# Chapter 4
# Analysis of Sidebands Failures in Asynchronous Drives

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## ABSTRACT

*This chapter deals with the diagnosis of induction motors (IM) with the so-called motor current signature analysis (MCSA). The MCSA is one of the most efficient techniques for the detection and the localization of electrical and mechanical failures, in which faults become apparent by harmonic components around the supply frequency. This chapter presents a summary of the most frequent faults and its consequences on the stator current spectrum of an IM. A three-phase IM model was used for simulation taking into account in one hand the normal healthy operation and in the other hand the broken rotor bars, the shorted turns in the stator windings, the voltage unbalance between phases of supply, and the abnormal behavior of load. The MCSA is used by many authors in literature for faults detection of IM. The major contribution of this work is to prove the efficiency of this diagnosis methodology to detect different faults simultaneously, in normal and abnormal functional conditions. The results illustrate good agreement between both simulated and experimental results.*

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## INTRODUCTION

Induction motors play an important role in industry for the rotating machine practice because of their robustness, low costs and quasi-absence of maintenance. Nevertheless, it is seen that this machine presents an electric or mechanical defect. The faults of these machines are varied. However the most frequent are (Benbouzid, 2000; Razik, 2002; Trajin et al., 2008): opening or shorting of one or more of a stator phase winding, broken rotor bar or cracked rotor end rings, static or dynamic air-gap irregularities, and bearing failures. In order to avoid such problems, these faults have to be detected to prevent a major failure from occurring. It is well known that a motor failure may yield an unexpected interruption at the industrial plant, with consequences in costs, product quality, and safety. During the past twenty years, there has been a substantial amount of fundamental research into the creation of condition monitoring and diagnostic techniques for IM drives.

Different detection approaches are proposed in the literature such as those based on the Extended Park's Vector Approach (EPVA), which allows the detection of inter-turn short circuits in the stator winding (Acosta et al., 2004). The EPVA is appropriate for the stator winding monitoring. Çalis and Çakir (2007) used the 2.s.fs spectral component in the stator current zero crossing times (ZCT) spectrum as an index of rotor bar faults. However, the major deficiency for this fault indicator, for low slip IM Operating at no load condition is that it may then be difficult to read its value. In Casimir et al. (2006), the authors studied the diagnosis of IM by pattern recognition method. This method consists in extracting features from the combination of the stator currents and voltages. Some of these features could be irrelevant or redundant. Therefore, the Sequential Backward Selection (SBS) algorithm is applied to the complete set of features to select the most relevant. Then they used the k-Nearest Neighbours (kNN) rules to monitor the IM functioning states. This rule is applied with reject options in order to avoid automatic classifications and diagnosis errors. Didier et al. (2007) employed the Fourier Transform of the stator current and then analyzed its phase. It is shown that the calculated phase gives good results when the motor operates near its nominal load. For weak load, the results obtained are not robust enough for the detection of an incipient rotor fault.

In Li and Mechefske (2004), the authors used the vibration monitoring methodology to detect incipient failures in IM. Vibration monitoring system requires storing of a large amount of data. Vibration is often measured with multiple sensors mounted on different parts of the machine. The examination of data can be tedious and sensitive to errors. Also, fault related machine vibration is usually corrupted with structural machine vibration and noise from interfering machinery. To overcome these problems Poyhonen et al. (2003) used the Independent Component Analysis