Chapter 4
Thermal Analysis

ABSTRACT

Over temperature is one of the main reasons of failure in electric power converters. In addition, some of other failure factors such as dielectric breakdown act as over temperature in damaging process of a converter. In the previous chapter, it is emphasized that temperature factor is a key index in reliability calculation. Unlike fully electrical variables, thermal calculations require details of geometry of the system and its environment. In this chapter, thermal analysis as the most important factor in failure of converters is presented. Two main approaches for this goal are presented: numerical and lumped mode. Principles of these methods are described with various examples and a comparison is presented. Basic principles of thermal modeling are described and concept of sample node is explained. Methods for thermal management of an electric power converter are described. These methods are at both component and system levels and contain various heat transfer mechanisms like conduction and convection. Theoretical methods and practical considerations for heat sink selection and proper mounting are presented. Thermal insulation classes and various standards related to thermal management are expressed. Industrial samples are presented to show application of theoretical topics in real world.

INTRODUCTION: FAILURES DUE TO THERMAL PROBLEMS

This chapter is considered as a support for reliability calculation as it is shown in Figure 1. Over temperature is one of the main reasons of failure in the systems. In the opposite of other failure factors (for example: dielectric breakdown), over temperature calculation is not performed easily as the analysis of other failure factors are taken place. Thus, in this chapter, temperature calculations of electrical machines and power electronic converters are explained.

METHOD OF HEAT TRANSFER

There are three modes of heat transfer from a source with higher temperature to a region of lower temperature.

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Conduction

Conduction heat transfer occurs when there is a temperature gradient in a system. Energy is transferred from the high temperature region to the low temperature region. The energy transferring requires a material medium to occur. The heat transfer rate is proportional to the temperature gradient in the direction of the heat flow, the area and a property of the system.