Scheda informativa su nuove norme

Electric components – Reliability – Reference conditions for failure rates and stress models for conversion

La Norma EN IEC 61709, Ed. 2-2011

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Peculiarità della Norma

La conoscenza dei tassi di guasto elementari dei componenti è stata alla base, fin dagli anni ‘50, dei metodi di previsione dell’affidabilità degli apparati. Il MIL-HDBK 217 –*Reliability Prediction of Electronic Equipment*, che ne riportava i valori, è stato un riferimento essenziale in particolare negli anni in cui l’affidabilità degli apparati era fortemente condizionata dall’affidabilità dei componenti, che poteva essere molto bassa e velocemente mutevole con l’evoluzione della tecnologia.

La successiva dismissione del MIL-HDBK 217ha trovato un parziale sostituto in questa norma IEC.

Questa norma, infatti, fornisce criteri guida su come i tassi di guasto possono essere utilizzati per previsioni di affidabilità dei componenti elettronici impiegati nelle apparecchiature.

Le condizioni di riferimento sono valori numerici dei valori di stress che sono tipicamente osservati per i componenti nella maggior parte delle applicazioni. Le condizioni di riferimento sono utili dal momento che essi costituiscono la base del calcolo dei tassi di guasto in ogni specifica condizione, attraverso l’uso di modelli di stress che tengano conto delle effettive condizioni d’uso.

Tassi di guasto fissati in condizione di riferimento consentono di effettuare previsioni realistiche di affidabilità negli stadi iniziali del progetto.

I modelli di stress descritti sono modelli generali e possono essere usati come base per la conversione dei dati di tasso di guasto nelle condizioni di riferimento alle condizioni di previsto effettivo funzionamento. La conversione dei dati di tasso di guasto è permessa solo entro i limiti specificati di funzionalità dei componenti.

La norma fornisce anche criteri di guida su come un data base dei dati di guasto dei componenti può essere costruita per fornire tassi di guasto che possono essere usati con i modelli di stress previsti. Le condizioni di riferimento per i tassi di guasto sono specificate, cosicché dati provenienti da differenti fonti possono essere comparati su una base uniforme. Se tassi di guasto sono dati in accordo con la presente norma non sono richieste altre informazioni aggiuntive sulle specifiche condizioni.

Questo standard non fornisce tassi di guasto base per i componenti-piuttosto fornisce modelli che consentono di convertire in condizione operative tassi di guasto ottenuti in altre condizioni. La metodologia di previsione descritta in questa norma assume che le parti siano usate entro la loro vita utile. I metodi utilizzati hanno un’applicazione generale ma sono specificamente applicati a una selezione di tipi di componenti come definiti nel capitolo 6 e in E2.

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Annex D (informative) Potential sources of failure rate data and methods of selection
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Bibliography

(La lunghezza della norma è di 90 pagine).

4 Context and conditions

La norma ne considera I seguenti aspetti:

4.1 Failure modes

4.2 Operating profile considerations

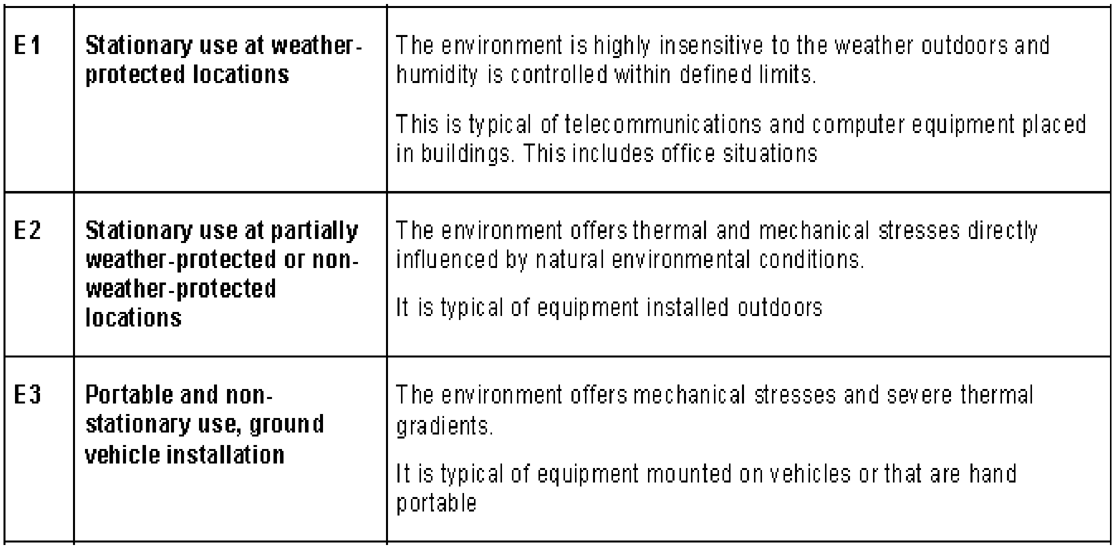
4.3 Storage conditions

4.4 Environmental conditions

The environment may be described in terms of several types of parameters. IEC 60721-3-3 describes the environment in terms of

- climatic conditions,
- special climatic conditions,
- biological conditions,
- chemically active substances,
- mechanically active substances,
- mechanical conditions (both static and dynamic).

Table 1 – Basic environments



E1	**Stationary use at weather-protected locations**	The environment is highly insensitive to the weather outdoors and humidity is controlled within defined limits. This is typical of telecommunications and computer equipment placed in buildings. This includes office situations
E2	**Stationary use at partially weather-protected or non-weather-protected locations**	The environment offers thermal and mechanical stresses directly influenced by natural environmental conditions. It is typical of equipment installed outdoors
E3	**Portable and non-stationary use, ground vehicle installation**	The environment offers mechanical stresses and severe thermal gradients. It is typical of equipment mounted on vehicles or that are hand portable

Table 2 shows the values of environmental parameters and their relationship to the classes indicated in the relevant IEC standards.

The effect of environment can be described as a change of failure rate, by applying an environmental application factor π_E (see Table 4). Note that π_E is a discrete factor since it is based on non-continuous data and summarizes a large number of different lower level factors.

Table 2 – Values of environmental parameters for basic environments

Basic environment	**E1**	**E2**	**E3**
	Stationary use at weather-protected locations	**Stationary use at partially weather-protected or non weather-protected locations**	**Portable and non-stationary use, ground vehicle installation**
Temperature rate of change	≤ 0,5 °C/min	> 0,5 °C/min	> 0,5 °C/min
Stationary vibration, sinusoidal	2-9 Hz <1,5 mm 9-200 Hz ≤ 5 m/s^2	2-9 Hz ≤3 mm 9-200 Hz ≤ 10 m/s^2	2-9 Hz >3 mm 9-200 Hz ≥ 10 m/s^2 200-500 Hz ≥15 m/s^2
Non-stationary vibration including shock	≤ 70 m/s^2	≤ 250 m/s^2	> 250 m/s^2
IEC 60721-3-3 Classes	3K1 3K2 3K3 3K4 3K5 3K6 3M1 3M2 3M3	3K7 3K7L 3K8 3K8H 3K8L 3K9 3K10 3M4 3M5 3M6 3M7	–
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5 Generic reference conditions and stress models

5.1 Recommended generic reference conditions

Table 3 – Recommended reference conditions for environmental and mechanical stresses

Type of stress	Reference condition [a]
Ambient temperature [b]	θ_0 = 40 °C
Environmental condition	Environment E1 (see Table 1)
Special stresses	Not addressed in this standard [c]

[a] The failure rates stated under these conditions apply only to components not damaged during transport and storage.

[b] For the purpose of this standard, the ambient temperature is the temperature of the medium next to the component during equipment operation, not taking into account any possible self-heating of the component. The surroundings of the component should be defined.

[c] Special stresses include wind, rain and snow, icing, drips, sprays or jets of water, dust (chemically active or not), effects of animal pests, corrosive gases, radioactive radiation, etc. These stresses may be significant contributors to failure; however, as a general good practice; they should be addressed by design practices. There may be cases where their effect can be treated by applicable models. These stresses have such wide ranges of effects it would be inappropriate to address them in this standard.

5.2 Generic stress models

5.2.1 General

The component failure rate under operating conditions is calculated as follows:

$$\lambda = \lambda_{\mathrm{ref}} \times \pi_{\mathrm{U}} \times \pi_{\mathrm{I}} \times \pi_{\mathrm{T}} \times \pi_{\mathrm{E}} \times \pi_{\mathrm{S}} \times \pi_{\mathrm{ES}}$$

where

λ_{ref} is the failure rate under reference conditions;
π_{U} is the voltage dependence factor;
π_{I} is the current dependence factor;
π_{T} is the temperature dependence factor;
π_{E} is the environmental application factor;
π_{S} is the switching rate dependence factor;
π_{ES} is the electrical stress dependence factor.

La norma riporta quindi le formule per I diversi fattori di Stress:

5.2.2 Stress factor for voltage dependence, ðU

5.2.3 Stress factor for current dependence, I

5.2.4 Stress factor for temperature dependence, π T

5.2.5 Environmental application factor, π E

5.2.5.1 General

5.2.5.2 Dependence on switching rate π S

5.2.5.3 Dependence on electrical stress π ES

5.2.6 Other factors of influence

6 Specific reference conditions and stress models

6.1 Integrated semiconductor circuits

6.1.1 Reference conditions

Table 5 – Memory

Component			θ_{ref} °C	Note
Bipolar	RAM, FIFO	Static	75	–
	PROM		75	
MOS, CMOS, BICMOS	RAM	Dynamic	55	
	RAM, FIFO	Static slow (≥ 30 ns) Static fast (< 30 ns)	55	
	ROM mask		55	
	EPROM, OTPROM	UV erasable	55	
	FLASH		55	
	EEPROM, EAROM		55	

La tabella 5 riporta, come esempio, il caso delle memorie, ma la Norma riporta analoghe tabelle per:

Table 6 – Microprocessors and peripherals, microcontrollers and signal processors

Table 7 – Digital logic families and bus interfaces, bus driver and receiver circuits

Table 8 – Analog integrated circuits (IC)

Table 9 – Application-specific ICs (ASICs)

6.1.2 Stress factors

6.1.2.1 Models

6.1.2.2 Voltage dependence, factor π U

6.1.2.3 Temperature dependence, factor π T

6.2 Discrete semiconductors

6.2.1 Reference conditions

Table 16 – Transistors common, low frequency

Table 17 – Transistors, microwave, e.g. RF >800 MHz

Table 18 – Diodes

Table 19 – Power semiconductors

6.2.2 Stress factors

6.2.2.1 General

The specific stress models are given for converting the failure rates between different conditions. These stress models contain constants which are average values for the individual component types from various manufacturers (determined from field experience and laboratory tests).

6.2.2.2 Models

The failure rate under operating conditions, from Equation (2), is as follows:

$\lambda = \lambda\text{ref} \times \pi U \times \pi\ T$ for transistors

6.2.2.3 Voltage dependence for transistors, factor π U

6.2.2.4 Temperature dependence, factor ð T

6.3 Optoelectronic components

6.3.1 Reference conditions

Table 26 – LEDs, IREDs, laser diodes and transmitter components

Table 27 – Optocouplers and light barriers

Table 28 – Passive optical components

Table 29 – Transceiver, transponder and optical sub-equipment

6.3.2 Stress factors

6.3.2.1 General

The specific stress models are given for converting the failure rates between different conditions. These stress models contain constants. They are average values for the individual component types from various manufacturers (determined from field experience and laboratory tests).

6.3.2.2 Models

6.3.2.3 Voltage dependence, factor πU

6.3.2.4 Current dependence, factor I

6.3.2.5 Temperature dependence, factor π T

6.4 Capacitors

6.4.1 Reference conditions

6.4.2 Stress factors

6.4.2.1 Model

6.4.2.2 Voltage dependence, factor πU

Table 37 – Constants for voltage dependence of capacitors

Table 38 – Factor π U for capacitors Factor πU for Uop

6.4.2.3 Temperature dependence, factor ð T

6.5 Resistors and resistor networks

6.5.1 Reference conditions

6.5.2 Stress factors
6.5.2.1 Model

The failure rate under operating conditions according to Equation (2) is:$\lambda = \lambda_{ref} \times \pi_T$

6.5.2.2 Temperature dependence, factor π T

6.6 Inductors, transformers and coils

6.6.1 Reference conditions
6.6.2 Stress factors
6.6.2.1 Model

The failure rate under operating conditions according to Equation (2) is: $\lambda = \lambda_{ref} \times \pi_T$
6.6.2.2 Temperature dependence, factorπ T

6.7 Microwave devices

6.7.1 Reference conditions

6.8 Other passive components

6.8.1 Reference conditions
The reference conditions are given in the Table 48.

6.10 Connectors and sockets

6.10.1 Reference conditions
The reference conditions are given in the Table 50.

6.11 Relays

6.11.1 Reference conditions
The reference conditions are given in the Table 51.
6.11.2 Stress factors

6.11.2.1 Model
6.11.2.2 Dependence on switching rate, factor π S

6.12 Switches and push-buttons
6.12.1 Reference conditions
The reference conditions are given in Table 57.

6.13 Signal and pilot lamps
6.13.1 Reference conditions
The reference conditions are given in Table 60.
6.13.2 Stress factors
6.13.2.1 Model

La norma contiene le seguenti importanti APPENDICI

Annex A- Failure modes of components

Annex B- Failure rate prediction

Annex C-Considerations for the design of a data base on failure rates

Annex D- Potential sources of failure rate data and methods of selection

Annex E- Overview of component classification

Annex F-Examples

Bibliography