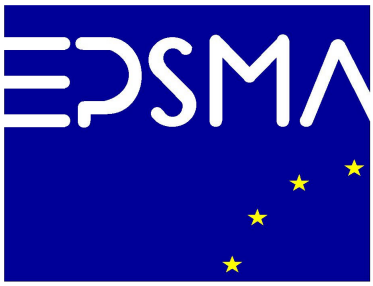

EUROPEAN POWER SUPPLIES MANUFACTURERS' ASSOCIATION
(Visit the EPSMA website at www.epsma.org)

Guidelines for Lifetime Specification of Power Converters

Document Revision: First Edition, October 2020

ABSTRACT

Full document available to EPSMA members

Paper prepared by the EPSMA Technical Committee. Special thanks and acknowledgements to the report champion Hubert Schoenenberger (PULS GmbH), Esa Väkeväinen (Murrelektronik Power), Dave Collins (Artesyn), Francesco Di Domenico (Infineon), Martin Neudecker (TDK) and Andreas Braun (Nippon Chemi-Con) for their contribution to this document.

The European Power Supplies Manufacturers' Association was established in 1995, to represent the European power supply industry.

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1 Aim / Objectives

Customers and even suppliers of power products sometimes confuse **lifetime** with Mean Time Between Failure (**MTBF)**, as both are expressed in hours. This document distinguishes between these two specifications with an emphasis on lifetime and might be regarded as an amendment to EPSMA publication "Guidelines to Understanding Reliability Prediction" from 2005 [1] explaining reliability/MTBF.

Lifetime terminology and formulae are shown in relation to MTBF and the stresses that affect the lifetime of components are discussed.

Components that contribute the most significant limitation to lifetime are examined to show what factors affect their lifetime.

The paper concludes with a summary of key points to be considered when including lifetime data in a data sheet, to help the end-user calculate the expected service life of their end product.

2 Terminology

2.1 Examples of Lifetime/MTBF confusion

When talking about reliability there has been confusion in understanding the difference between mean time between failures (MTBF) and lifetime figures in a datasheet. A power converter might be rated with an MTBF of >1,000,000 hours, but only with a lifetime expectancy of 30,000 hours. One might wonder, why there is such a large difference?

2.2 Differentiating Lifetime from MTBF

In this chapter, definitions of **Failures In Time** (**FITs**), '**failure rate *λ*'**, '**lifetime**', '**reliability function R(t)**' and '**failure distribution function F(t)**' are given. The so-called 'bath-tub' curve is explained with its description of infant mortalities, operational failure rate and wear-out. Mathematical relationships between the different quantities are given.

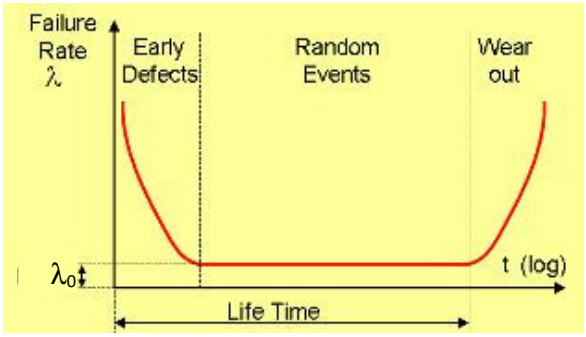

Figure 2.1 Failure Rate Bathtub Curve (© PULS LP)

2.3 Example of Components with short lifetime but long MTBF

In this section, an example is given of an application demanding very high reliability, measured in millions of hours MTBF, but short lifetime, measured in minutes.

3 Factors affecting product lifetime

3.1 Unit Life Expectancy

This section discusses how lifetime is affected by the weakest part in a system and what a reasonable definition of 'end of life' might be. It is pointed out that environmental stress is a major factor in determining lifetime but there are also effects, specific to power supplies, such as on/off cycling, which are also factors.

3.2 Electrical Stress

This section discusses the particular electrical stresses that apply to power supplies because of their position in systems as an interface between AC source and load under different environmental, load and nominal supply conditions. The potential effects of stress on functionality, lifetime and safety are discussed.

3.3 Mechanical Stress

In this section, types of mechanical stress and their effects are discussed. Mention is made of HALT (Highly Accelerated Life tests) for identification of weakest parts.

3.4 Climatic Stress

3.4.1 Temperature

The effect of temperature on lifetime of power supply products is discussed in this section with reference to the 'Arrhenius' equation to identify acceleration factor. Failures induced at high and low temperatures are mentioned.

3.4.2 Altitude, Air pressure

This section outlines the effect of altitude and corresponding low air pressure on cooling efficiency and consequent lifetime degradation of power supply products.

3.4.3 Humidity

The effect of humidity on lifetime of components is discussed in this section with reference to 'Peck's' equation.

4 Lifetime prediction of key components

In the full document, the following sections describe the failure mechanisms, stressors and analytical method for evaluating lifetime of a range of components typically used in power supply products. Methodology used by different component suppliers is described, with standards referenced as relevant. In the full document, references are made to web tools for analysis and there is also an embedded excel tool for lifetime prediction of aluminium electrolytic capacitors.

4.1 Aluminium Electrolytic Capacitors

4.2 Film Capacitors

4.3 Analog Optocouplers

4.4 Fans

4.5 Semiconductors

4.6 Rechargeable Batteries

4.7 Thin Film Resistors

4.8 Electromechanical Parts (Contact Components)

4.9 Inductive Parts

4.10 Metal Oxide Varistor (MOV)

5 Conclusions: Optimized Datasheet Specification for Lifetime

This paper shows how the lifetime of components is affected by stresses from the operating environment and the way the product is used. In this section, the paper is summarised and further guidance is given on analysis methods.

6 References

1. References to other EPSMA documents, publications and supplier data relevant to life time prediction.