

Electronics Design-for-eXcellence Guideline

EDM-D-014 Design-for-Robustness of Electronics

V1.0
September 2019

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The Electronics Design-for-eXcellence Guidelines principles

The Electronics Design-for-eXcellence (DfX) Guidelines are designed to provide all electronic supply chain actors involved in the design, qualification, industrialization and production of Electronics practical guidelines to master the multi-disciplinary hardware aspects of electronic module realization and operation in a cost-effective way. The Electronics DfX guidelines provide the system designer the boundary conditions of industrial electronic manufacturing technology and guidelines to achieve quality, operational reliability and regulatory compliancy. It is intended to support the development of cost-effective, reliable electronics with a short time-to-market requiring a minimum number of design iterations.

Some of the characteristics of the Electronics DfX Guidelines are:

- The Electronics DfX Guidelines are oriented towards the overall optimization of the physical design of the electronic product.
- The guidelines refer to the relevant industry standards that are predominantly used in the international electronics industry such as those published by organizations as IPC and JEDEC. The guidelines do not replace industrial standards but define or recommend what options in the standards to use and will fill-in gaps if necessary. They provide the basis on which a company/product/product-line or application specific approach for design, industrialization and/or realization can be defined.
- Scientific argumentation and physical models form the basis of a large part of the guidelines and of the associated tools. This allows the use of the guidelines beyond the boundary of the users' experience domain. Therefore, it provides a powerful product and process innovation aid.
- The Electronics DfX Guidelines will not specify, recommend or exclude specific brands of materials, components, suppliers or products. They will put forward minimal requirements on quality, physical and chemical properties and testing.
- The Electronics DfX Guidelines are based on verifiable physical models, standards and empirical data.

Design-for-Robustness guideline scope

This guideline supports the Design-for-Robustness of electronics, i.e., the ruggedization of electronics or equipment containing electronics against failure of the electronics due to exceptional over-stress events of different kinds.

Acknowledgement

This document was realized in collaboration with the industrial and academic partners of imec's Center of Electronics Design & Manufacturing and Sirris.

Funding organizations

IWT/VLAIO is acknowledged for funding the VIS-traject project InProVoL that provided the basis for this guideline.

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1. Applicable Documents

This Electronics DfX Guideline refers to the most recent version including amendments and addendums of the following documents:

EDM-D-100	Reliability Quantification
EDM-D-002	Electronic Component Specification for Printed Board Assembly
EDM-D-003	PBA Assembly Material Specification
EDM-D-004	Design-for-Assembly
EDM-D-009	Signal Integrity
EDM-D-010	Power Integrity
EDM-D-011	Electro-Magnetic Compatibility
EDM-D-012	Mechanical Integration
EDM-Q-014	Robustness Qualification
ANSI C63.16	American National Standard Guide for Electrostatic Discharge Test Methodologies and Acceptance Criteria for Electronic Equipment
ASTM B827-05	Standard Practice for Conducting Mixed Flowing Gas (MFG) Environmental Tests.
BS 7195 (1989)	Prevention of corrosion of metals caused by vapours from organic materials
ETS 300 019-2-2	Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment. Part 2-2: Specification of environmental tests Transportation.
IEC 60068-3-3	Environmental testing - Part 3-3: Guidance - Seismic test methods for equipments.
IEC 60068-2-10	Environmental testing. Part 2-10: Tests. Test J and guidance: Mould growth.
IEC 60068-2-13	Environmental testing. Part 2: Tests. Test M: Low air pressure.
IEC 60068-2-30	Environmental testing. Part 2-30: Tests. Test Db: Damp heat, cyclic (12h + 12h cycle).
IEC 60068-2-31	Test Ec: Drop and topple, primarily for equipment-type specimens
IEC 60068-2-40	Environmental testing. Part 2: Tests. Test Z/AM: Combined cold/low air pressure tests.
IEC 60068-2-41	Environmental testing. Part 2: Tests. Test Z/BM: Combined dry heat/low air pressure tests.
IEC 60068-2-52	Environmental testing. Part 2: Tests. Test Kb: Salt mist, cyclic (sodium, chloride solution).
IEC 60068-2-60	Environmental testing. Part 2: Tests. Test Ke: Flowing mixed gas corrosion test.
IEC 60068-2-68	Environmental testing. Part 2: Tests. Test L: Dust and sand
IEC 60068-2-78	Environmental testing. Part 2-78: Tests. Test Cab: Damp heat, steady state.
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60654-1	Industrial-process measurement and control equipment. Operating conditions. Part 1: Climatic conditions
IEC 60721 series	Classification of Environmental Conditions
IEC 60721-2-3	Classification of environmental conditions. Part 2: Environmental conditions appearing in nature. Air pressure.
IEC 60721-2-5	Classification of environmental conditions. Part 2: Environmental conditions appearing in nature. Section 5: Dust, sand, salt mist.
IEC 61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
IEC 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test

IEC 61000-4-23	Electromagnetic compatibility (EMC) - Part 4-23: Testing and measurement techniques - Test methods for protective devices for HEMP and other radiated disturbances
IEC 61340-5	Protection of electronic devices from electrostatic phenomena
IEEE 1848	Techniques & Measures to Manage Functional Safety and Other Risks With Regard to Electromagnetic Disturbances ¹
IPC-2221	Generic Standard on Printed Board Design
IPC-JEDEC-9702	Monotonic Bending Characterization of Board-Level Interconnects
ISO 9223	Corrosion of metals and alloys. Classification of corrosivity of atmospheres.
ISO-16750-3	Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 3: Mechanical Loads.
JESD22-B113	Board Level Cyclic Bend Test Method for Interconnect Reliability Characterization of Components for Handheld Electronic Products
JESD22-B110B	Mechanical shock – component and subassembly
JESD22-B111A	Board level drop test method of components for handheld electronic products
JS-001	ESDA/JEDEC Joint Standard for Electrostatic Discharge Sensitivity Testing -Human Body Model (HBM) - Component Level
J-STD-001FS	Space application addendum to J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies.
J-STD-075	Classification of Non-IC Electronic Components for Assembly Processes

Recommended reading:

VTT Publication 626 by Risto Hienonen & Reima Lahtinen, Corrosion and climatic effects in electronics, VTT 2007.

IET Code of Practice for Electromagnetic Resilience, IET2017

2. Applicability of the DfX Guideline EDM-D-014

- High stress events that are within the common operational conditions of the electronics or the equipment containing electronics are part of Design-for-Reliability and out-of-scope of this guideline.
- The recommendations given in the guideline are intended to help the user in designing electronics that is capable of withstanding a limited number of exceptional over-stress events without physical failure or failure opportunities of the electronic assembly (PBA). System level ruggedization using redundancy and fault-tolerant behavior are out-of-scope.
- Robustness aspects are addressed by many standards applied in different application domains. This guideline refers to a limited number of them. It does not provide a comprehensive overview of all standards that are relevant to robustness. Only the expressions “shall be per *Standard ID*” or “*Standard ID* is recommended” indicates a specific standard to be (preferably) used. Other standard references are intended as a guide to relevant standards for the user of this guideline.
- Robustness aspects during transport including storage, installation and operation including maintenance are covered. Exceptional stress situation in manufacturing are mentioned. Good Design-for-Assembly and good manufacturing practices must assure good quality. This lies outside the scope of this guideline.
- For the different cases of exceptional loads, the following elements are discussed:
 - Description of the main load sources.
 - Description of the failure mechanisms which are triggered.

¹ Standard currently under balloting at the release date of this guideline.