

## An Analytical Approach to Solving Motor Vibration Problems

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**Abstract:** Vibration problems in induction motors can be extremely frustrating and may lead to greatly reduced reliability. It is imperative, in all operations and manufacturing processes that down time is avoided or minimized, if a problem does occur the source of the problem is quickly identified and corrected. With proper knowledge and diagnostic procedures, it is normally possible to quickly pinpoint the cause of the vibration. All too often erroneous conclusions are reached as a consequence of not understanding the root cause of the vibration. This may result in trying to fix an incorrectly diagnosed problem, spending a significant amount of time and money in the process. By utilizing the proper data collection and analysis techniques, the true source of the vibration can be discovered. This includes, but is not limited to:

Electrical imbalance  
Mechanical imbalance – motor, coupling, or driven equipment  
Mechanical effects – looseness, rubbing, bearings, etc.  
External effects - base, driven equipment, misalignment, etc.  
Resonance, critical speeds, reed critical etc.

Once the electrical and mechanical interactions in a motor are understood, and the influence external components have on the apparent motor vibration, identification of the offending component is usually straightforward. This paper provides an analytical approach for expeditiously understanding and solving these types of problems.

**Index Terms:** Induction Motors, Troubleshooting Vibrations, Cause of Vibration.

### I. INTRODUCTION

Much has been written about vibration over the years. This includes many papers and books on vibration in general and a number of papers on vibration in induction motors in particular. This is an ongoing subject, continually extended by advances in analytical and diagnostic tools and methods. For this reason, and because this is an important and complex subject, it is worthwhile periodically to both present any new knowledge and experience as well as to review prior knowledge and concepts.

Vibration problems can occur at anytime in the installation or operation of a motor. When they occur it is normally critical that one reacts quickly to solve the problem. If not solved quickly, one could either expect long term damage to the motor or immediate failure, which would result in immediate loss of production. The loss of production is oftentimes the

most critical concern. To solve a vibration problem one must differentiate between cause and effect. For this to happen, one must first understand the root cause of the vibration. In other words: where does the force come from? Is the vibratory force the cause of the high levels of vibration or is there a resonance that amplifies the vibratory response. Perhaps the support structure is just not stiff enough to minimize the displacement. In this paper the various sources of electrical and mechanical forces will be explained. Additionally, how the motor reacts or transmits this force and how this force can be amplified or minimized will be explained as well. When a vibration problem occurs it is important that one use a good systematic, analytical approach in resolving the problem. This includes performing the proper diagnostic tests. The process starts by listing all the possible causes for the particular identified frequency of vibration and any variations under different operating conditions. Then eliminate the incorrect causes one by one until all that remains is the true source of the problem, and now this can be efficiently eliminated.

### II. SOURCES OF VIBRATION

There are many electrical and mechanical forces present in induction motors that can cause vibrations. Additionally, interaction of these various forces make identification of the root cause elusive. In subsequent sections, the major mechanisms are discussed. For a more comprehensive list of electrically and mechanically induced vibrations Table I should be referenced.

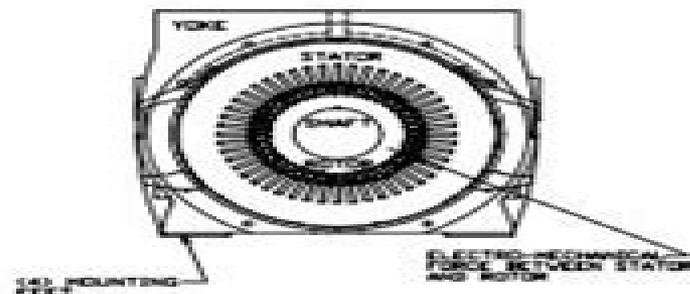


FIG. 1. Stator and Rotor

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**Christian G. Meyer**



## **An Analytical Approach To Solving Motor Vibration Problems:**

**Vibration Control and Actuation of Large-Scale Systems** Hamid Reza Karimi, 2020-05-20 Vibration Control and Actuation of Large Scale Systems gives a systematically and self contained description of the many facets of envisaging designing implementing or experimentally exploring advanced vibration control systems The book is devoted to the development of mathematical methodologies for vibration analysis and control problems of large scale systems including structural dynamics vehicle dynamics and wind turbines for example The research problems addressed in each chapter are well motivated with numerical and simulation results given in each chapter that reflect best engineering practice Provides a series of the latest results in vibration control structural control actuation component failures and more Gives numerical and simulation results to reflect best engineering practice Presents recent advances of theory technological aspects and applications of advanced control methodologies in vibration control Rotating Machinery, Vibro-Acoustics & Laser Vibrometry, Volume 7 Dario Di Maio, 2025-08-07 Rotating Machinery Vibro Acoustics Vibro Acoustics Experimental Techniques Scanning Laser Doppler Vibrometry Methods *Mechanical Design and Manufacturing of Electric Motors* Wei Tong, 2022-05-19 This Second Edition of Mechanical Design and Manufacturing of Electric Motors provides in depth knowledge of design methods and developments of electric motors in the context of rapid increases in energy consumption and emphasis on environmental protection alongside new technology in 3D printing robots nanotechnology and digital techniques and the challenges these pose to the motor industry From motor classification and design of motor components to model setup and material and bearing selections this comprehensive text covers the fundamentals of practical design and design related issues modeling and simulation engineering analysis manufacturing processes testing procedures and performance characteristics of electric motors today This Second Edition adds three brand new chapters on motor breaks motor sensors and power transmission and gearing systems Using a practical approach with a focus on innovative design and applications the book contains a thorough discussion of major components and subsystems such as rotors shafts stators and frames alongside various cooling techniques including natural and forced air direct and indirect liquid phase change and other newly emerged innovative cooling methods It also analyzes the calculation of motor power losses motor vibration and acoustic noise issues and presents engineering analysis methods and case study results While suitable for motor engineers designers manufacturers and end users the book will also be of interest to maintenance personnel undergraduate and graduate students and academic researchers *Energy Efficiency in Motor Systems* Paolo Bertoldi, 2021-09-24 This book contains selected peer reviewed papers presented at the 11th International Conference on Energy Efficiency in Motor Systems EEMODS 19 held in Tokyo Japan from 17 19 September 2019 As with previous conferences in this series EEMODS 19 provided a scientific forum to discuss and debate the latest developments and impacts of electrical motor systems on energy and the environment energy efficiency policies and programmes adopted and planned standards including ISO 50 001

and the technical and commercial advances made in the dissemination and penetration of energy efficient motor systems Topics covered include technologies research and innovation in the areas of electric motors from life cycle costing to 3D printing to artificial intelligence machine learning based monitoring systems emerging motor technologies power electronics and drives pump systems including life cycle costing energy efficiency improvements maintenance and operation for industrial water supply and treatment building and irrigation compressed air systems fans exhaust systems refrigeration systems maintenance and operation mechanical power transmission motors in household appliances and HVAC residential and commercial motors and drives for transport applications including policies programmes regulation and international standards industrial management policies and standards motor system audit and verification policies programmes and financing analysis of motor system energy use and greenhouse gas emissions for motor systems e vehicles and related charging infrastructure harmonization of global motor efficiency test standards evaluation of utility programmes for improving energy efficiency in motor systems and policy implementation market surveillance and enforcement mechanisms including case studies The conference is international by nature and aims to attract high quality and innovative contributions from all corners of the globe while the papers facilitate the development of new technologies policies and strategies to increase energy efficiency

Nonlinear Dynamical Systems in Engineering Vasile Marinca, Nicolae Herisanu, 2012-01-05 This book presents and extend different known methods to solve different types of strong nonlinearities encountered by engineering systems A better knowledge of the classical methods presented in the first part lead to a better choice of the so called base functions These are absolutely necessary to obtain the auxiliary functions involved in the optimal approaches which are presented in the second part Every chapter introduces a distinct approximate method applicable to nonlinear dynamical systems Each approximate analytical approach is accompanied by representative examples related to nonlinear dynamical systems from to various fields of engineering

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