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Guidelines for Accelerated Reliability Testing of Surface Mount Solder Attachments

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1.0 SCOPE

This document provides guidelines for accelerated reliability testing of surface mount solder attachments and for evaluating and extrapolating the results of these accelerated reliability tests towards actual use environments of electronic assemblies. Background and design information is provided for an understanding of the accelerated test issues.

1.1 Purpose The purpose of accelerated reliability testing is to provide confidence that the design and the manufacturing/assembly processes are capable of meeting the intended goals of product performance. These guidelines provide adequate commonality and validity for accelerated reliability tests:

- To allow comparison of results from different test programs
- To provide the generic technical understanding of the underlying issues necessary to the design for adequate reliability
- To permit the analytical prediction of reliability based on a generic database and technical understanding
- To reduce cost and avoid time-consuming testing of every design iteration
- To establish practical alternatives to replace the excessively long test durations necessary to verify reliability of products subject to severe use environments or low failure tolerances

1.2 Document Organization This document has been organized to provide the reader with consistent information on the various aspects of reliability and identifies the parameters that need to be addressed. Each section serves a specific function in the reliability description chain. Where appropriate, references are provided as to where additional information may be obtained.

- *Section 3, "Requirements"*
  This section provides an overview of the concepts of reliability and all of the characteristics that need to be considered in the validation of a product design. Included are the definitions of the appropriate terms, as well as generic models for fatigue life and failure probability, manufacturing process flow, use environments, and testing methodology.
- *Section 4, "Surface Mount Solder Attachment Fatigue Behavior and Prediction"*
  This section deals with the fatigue life models for solder joints including their behavior when subjected to multiple cyclic loads during large temperature excursions or high frequency cycles at low temperatures. Also discussed are the acceleration factors, the acceleration transforms, and statistical considerations.
- *Section 5, "Design for Solder Joint Reliability"*
  This section details the various design parameters that have a primary influence on solder attachment fatigue reliability. All aspects of the solder joint formation are addressed including component size, lead stiffness, coefficient of thermal expansion, solder joint uniformity, as well as solder composition, grain structure and the value that conformal coating or compliant layers provide to the attachment system.
- *Section 6, "Manufacturing Processes"*
  This section provides the relationship between the assembly and attachment processes, including their control and verification, and the resultant defects or potential defects from the original processes or touch-up, rework or repair actions. Material properties of solder (including volume), components, printed boards, adhesives and conformal coatings are discussed as to their interrelationships and the impact that these characteristics have on the manufacturing processes.
- *Section 7, "Accelerated Reliability Testing"*
  This section deals with the goals of accelerated testing to produce a failure in the shortest time using techniques intended to simulate the use environment in order to establish the appropriate confidence level of product performance. Various types of stress cycling are reviewed and correlated to damage mechanisms. Also discussed is the need for developing a strategy which includes a test plan, sampling methodology, test vehicles, and failure mode analysis.
- *Appendix A, "Step-by-Step Example"*
  This section shows illustrations of applying the principles detailed in the information provided in this publication. Numerical examples are provided that highlight the relationship of the various parameters.
- *Appendix B, "References"*
  This section provides reference to published information that has a bearing on solder joint reliability and is referenced in the body of the text of this document. Details are shown as to Title, Author, and Publisher.
- *Appendix C, "Bibliography"*
  This section provides references to additional published information that could be of use to the practitioner. The references are organized into three major topics