

# AUTOMOTIVE ELECTRONICS RELIABILITY HANDBOOK

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**AE-9**

# Automotive Electronics Reliability Handbook

**Ronald K. Jurgen**



## **Automotive Electronics Reliability Handbook:**

*Automotive Electronics Reliability Handbook*, 1987 This handbook was designed to provide the automotive electronics community with an understanding of the concepts principles and methodologies concerning all aspects of automotive electronic systems reliability engineering Chapters include Reliability Terminology Associated with Automotive Electronics Reliability Theory Reliability Data Analysis Regression Analysis Reliability Specification and Allocation Reliability Prediction Reliability Design Guidelines FMEA FTA and SCA Reliability Demonstration and Reliability Growth The handbook is based upon information from several sources which are listed at the end of each chapter *Reliability Prediction for Automotive Electronics Based on Field Return Data* Automotive Electronic Systems Reliability Standards, 2017 This document should be used as guidance for non handbook based reliability predictions conducted on automotive electronics products It presents a method that utilizes warranty and field repair data to calculate the failure rates of individual electronic components and predict the reliability of the entire electronic system It assumes that the user has access to a database containing field return data with classification of components times to failure and a total number of components operating in the field In early design activities typically before the hardware is built a reliability prediction is often required for the electronic components and systems in order to assess their future reliability and in many cases to meet customer specifications Those specifications may include the allocated reliability for a particular electronic unit and in the cases of functional safety products to meet the ASIL Automotive Safety and Integrity Level requirement specified by the international functional safety standard ISO 26262 This Recommended Practice RP document will provide guidance on performing reliability predictions for automotive electronic products utilizing field return data or any other types of failure data available to an automotive electronics supplier This document will cover the possible sources of data types of the data required ways to collect it and the methodology of how to process these data to calculate the failure rates and the expected reliability This document will also include a case study based on the data obtained by Delphi Electronics Safety a Tier 1 automotive supplier to illustrate the process of reliability prediction based on field return data *Automotive Electronics Reliability Handbook*, 1987 This handbook was designed to provide the automotive electronics community with an understanding of the concepts principles and methodologies concerning all aspects of automotive electronic systems reliability engineering Chapters include Reliability Terminology Associated with Automotive Electronics Reliability Theory Reliability Data Analysis Regression Analysis Reliability Specification and Allocation Reliability Prediction Reliability Design Guidelines FMEA FTA and SCA Reliability Demonstration and Reliability Growth The handbook is based upon information from several sources which are listed at the end of each chapter *Automotive Electronics Reliability* Ronald K Jurgen, 2010-08-10 Vehicle reliability problems continue to be the news because of major vehicle recalls from several manufacturers This book includes 40 SAE technical papers published from 2007 through 2010 that describe the latest research on automotive electronics reliability technology This

book will help engineers and researchers focus on the design strategies being used to minimize electronics reliability problems and how to test and verify those strategies After an overview of durability risk assessment and failure mechanisms this book focuses on state of the art techniques for reliability based design and reliability testing and verification Topics include powertrain control monitoring distributed automotive embedded systems model based design x by wire systems battery durability design verification fault tree analysis The book also includes editor Ronald K Jurgen s introduction Striving for Maximum Reliability in a Highly Complex Electronic Environment and a concluding section on the future of electronics reliability including networking technology domain control units the use of AUTOSAR and embedded software *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 of 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 its 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 10<sup>6</sup> 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 10<sup>6</sup> 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

**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 indicates 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

**Handbook of Performability Engineering** Krishna B. Misra,2008-08-24

Dependability and cost effectiveness are primarily seen as instruments for conducting international trade in the free market environment. These factors cannot be considered in isolation of each other. This handbook considers all aspects of performability engineering. The book provides a holistic view of the entire life cycle of activities of the product along with the associated cost of environmental preservation at each stage while maximizing the performance.

**Automotive Electronics Handbook** Ronald K. Jurgen, 1999. This second edition of the widely sold title contains new and updated chapters on areas such as safety features. It also includes new sections on adding electronic intelligence to automotive features.

**The Electronic Packaging Handbook** Glenn R. Blackwell, 2017-12-19. The packaging of electronic devices and systems represents a significant challenge for product designers and managers. Performance efficiency cost considerations dealing with the newer IC packaging technologies and EMI/RFI issues all come into play. Thermal considerations at both the device and the systems level are also necessary. The Electronic Packaging Handbook, a new volume in the Electrical Engineering Handbook Series, provides essential factual information on the design, manufacturing, and testing of electronic devices and systems. Co-published with the IEEE, this is an ideal resource for engineers and technicians involved in any aspect of design, production, testing, or packaging of electronic products regardless of whether they are commercial or industrial in nature. Topics addressed include design automation, new IC packaging technologies, materials, testing, and safety. Electronics packaging continues to include expanding and evolving topics and technologies as the demand for smaller, faster, and lighter products continues without signs of abatement. These demands mean that individuals in each of the specialty areas involved in electronics packaging, such as electronic mechanical and thermal designers and manufacturing and test engineers, are all interdependent on each other's knowledge. The Electronic Packaging Handbook elucidates these specialty areas and helps individuals broaden their knowledge base in this ever-growing field.

GLOSSARY OF RELIABILITY TERMINOLOGY ASSOCIATED WITH AUTOMOTIVE ELECTRONICS Automotive Electronic Systems Reliability Standards, 1988. This compilation of terms, acronyms, and symbols was drawn from usage which should be familiar to those working in automotive electronics reliability. Terms are included which are used to describe how items, materials, and systems are evaluated for reliability, how they fail, how failures are modeled, and how failures are prevented. Terms are also included from the disciplines of designing for reliability, testing, and failure analysis, as well as the general disciplines of Quality and Reliability Engineering. This glossary is intended to augment SAE J1213 Glossary of Automotive Electronic Terms. Not applicable.

**Automotive Engineering**, 1994. History of Automotive Electronics Ronald K. Jurgen, 1998. 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      **Subject Guide to Books in Print** ,1997

*Driving Future Vehicles* A M Parkes,S. Franzen,2003-09-02 This book has been generated by the EC funded Dedicated Road Infrastructure for Vehicle Safety in Europe DRIVE collaborative research programme it brings together work on driver behaviour traffic safety and human machine interfacing to review the state of the art in Europe in terms of systems specification design evaluation and implementation for near future vehicles Changes in vehicle functionality will be fundamental through the 1990 s and this book demonstrates that a purely technology driven approach is a recipe for disaster integrated and co ordinated multidisciplinary initiatives in complex system design are preferable and are more likely to deliver system efficiency acceptability and safety It is aimed at transport ergonomists vehicle designers HCI researchers applied psychologists and cognitive ergonomists      **Cumulative Index [of The] SAE Papers** Society of Automotive Engineers,1990

**Automotive E/E/ Reliability** John Day,2011-11-15 Electrical and electronic reliability is a critical issue for automakers and suppliers as well as car buyers and dealers The burden of reliability falls most heavily on automotive E E engineers system and software developers component suppliers and tools vendors This book explores ways that the automotive industry continues to add E E features while maintaining if not improving overall reliability This book helps executives decision makers and managers to quickly grasp the key drivers associated with E E reliability in the automotive market Academics who teach electronics and automotive engineering will also be interested in the book as well as those in government who legislate and regulate automotive electronics Author John Day interviewed nearly 50 experts on all facets of E E systems and reliability during preparation of this manuscript In addition he culled information from press releases and presentations He synthesized a massive amount of information and data into an easy to digest manuscript that gives a clear picture of the current state of E E reliability and where the technology it is headed      **Applications in Electronics**

**Pervading Industry, Environment and Society** Alessandro De Gloria,2017-01-02 This book provides a thorough overview of cutting edge research on electronics applications relevant to industry the environment and society at large It covers a broad spectrum of application domains from automotive to space and from health to security while devoting special attention to the use of embedded devices and sensors for imaging communication and control The book is based on the 2015 ApplePies Conference held in Rome which brought together researchers and stakeholders to consider the most significant current



trends in the field of applied electronics and to debate visions for the future Areas addressed by the conference included information communication technology biotechnology and biomedical imaging space secure clean and efficient energy the environment and smart green and integrated transport As electronics technology continues to develop apace constantly meeting previously unthinkable targets further attention needs to be directed toward the electronics applications and the development of systems that facilitate human activities This book written by industrial and academic professionals represents a valuable contribution in this endeavor      *Gale's Auto Sourcebook* ,1992 Guide to information on cars and light trucks

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