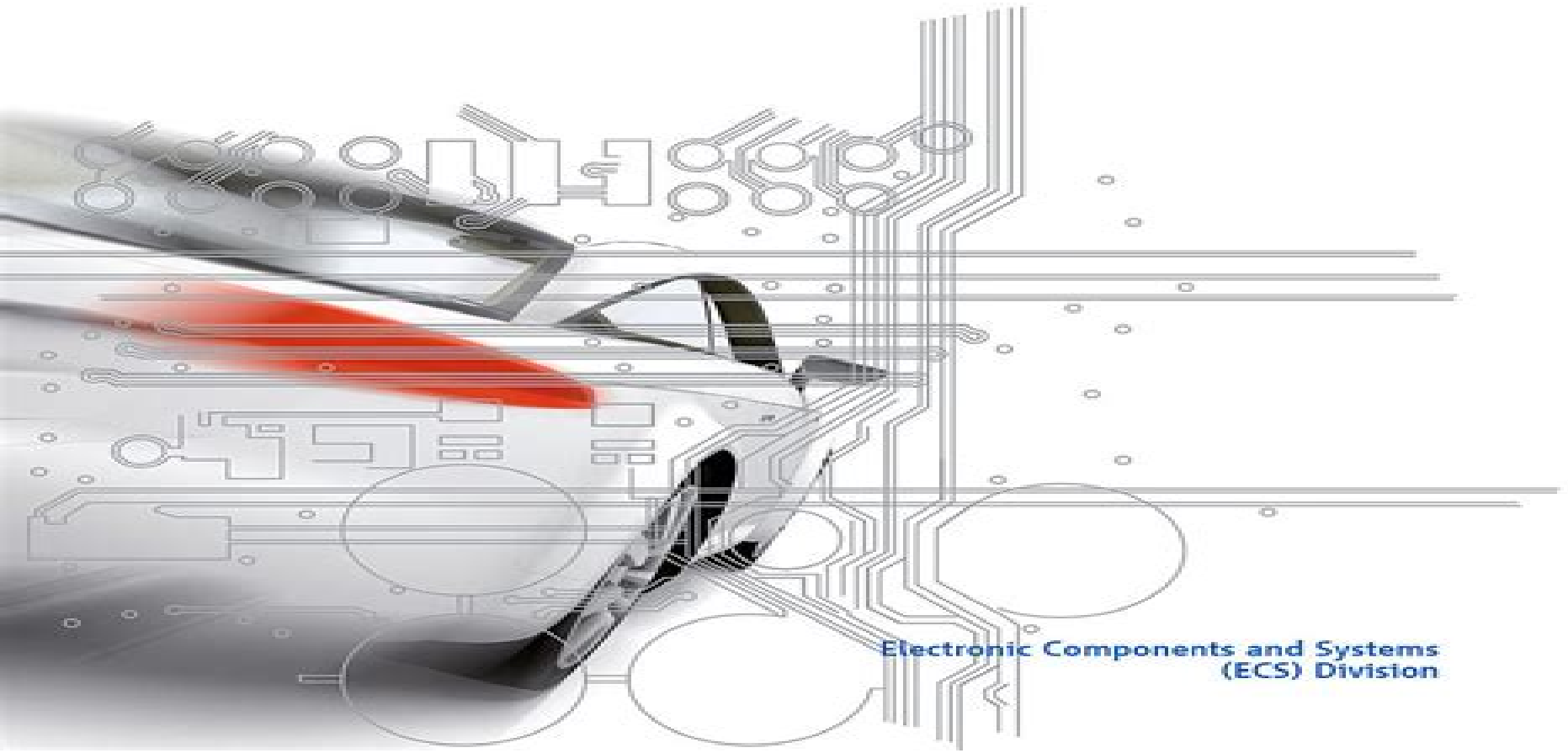


Handbook for Robustness Validation of Automotive Electrical/ Electronic Modules



Electronic Components and Systems
(ECS) Division

Handbook For Robustness Validation Of Automotive Electrical

**Abdelkhalak El Hami, David
Delaux, Henri Grzeskowiak**



Handbook For Robustness Validation Of Automotive Electrical:

Handbook for Robustness Validation of Automotive Electrical/electronic Modules, 2008 **Handbook for Robustness Validation of Automotive Electrical/Electronic Modules** Automotive Electronic Systems Reliability Standards, 2012 This document addresses robustness of electrical electronic modules for use in automotive applications Where practical methods of extrinsic reliability detection and prevention will also be addressed This document primarily deals with electrical electronic modules EEMs but can easily be adapted for use on mechatronics sensors actuators and switches EEM qualification is the main scope of this document Other procedures addressing random failures are specifically addressed in the CPI Component Process Interaction section 10 This document is to be used within the context of the Zero Defect concept for component manufacturing and product use It is recommended that the robustness of semiconductor devices and other components used in the EEM be assured using SAE J1879 OCT2007 Handbook for Robustness Validation of Semiconductor Devices in Automotive Applications The emphasis of this document is on hardware and manufacturing failure mechanisms however other contemporary issues as shown in Figure 1 need to be addressed for a thorough Robustness Validation A Pareto of contemporary issues is shown in Figure 1 Although this document addresses many of the issues shown however some are outside the scope of this document and will need to be addressed for a thorough RV process application Examples of issues outside the scope of this document are system interactions interfaces functionality HMI Human Machine Interface and software At the time of publication of this handbook a system level Robustness Validation handbook which addresses these issues had been initiated In late 2006 Members of the SAE International Automotive Electronic Systems Reliability Standards Committee and ZVEI German Electrical and Electronic Manufacturers Association formed a joint task force to update SAE Recommended Practice J1211 NOV1978 Recommended Environmental Practices for Electronic Equipment Design The 1978 version of SAE J1211 was written in an era when electronics were first being introduced to the automobile There was a high level of concern that the harsh environmental conditions experienced in locations in the vehicle could have a serious negative affect on the reliability of electronic components and systems Some early engine control modules ECMs had failure rates in the 350 failures per million hours f 106 hrs range or expressed in the customer s terms a 25% probability of failure in the first 12 months of vehicle ownership At that time warranty data was presented in R 100 repairs per 100 vehicles units for example 25 R 100 at 12 months In these early years when the automotive electronics industry was in it s infancy a large percentage of these were hard catastrophic and intermittent failures exacerbated by exposure to environmental extremes of temperature 40 C to 85 C high mechanical loads from rough road vibration and rail shipment mechanical shocks of up to 100g from handling and crash impact severe electrical transients electrostatic discharge and electromagnetic interference large swings in electrical supply voltage reverse electrical supply voltage and exposure to highly corrosive chemicals e g road salt and battery acid The focus of the 1978 version of J1211 was on

characterizing these harsh vehicle environment for areas of the vehicle engine compartment instrument panel passenger compartment truck under body etc and suggesting lab test methods which design engineers could use to evaluate the performance of their components and systems at or near the worst case conditions expected in the area of the vehicle where their electrical electronic components would be mounted By testing their prototypes at the worst case conditions i e at the product s specification limits described in the 1978 version of J1211 designers were able to detect and design out weaknesses and thereby reduce the likelihood of failure due to environmental factors By the mid 1980s it became common practice to specify test to pass zero failures allowed environmental conditions based reliability demonstration life tests with acceptance levels in the 90% to 95% reliability range with confidence levels of 70% to 90% This translates to approximately 5 to 20 f 106 hrs The sample size for these tests was determined using binomial distribution statistical tables and this would result in a requirement to test 6 to 24 test units without experiencing a failure If a failure occurred the sample size would have to be increased and the testing continued without another failure till the bogie was reached The environmental conditions during the test were typically defined such that the units under test were operated at specification limits based on J1211 recommended practices e g 40 C and 85 C for at least some portion of the total test time The goal of passing such a demonstration test was often very challenging and the test analyze fix programs that resulted although very time consuming and expensive produced much needed reliability growth Reliability improved significantly in the late 1980s and early 1990s and vehicle manufactures and their suppliers began expressing warranty data in R 1000 units instead of R 100 units By the turn of the century automobile warranty periods had increased from 12 months to 3 4 5 and even 10 years for some systems and most manufacturers had started specifying life expectancies for vehicle components of 10 15 and sometimes 20 years And by this time several vehicle manufacturers and their best electrical electronic component suppliers had improved reliability to the point where warranty data was being expressed in parts per million ppm in the triple double and even single digit range This translates to failure rates in the 0 05 f 106 hrs range and better The achievement of such high reliability is not the result of test to pass reliability demonstration testing based on binomial distribution statistical tables With this method reliability demonstration in the 99 99% to 99 9999% range would require thousands of test units On the contrary the methods and techniques used by engineering teams achieving such reliability excellence did not require increasingly large sample sizes more expensive and lengthy testing or more engineers It is about working smarter not harder and about systems level robust design and robustness validation thinking rather than component level test to pass thinking The task force leaders and members were of the strong opinion that the 2008 version of SAE J1211 should document the state of the art methods and techniques being used by leading companies and engineering teams to achieve ultra high reliability while at the same time reducing overall cost life cycle and shortening time to market The SAE International Automotive Electronic Systems Reliability Standards Committee and ZVEI German Electrical and Electronic Manufacturers Association are hopeful

that this Handbook for Robustness Validation of Automotive Electrical Electronic Modules will help many companies and engineering teams make the transition from the 1980s cookbook reliability demonstration approach to a more effective economically feasible knowledge based Robustness Validation approach Relevant information and data from SAE J1211 NOV1978 is preserved in SAE J2837 Environmental Conditions and Design Practices for Automotive Electronic Equipment Reference Data from SAE J1211 NOV1978 (R) *Handbook for Robustness Validation of Automotive Electrical/electronic Modules*, 2012 This document addresses robustness of electrical electronic modules for use in automotive applications Where practical methods of extrinsic reliability detection and prevention will also be addressed This document primarily deals with electrical electronic modules EEMs but can easily be adapted for use on mechatronics sensors actuators and switches EEM qualification is the main scope of this document Other procedures addressing random failures are specifically addressed in the CPI Component Process Interaction section 10 This document is to be used within the context of the Zero Defect concept for component manufacturing and product use It is recommended that the robustness of semiconductor devices and other components used in the EEM be assured using SAE J1879 OCT2007 Handbook for Robustness Validation of Semiconductor Devices in Automotive Applications The emphasis of this document is on hardware and manufacturing failure mechanisms however other contemporary issues as shown in Figure 1 need to be addressed for a thorough Robustness Validation A Pareto of contemporary issues is shown in Figure 1 Although this document addresses many of the issues shown however some are outside the scope of this document and will need to be addressed for a thorough RV process application Examples of issues outside the scope of this document are system interactions interfaces functionality HMI Human Machine Interface and software At the time of publication of this handbook a system level Robustness Validation handbook which addresses these issues had been initiated Publisher's website *SAE International's Dictionary of Testing, Verification, and Validation* Jon M. Quigley, 2023-10-30 Created to elevate expertise in testing verification and validation with industry specific terminology readers are empowered to navigate the complex world of quality assurance From foundational concepts to advanced principles each entry provides clarity and depth ensuring the reader becomes well versed in the language of precision This dictionary is an indispensable companion for both professionals and students seeking to unravel the nuances of testing methodologies verification techniques and validation processes Readers will be equipped with the tools to communicate effectively make informed decisions and excel in projects In addition references to SAE Standards are included to direct the read to additional information beyond a practical definition ISBN 9781468605907 ISBN 9781468605914 ISBN 9781468605921 DOI 10 4271 9781468605914 *Handbook for Robustness Validation of Semiconductor Devices in Automotive Applications* Automotive Electronic Systems Reliability Standards, 2007 This document will primarily address intrinsic reliability of electronic components for use in automotive electronics Where practical methods of extrinsic reliability detection and prevention will also be addressed This document primarily deals with integrated circuit issues but can easily be

adapted for use in discrete or passive component qualification with the generation of a list of failure mechanisms relevant to those devices Component qualification is the main scope of this document Other procedures addressing extrinsic defects are specifically addressed in the monitoring chapter This document is to be used within the context of achieving Zero Defect in component manufacturing and product use NOTE The term shall indicate a binding requirement Members of SAE International Automotive Electronic Systems Reliability Standards Committee ZVEI German Electrical and Electronic Manufacturers Association AEC Automotive Electronics Council and JSAE Japanese Society of Automotive Engineers formed a joint task force and met to update SAE Recommended Practice J1879 October 1988 General Qualification and Production Acceptance Criteria for Integrated Circuits in Automotive Applications This version did not describe methods to demonstrate that a device under test would meet the customer demand for failure levels in the single digit parts per million ppm range Additionally with the old qualification test to pass approach there is very little knowledge generated about the relevant component failure mechanisms that may occur at the boundaries of the specification limits Extending the old approach to single digit ppm levels is unfeasible with respect to both economics and time A new knowledge based approach to understanding and preventing the occurrence of the relevant component failure mechanisms was required The joint task force concluded that the J1879 Recommended Practice should be revised to encompass a Robustness Validation approach and that an Automotive Electronics Robustness Validation Handbook should be published This handbook is based on information from a wide number of sources including international Automotive OEMs and their full supply chain engineering societies and other related organizations

The Safety of Controllers, Sensors, and Actuators Juan

Pimentel, 2019-03-07 Safety has been ranked as the number one concern for the acceptance and adoption of automated vehicles since safety has driven some of the most complex requirements in the development of self driving vehicles Recent fatal accidents involving self driving vehicles have uncovered issues in the way some automated vehicle companies approach the design testing verification and validation of their products Traditionally automotive safety follows functional safety concepts as detailed in the standard ISO 26262 However automated driving safety goes beyond this standard and includes other safety concepts such as safety of the intended functionality SOTIF and multi agent safety The Safety of Controllers Sensors and Actuators addresses the concept of safety for self driving vehicles through the inclusion of 10 recent and highly relevant SAE technical papers Topics that these papers feature include risk reduction techniques in semiconductor based systems component certification and safety assessment and audits for vehicle components As the fifth title in a series on automated vehicle safety this contains introductory content by the Editor with 10 SAE technical papers specifically chosen to illuminate the specific safety topic of that book

Advanced Microsystems for Automotive Applications 2009 Gereon Meyer, Jürgen Valldorf, Wolfgang Gessner, 2009-04-15 The current economic crisis is cutting the automotive sector to the quick Public authorities worldwide are now faced with requests for providing loans and accepting guarantees and even for

putting large automotive companies under state control Assessing the long term benefits of such help and weighing the needs of different sectors against each other poses a major challenge for the national policies Given the upcoming change of customer preferences and state regulations towards safety sustainability and comfort of a car the automotive industry is particularly called to prove its ability to make necessary innovations available in order to accelerate its pace to come out of the crisis Consequently the Green Car is assuming a prominent role in the current debate Various power train concepts are currently under discussion for the Green Car including extremely optimised internal combustion engines hybrid drives and battery electric traction Electrical cars are the most appealing option because they are free of local emissions and provide the opportunity to use primary energy from sources other than crude oil for transport Well to wheel analysis show that their green house gas emissions can be rated negligibly small if electricity from renewable sources like wind and solar is used

Semiconductor Power Devices Josef Lutz, Heinrich Schlangenotto, Uwe Scheuermann, Rik De Doncker, 2011-01-15

Semiconductor power devices are the heart of power electronics They determine the performance of power converters and allow topologies with high efficiency Semiconductor properties pn junctions and the physical phenomena for understanding power devices are discussed in depth Working principles of state of the art power diodes thyristors MOSFETs and IGBTs are explained in detail as well as key aspects of semiconductor device production technology In practice not only the semiconductor but also the thermal and mechanical properties of packaging and interconnection technologies are essential to predict device behavior in circuits Wear and aging mechanisms are identified and reliability analyses principles are developed Unique information on destructive mechanisms including typical failure pictures allows assessment of the ruggedness of power devices Also parasitic effects such as device induced electromagnetic interference problems are addressed The book concludes with modern power electronic system integration techniques and trends

Embedded Mechatronic Systems, Volume 2 Abdelkhalak El Hami, Philippe Pougnet, 2015-07-16 In operation mechatronics embedded systems are stressed by loads of different causes climate temperature humidity vibration electrical and electromagnetic These stresses in components induce failure mechanisms should be identified and modeled for better control AUDACE is a collaborative project of the cluster Moveo that address issues specific to mechatronic reliability embedded systems AUDACE means analyzing the causes of failure of components of mechatronic systems onboard The goal of the project is to optimize the design of mechatronic devices by reliability The project brings together public sector laboratories that have expertise in analysis and modeling of failure major groups of mechatronics Valeo and Thales in the automotive and aerospace and small and medium enterprises that have skills in characterization and validation tests Find and develop ways to characterize and validate the design robustness and reliability of complex mechatronic devices Develop ways to characterize physical and chemical phenomena Identify mechanisms of failure of components of these devices Analyze the physical and or chemical mechanisms of failure in order of importance To model failure mechanisms and design optimization

Communication in

Transportation Systems Strobel, Otto, 2013-02-28 Typically communication technology breakthroughs and developments occur for the purposes of home work or cellular and mobile networks Communications in transportation systems are often overlooked yet they are equally as important Communication in Transportation Systems brilliantly bridges theoretical knowledge and practical applications of cutting edge technologies for communication in automotive applications This reference source carefully covers innovative technologies which will continue to advance transportation systems Researchers developers scholars engineers and graduate students in the transportation and automotive system communication electrical and information technology fields will especially benefit from this advanced publication *Embedded Mechatronic Systems* 2 Abdelkhalak El Hami, Philippe Pougnet, 2020-02-28 Embedded Mechatronic Systems 2 Analysis of Failures Modeling Simulation and Optimization presents advances in research within the field of mechatronic systems which integrates reliability into the design process Providing many detailed examples this book develops a characterization methodology for faults in mechatronic systems It analyzes the multi physical modeling of faults revealing weaknesses in design and failure mechanisms This development of meta models enables us to simulate effects on the reliability of conditions of use and manufacture Provides many detailed examples Develops a characterization methodology for faults in mechatronic systems Analyzes the multi physical modeling of faults revealing weaknesses in design and failure mechanisms Next Generation HALT and HASS Kirk A. Gray, John J. Paschkewitz, 2016-03-11 Next Generation HALT and HASS presents a major paradigm shift from reliability prediction based methods to discovery of electronic systems reliability risks This is achieved by integrating highly accelerated life test HALT and highly accelerated stress screen HASS into a physics of failure based robust product and process development methodology The new methodologies challenge misleading and sometimes costly mis application of probabilistic failure prediction methods FPM and provide a new deterministic map for reliability development The authors clearly explain the new approach with a logical progression of problem statement and solutions The book helps engineers employ HALT and HASS by illustrating why the misleading assumptions used for FPM are invalid Next the application of HALT and HASS empirical discovery methods to quickly find unreliable elements in electronics systems gives readers practical insight to the techniques The physics of HALT and HASS methodologies are highlighted illustrating how they uncover and isolate software failures due to hardware software interactions in digital systems The use of empirical operational stress limits for the development of future tools and reliability discriminators is described Key features Provides a clear basis for moving from statistical reliability prediction models to practical methods of insuring and improving reliability Challenges existing failure prediction methodologies by highlighting their limitations using real field data Explains a practical approach to why and how HALT and HASS are applied to electronics and electromechanical systems Presents opportunities to develop reliability test discriminators for prognostics using empirical stress limits Guides engineers and managers on the benefits of the deterministic and more efficient methods of HALT and HASS Integrates the empirical limit discovery methods

of HALT and HASS into a physics of failure based robust product and process development process

Sensors for Safety and Process Control in Hydrogen Technologies Thomas Hübert,Lois Boon-Brett,William Buttner,2018-10-09 Understand Select and Design Sensors for Hydrogen Based Applications The use of hydrogen generated from renewable energy sources is expected to become an essential component of a low carbon environmentally friendly energy supply spurring the worldwide development of hydrogen technologies Sensors for Safety and Process Control in Hydrogen Technologies provides practical expert driven information on modern sensors for hydrogen and other gases as well as physical parameters essential for safety and process control in hydrogen technologies It illustrates how sensing technologies can ensure the safe and efficient implementation of the emerging global hydrogen market The book explains the various facets of sensor technologies including practical aspects relevant in hydrogen technologies It presents a comprehensive and up to date account of the theory physical and chemical principles design and implementations of sensors in hydrogen technologies The authors also offer guidance on the development of new sensors based on the analysis of the capabilities and limitations of existing sensors with respect to current performance requirements Suitable for both technical and non technical personnel the book provides a balance between detailed descriptions and simple explanations It gives invaluable insight into the role sensors play as key enabling devices for both control and safety in established and emerging hydrogen technologies

Reliability and Physics-of-Healthy in Mechatronics Abdelkhalak El Hami,David Delaux,Henri Grzeskowiak,2023-01-12 This book illustrates simply but with many details the state of the art of reliability science exploring clear reliability disciplines and applications through concrete examples from their industries and from real life based on industrial experiences Many experts believe that reliability is not only a matter of statistics but is a multidisciplinary scientific topic involving materials tests simulations quality tools manufacturing electronics mechatronics environmental engineering and Big Data among others For a complex mechatronic system failure risks have to be identified at an early stage of the design In the automotive and aeronautic industries fatigue simulation is used both widely and efficiently Problems arise from the variability of inputs such as fatigue parameters and life curves This book aims to discuss probabilistic fatigue and reliability simulation To do this Reliability and Physics of Healthy in Mechatronics provides a study on some concepts of a predictive reliability model of microelectronics with examples from the automotive aeronautic and space industries based on entropy and Physics of Healthy

Fires in Conventional and Electrified Vehicles Erbis Llobet Biscarri,2024-11-19 In the ever evolving landscape of automotive technology fire safety remains a critical concern From the era of steam powered vehicles to today s cutting edge electric and hybrid models understanding the risks and preventive measures for automotive fires is essential for protecting lives and assets In Fires in Conventional and Electrified Vehicles Erbis Biscarri a seasoned expert with extensive experience in both automotive equipment manufacturing and major car manufacturers presents a definitive guide on the subject This book provides a thorough exploration of the physical phenomena leading to vehicle fires offering in depth analysis methods and

prevention strategies tailored to both traditional internal combustion engines and the latest hybrid and electric vehicles Organized into three key sections Theory Prevention and Analysis the book delves into the fundamental concepts of fire initiation sustenance and propagation covering a wide range of vehicle systems It examines safety risks and effective prevention strategies using industry best practices and advanced technologies Additionally the analysis section provides real world case studies and expert insights into investigating and understanding automotive fires Whether you re an automotive engineer fire safety professional forensic consultant or fleet manager Biscarri s comprehensive guide is an invaluable resource Equip yourself with the knowledge to navigate the complexities of automotive fire safety and contribute to a safer more resilient automotive industry This book will be a valuable resource for experts in vehicle fire analysis Aubert George Expert in vehicle fire analysis and prevention France ISBN 9781468607949 ISBN 9781468607956 ISBN 9781468607963 DOI <https://doi.org/10.4271/9781468607956> **Reliability Characterisation of Electrical and Electronic Systems**

,2014-12-24 This book takes a holistic approach to reliability engineering for electrical and electronic systems by looking at the failure mechanisms testing methods failure analysis characterisation techniques and prediction models that can be used to increase reliability for a range of devices The text describes the reliability behavior of electrical and electronic systems It takes an empirical scientific approach to reliability engineering to facilitate a greater understanding of operating conditions failure mechanisms and the need for testing for a more realistic characterisation After introducing the fundamentals and background to reliability theory the text moves on to describe the methods of reliability analysis and charactersation across a wide range of applications Takes a holistic approach to reliability engineering Looks at the failure mechanisms testing methods failure analysis characterisation techniques and prediction models that can be used to increase reliability Facilitates a greater understanding of operating conditions failure mechanisms and the need for testing for a more realistic characterisation *Applied Reliability for Industry 3* Abdelkhalak El Hami,David Delaux, Henri Grzeskowiak,2023-04-03

Applied Reliability for Industry 3 illustrates the multidisciplinary state of the art science of operational reliability Many experts are now convinced that reliability is not limited to statistical sciences In fact many different disciplines interact in order to bring a product to its highest possible level of reliability made available through today s technologies developments and production methods These three books of which this is the third propose new methods for analyzing the lifecycle of a system enabling us to record the development phases according to development time and levels of complexity for its integration Operational reliability as presented in *Applied Reliability for Industry 3* verifies the reliability performance of the mechatronic system in real life through an analysis of field data **3D Microelectronic Packaging** Yan Li,Deepak Goyal,2017-01-20 This volume provides a comprehensive reference for graduate students and professionals in both academia and industry on the fundamentals processing details and applications of 3D microelectronic packaging an industry trend for future microelectronic packages Chapters written by experts cover the most recent research results and industry progress in

the following areas TSV die processing micro bumps direct bonding thermal compression bonding advanced materials heat dissipation thermal management thermal mechanical modeling quality reliability fault isolation and failure analysis of 3D microelectronic packages Numerous images tables and didactic schematics are included throughout This essential volume equips readers with an in depth understanding of all aspects of 3D packaging including packaging architecture processing thermal mechanical and moisture related reliability concerns common failures developing areas and future challenges providing insights into key areas for future research and development

Humidity and Electronics Rajan Ambat, Kamila Piotrowska, 2021-11-30 Humidity and Electronics Corrosion Reliability Issues and Preventive Measures provides comprehensive information on humidity related corrosion reliability issues surrounding electronics and how to tackle potential issues from a pro active design prevention perspective The book contains a mix of academic and industrial relevance making it suitable for a detailed understanding on humidity issues on electronics both for materials and corrosion experts and electronics and electrical experts It will be useful for researchers academics and industrial personals involved in materials corrosion and electronics reliability aspects Provides basic and applied knowledge surrounding corrosion in electronics Combines electronics electrical and electrochemical aspects related to failure modes and mechanisms Presents knowledge on influencing factors and how they can be used as preventive measures at the material component device and system level

Power Electronics for the Next Generation Wind Turbine System Ke Ma, 2015-07-25 This book presents recent studies on the power electronics used for the next generation wind turbine system Some criteria and tools for evaluating and improving the critical performances of the wind power converters have been proposed and established The book addresses some emerging problems as well as possibilities for the wind power conversion and may be useful as an inspiring reference for the researchers in this field

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