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Road vehicles — Application of predictive maintenance to hardware with ISO 26262-5

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Contents

Page

Foreword ... **iv**
Introduction ... **v**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **1**
4 Abbreviated terms ... **2**
5 Literature survey of degrading faults ... **4**
5.1 General ... 4
5.2 Degrading faults in industry standards ... 4
5.2.1 JEDEC JEP122H[4] ... 4
5.3 Degrading faults in technical publications ... 5
5.3.1 Advanced CMOS Reliability Update: Sub 20 nm FinFET Assessment[5] ... 5
5.3.2 Circuit-Based Reliability Consideration in FinFET Technology[6] ... 6
5.3.3 Intermittent Faults and Effects on Reliability of Integrated Circuits[7] ... 6
6 Literature survey on predictive maintenance ... **6**
6.1 General ... 6
6.2 Predictive maintenance in industry standards ... 6
6.2.1 IEC 61508[9] ... 6
6.2.2 IEEE Std 1856[3] ... 6
6.3 Predictive maintenance in technical publications ... 7
6.3.1 A Survey of Online Failure Prediction Methods[10] ... 7
6.3.2 An Odometer for CPUs[11] ... 7
6.3.3 Circuit Failure Prediction for Robust System Design in Scaled CMOS [12] ... 8
6.3.4 A Circuit Failure Prediction Mechanism (DART) for High Field Reliability [13] ... 8
6.3.5 Predicting Remediations for Hardware Failures in Large-Scale Datacenters[14] ... 8
6.3.6 Improving Analog Functional Safety Using Data-Driven Anomaly Detection [15] ... 8
7 Degrading faults and the ISO 26262 series ... **8**
7.1 Understanding the lifecycle of degrading faults ... 8
7.2 Classification of degrading faults ... 12
7.3 Quantifying degrading fault base failure rate ... 12
7.3.1 Industry standards and models ... 12
7.3.2 Field data ... 13
7.3.3 Expert judgement ... 13
8 Applying predictive maintenance ... **13**
8.1 Diagnostic coverage (DC) evaluation for predictive mechanisms ... 13
8.2 Considering random hardware metrics ... 13
8.2.1 Impacting the SPFM and LFM ... 13
8.2.2 Application as a dedicated measure ... 14
8.3 Considering RUL prediction ... 14
Annex A (informative) **An approach to handling degrading faults** ... **16**
Bibliography ... **18**

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Foreword

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Introduction

Hardware elements wear out or degrade with time and usage. The presence of certain faults can cause the rate of degradation to increase. If the rate of degradation exceeds critical thresholds, then a hardware element can fail during its normal expected lifespan. Addressing fault behaviours which change over time is difficult. Functional safety standards such as the ISO 26262 series have traditionally addressed degrading faults with avoidance measures and simplified assumptions of static behaviours.

Understanding of degrading faults is improving over time. Many industries are taking proactive steps to control degrading faults using predictive maintenance. Predictive maintenance can detect degrading faults and predict remaining useful life. Safety mechanisms based on predictive maintenance are not explicitly discussed in the ISO 26262 series.

This document provides a survey of current state of the art for degrading faults and predictive maintenance techniques. Approaches are presented to consider degrading faults and predictive maintenance techniques in an ISO 26262 safety argument. Much of the content is focused on semiconductors, but the concepts can be applied to other hardware elements.

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Road vehicles — Application of predictive maintenance to hardware with ISO 26262-5

1 Scope

This document is intended to be applied to the usage of predictive maintenance methods for the detection of degrading faults in safety related E/E hardware elements. It applies to hardware elements developed for compliance with the ISO 26262[1] series in which degrading faults are shown to be relevant due to, for instance, the technology used.

Specific technical implementations of predictive maintenance solutions are not in scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 26262-1, *Road vehicles — Functional safety — Part 1: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 26262-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
degrading fault
fault whose characteristics are not constant and degrade over time, that can result in an error or failure when stimulated after degradation exceeds a critical threshold

Note 1 to entry: Permanent and intermittent faults can first manifest as degrading faults. Transient faults do not manifest as degrading faults.

Note 2 to entry: Degrading faults do not create errors or failures until degradation exceeds critical thresholds. The capability to generate an error or failure is related to the current state of degradation.

Note 3 to entry: Degrading faults exhibit abnormal conditions which can cause an error or failure over time. Normal degradation does not exhibit abnormal conditions which are necessary to be classified as a fault. Normal degradation can result in a loss of functionality after expected lifespan has elapsed but cannot be considered a fault as it is not abnormal.

3.2
degrading fault detection time interval
DFDTI
timespan from the occurrence of a *degrading fault* (3.1) to its detection

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