
Contents

Foreword by Laurent Denis	ix
Foreword by Serge Zaninotti	xiii
Acknowledgements	xv
Introduction	xvii
Chapter 1. Reliability Review	1
1.1. Failure rate	1
1.2. Temperature effect.	6
1.3. Effect of maintenance	6
1.4. MTBF.	7
1.5. Nature of the reliability objective	9
Chapter 2. Maturity	11
Serge ZANINOTTI	
2.1. Context	11
2.2. Normative context and its implications	13
2.2.1. Quality standards	13
2.2.2. Quality management system and product quality	13
2.2.3. Product quality and dependability	16
2.2.4. Product dependability and maturity	18
2.2.5. Standards in various domains	23
2.2.6. Perspectives	24
2.3. Building of maturity.	28
2.4. Confirmation of maturity	30

Chapter 3. Derating Analysis	33
3.1. Derating	33
3.2. Rules provided by the manufacturers of components.	34
3.2.1. CMS resistors	34
3.2.2. Capacitors	38
3.2.3. Magnetic circuits	41
3.2.4. Fuses	41
3.2.5. Resonators	42
3.2.6. Oscillators	42
3.2.7. Photocouplers	42
3.2.8. Diodes	43
3.2.9. Zener diodes.	43
3.2.10. Tranzorb diodes	43
3.2.11. Low power bipolar transistors	45
3.2.12. Power bipolar transistors	45
3.2.13. Low power MOSFET transistors.	46
3.2.14. High power MOSFET transistors	46
3.2.15. Integrated circuits	47
3.3. Reference-based approach	47
3.4. Creation of derating rules	49
3.4.1. Rules for constant temperature.	53
3.4.2. Rule for voltage.	58
3.5. Summary	59
Chapter 4. Components with Limited Service Life.	61
4.1. RDF 2000 guide	63
4.1.1. Power transistor.	63
4.1.2. Photocouplers	64
4.1.3. Switch or push button	64
4.1.4. Connectors.	65
4.2. FIDES 2009 guide	65
4.2.1. Fans	66
4.2.2. Batteries	66
4.3. Manufacturer's data	68
4.3.1. Wet electrolytic capacitor	68
4.3.2. Connectors.	71
4.3.3. Relays	72
4.3.4. Optocouplers	73
4.3.5. Batteries	76
4.3.6. Fans	77
4.3.7. Flash memories	78

4.3.8. Potentiometers	79
4.3.9. Quartz oscillators	81
4.3.10. Voltage references	81
4.4. Summary of components with limited service life	82
Chapter 5. Analysis of Product Performances	85
5.1. Analyses during the design stage	85
5.1.1. Worst-case analysis	85
5.1.2. Quadratic analysis	88
5.1.3. Monte-Carlo analysis	89
5.1.4. Numerical simulations	91
5.2. Analyses during the manufacturing stage	92
Chapter 6. Aggravated Tests	95
6.1. Definition	95
6.2. Objectives of aggravated tests	95
6.3. Principles of aggravated tests	97
6.3.1. Choice of physical constraints	101
6.3.2. Principle of HALT	101
6.3.3. Specific or additional constraints	106
6.3.4. Number of required samples	106
6.3.5. Operational test, diagnosis and identification of weaknesses	107
6.3.6. Monitoring specification	107
6.3.7. Instrumentation	108
6.3.8. Root cause analysis, corrective actions and breakdown management	108
6.4. Robustness	111
6.4.1. Estimation of robustness margins	111
6.4.2. Sufficient margins	112
Chapter 7. Burn-In Test	117
7.1. Link between HALT and HASS tests	119
7.2. POS1 test	119
7.2.1. Miner's approach	119
7.2.2. Approach according to the physical laws of failure	121
7.2.3. Zero-failure reliability proof approach	124
7.3. POS2 test	125
7.3.1. Influence of parameter Q	128
7.3.2. Influence of parameter p	129
7.3.3. Summary of the POS2 test	133
7.4. HASS cycle	133
7.4.1. Precipitation stage	133

7.4.2. Detection stage	134
7.5. Should burn-in tests be systematically conducted?	136
7.5.1. Constraints extrinsic to the equipment manufacturer	137
7.5.2. Constraints intrinsic to the equipment manufacturer	137
7.5.3. Decision criteria.	137
7.6. Test coverage.	142
7.7. Economic aspect of burn-in.	144
7.7.1. No burn-in test is conducted	145
7.7.2. Burn-in test is conducted	146
Chapter 8. Run-In	153
8.1. Run-in principle	153
8.2. Stabilization	156
8.2.1. Proposed principle	156
8.2.2. Drift acceleration law.	159
8.2.3. Choice of the drift model.	161
8.2.4. Equivalent level of physical contribution	162
8.3. Expression of the corresponding degradation	164
8.4. Optimization of the stabilization time	165
8.5. Estimation of a prediction interval of the degradation	167
8.5.1. Principle of the stabilization method.	167
List of Notations	171
List of Definitions	173
List of Acronyms	179
References	183
Index	187