PART ONE:

VIBRATION

2. INTRODUCTION

When vibration arises in a tool or machine, the excitation is transmited through the whole of it, affecting the different components contained, including the printed circuit board. According to [1] there are four basic failure modes which could be related to vibration excitement and which therefore should be considered in the design process.

1. High acceleration levels, which can lead some components to electrical malfunction.
2. High stress levels, producing structural damage.
3. Large displacements, resulting in collision of the PCB.
4. Electrical signals out of tolerance, for example due to relative motion in cables and harnesses.

This part will focus mainly on the second point, since it is usually the most critical restriction to design, and its only fulfillment will assure the structural integrity of the system, although the other casuistry will be mentioned when it concerns.

Stress failure appears due to the fact that the PCB is usually relatively flexible, whereas the electronic components mounted on it, on the contrary, are very stiff. This way, while the former tend to acquaire noticiable deformation, essentially bending, when subjected to vibrational excitement, the second remain undeformed. This situation derives in a relative motion between both elements, which must be assumed by a defformation in the mounting system and the solder joints, since one of their purposes is to maintain the electronic components fixed to the PCB. This defformation produces the stress which is the cause of the failure. As both joints and mounting system are not only the structural support of the electronic component, but also the electrical transmission system, it is also possible that an electronic failure due to the loss of a contact occurs even before a serious structural damage has taken place.

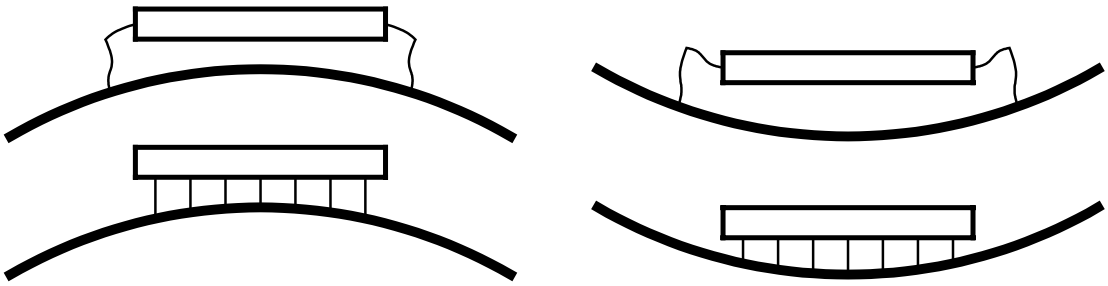

Fig. 2.1.- Deformation of electronic components packaging due to relative motion with the PCB.

As can be seen in the figure, the lead wires in legged components will alternately bend due to the mentioned relative motion. In the case of other types of mounting, such as pin or solder balls, the effect can be shear stress or traction/compression.

The failure occurs although stress leves are usually lower than the ultimate tensile stress of the material of the mounting. This is due to the process of material fatigue, by which a material is weakened by cumulative cyclic loading.

In the following chapters a study of the failures due to vibration and the possible solutions available will be conducted. It starts with a general review of both vibration and fatigue processes, covering both general theory and the concrete models and techniques used for the analysis of electronic components. After this theoretical foundation, the different solutions found in literature will be presented.