

## 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 unbalance – 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.

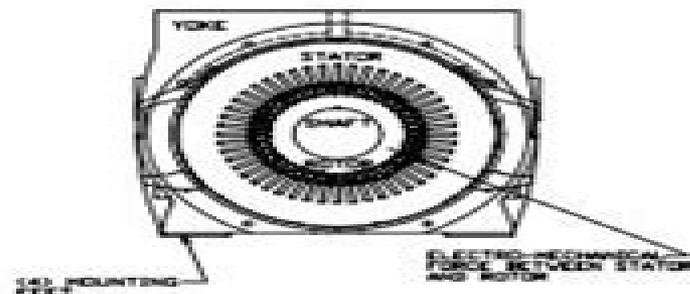


FIG. 1. Stator and Rotor

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