami percepatan yang searah dengan gerak benda

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