Automotive Electronics Council

Component Technical Committee

AEC WG on Extended Mission Profiles - Status

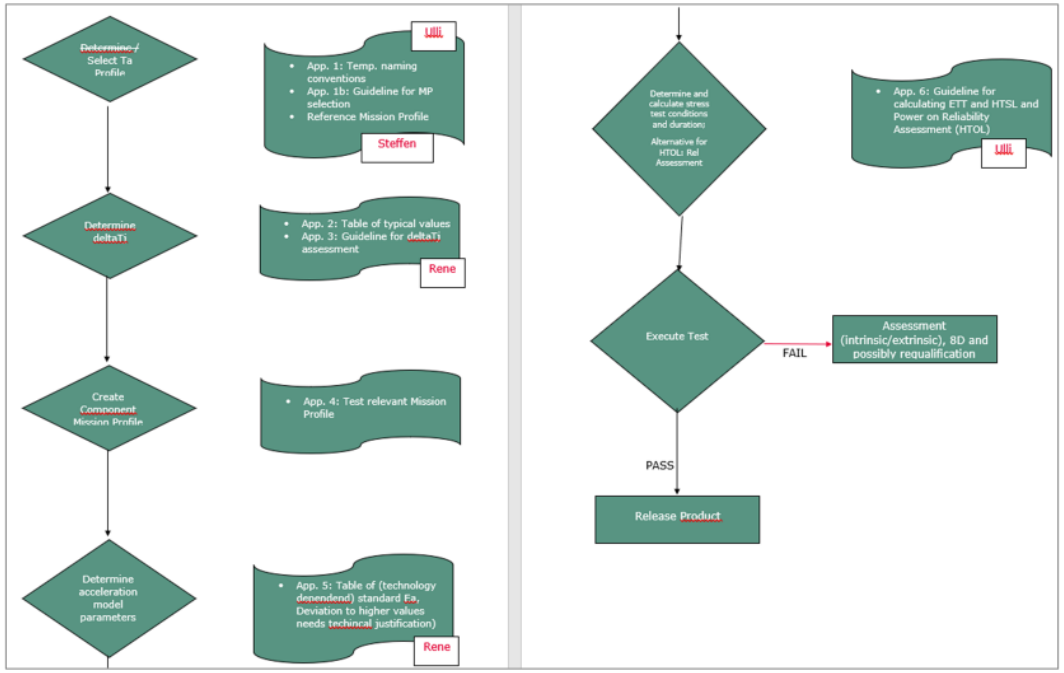
October 9th, 2025

Moderator: R. Rongen (NXP)

From AEC-RW 2024 (1)

AEC-WG Extended Lifetime Requirements (2019/20)

- Qualification Flow Chart was discussed
- With details on how to execute every step
- Draft exists but was not finalized



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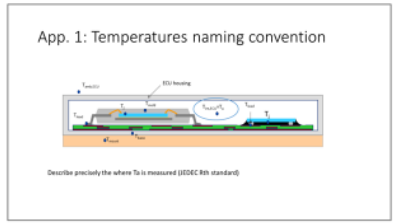
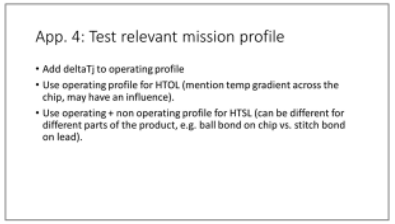
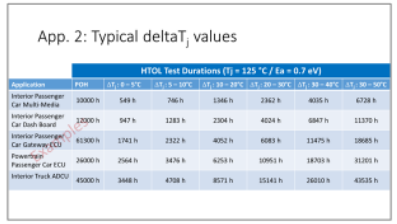
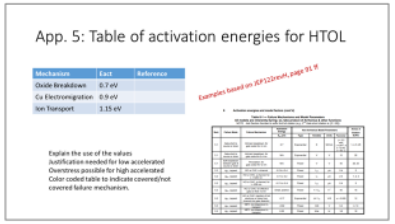
Tom van Damme	*Magna*	Alan Webber	*TI*

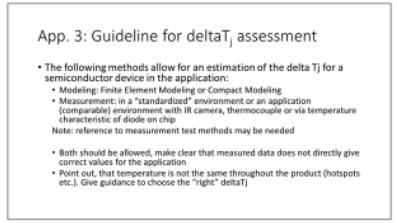

App. 1: Temperatures naming convention


App. 4: Test relevant mission profile

- Add deltaTj to operating profile
- Use operating profile for HTOL (mention temp gradient across the chip, may have an influence).
- Use operating + non operating profile for HTSL (can be different for different parts of the product, e.g. ball bond on chip vs. stitch bond on lead).


App. 2: Typical deltaT$_j$ values

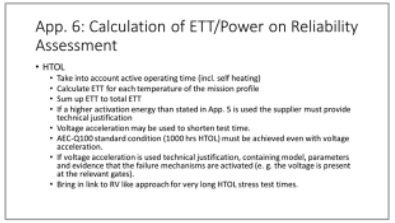

App. 5: Table of activation energies for HTOL


App. 3: Guideline for deltaT$_j$ assessment

- The following methods allow for an estimation of the delta Tj for a semiconductor device in the application:
  - Modeling: Finite Element Modeling or Compact Modeling
  - Measurement: in a "standardized" environment or an application (comparable) environment with IR camera, thermocouple or via temperature characteristic of diode on chip

Note: reference to measurement test methods may be needed

- Both should be allowed, make clear that measured data does not directly give correct values for the application
- Point out, that temperature is not the same throughout the product (hotspots etc.). Give guidance to choose the "right" deltaTj


App. 6: Calculation of ETT/Power on Reliability Assessment

- HTOL
  - Take into account active operating time (incl. self heating)
  - Calculate ETT for each temperature of the mission profile
  - Sum up ETT to total ETT
  - If a higher activation energy than stated in App. 5 is used the supplier must provide technical justification
  - Voltage acceleration may be used to shorten test time.
  - AEC-Q100 standard condition (1000 hrs HTOL) must be achieved even with voltage acceleration.
  - If voltage acceleration is used technical justification, containing model, parameters and evidence that the failure mechanisms are activated (e. g. the voltage is present at the relevant gates).
  - Bring in link to IRV like approach for very long HTOL stress test times.

From AEC-RW 2024 (2)

Challenges:

- Tier2 needs reliability goals/targets to design for
- Overhead of communication: high number of MPs for one part before and after the design finished / product released

Standardization:

- Do we need standardized extended mission profiles?
  - Yes, but not to be generated by AEC. VDE looks to be the right consortium to generate them in the series of WP sub-papers under drafting
  - How many MP would be needed and how “realistic” should they be; are artificial envelopes a solution?
  - Can we extend the current AEC-Q framework of grading: Introduce a new AEC lifetime reliability definition
    - HT-Class: x hours active operation @ Tj y (hot temp device capability)
    - LT-Class: x hours active operation @ Tj y (cold temp device capability)
- We may have to extend some of the current requirements in AEC-Q specs, but testing “forever” (i.e., very long duration) is not the way forward.
  - It is difficult to turn Robustness Validation principles into requirements in a standard…

From AEC-RW 2024 (3) _ Next Steps…

- Create a new separate Q-document?
- How to add Technology Qualification details/requirements?
- (Re)start WG Extended Lifetime Requirements?

Content

1. WG Members (Direct & Indirect) / Meetings
2. Objectives
3. Deliverable 1: Classes of Mission Profiles
4. Deliverable 2: Qualification Requirements per “Class

The Working Group per October 1, 2025

- Members:

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- Meeting every 3 weeks since kick-off on Feb 5th, 2025

Objectives AEC WG EMP

In scope:

- Classes of Mission Profiles (e.g., via “extension” of the Q100 grade framework)

Not in scope:

- Standardized Extended Mission Profiles

Deliverables

- Classes of Mission Profiles
- Qualification Requirements per “Class”
- Guidelines for assessing Extended Mission Profiles (Application of Robustness Validation)
- Guidelines for Tiers 1 how to judge whether a qualified part in “Class xyz” for “Application A” may fit in “Application B”; i.e, if any new Mission Profile is within the qualified scope

Schedule

- Target for completing a proposal: not defined yet

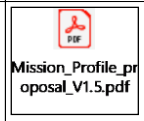
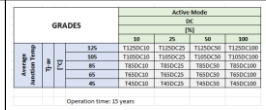
Deliverable 1: Classes of Mission Profiles / Intro

Key starting points:

1. What makes a mission profile extended :
   - longer (e.g., 30.000h),
   - more stress (e.g., higher **T**),
   - or even a combination

2. About **T: Ambient Ta** can be a reference to start from but there is a preference to change to **junction Tj** as it becomes more often a more relevant parameter (may also imply change of AEC-Q100 grades), some remarks :
   - How to determine Tj?
   - Self-heating estimates (e.g., worst case?)

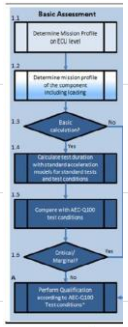
Deliverable 1: Classes of Mission Profiles / Overview Prop.)

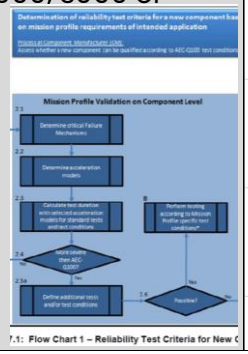
Proposal *	AEC-Q100 adaption	Classes	Reference
Fritz / Bosch	Standard AEC Grade Tamb +deltaT (for Tj) at Tamb,max	- HT-Class (e.g. 2000h at Tj=175, with evidence / Ea = xyz eV) - LT-Class (e.g. 20kh at -40°C) - TC-class (e.g. 2000 cycles @ 185°C / CM exponent 3.0)	 Mission_Profile_proposal_V1.5.pdf
Matthias/ Aumovio	Standard AEC grades with Tj,avg and potentially adding grades	Active mode class (e.g. T125DC50 = Tj=125°C / DC = 50%)	
Mykola/ Melexis	Adding Grade 4 (0 to 70°C)	- Low Power Combustion (LPC) vs Electrical (LPE) and High Power Combustion (HPC) vs Electrical HPE) - LPE and HPE upto 60 kh operation - All LP: Tamb	 Deliverable es V1_MBL_Propo
Jim/ Intel	- Standard AEC Grade Tamb +25°C (for Tj) at Tamb, max - adding Grade 4 (0 to 95°C)	Target EMP converted to (Tj-eff, t-eff, V-eff, f-eff) go to model per mechanism and pass/fail cirteria set for EMP	 AEC WG on EMP l 16 2025_V1.0_Inte
Alan/ TI	Not needed, AEC-Q100 is minimum requirement, transform from Tamb to Tjunc	Not needed, instead communicate device capability in Lx/Bx terminology, e.g.: - Adopt 0.1% failure rate limit - Electromigration : EM-L0.1 : 100,000 POH @105C	 AEC-EMP-TI-Prop discussions 5-7-2

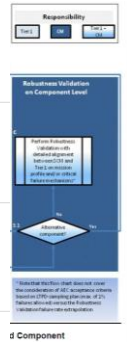
* These proposals are from the individual WG members and do not necessarily reflect an aligned company position

Deliverable 1: Classes of Mission Profiles / Discussion

Scope:	Temp-Time Profiles			
	AEC-Q100-class	**HT-class**	**LT-Class**	**RV-Class**
Lx is Life Percent	L1%	L1% or L0.1%	L1% or L0.1%	
Grade 0	Ta 150 °C / 1000 h	e.g., Tj 175°C / 200(	e.g., Tj 25°C / 10000 h	Per Failure Mechanism; e.g. EM: L0.1% / Tj 105°C / 100.000h
Grade 1	Ta 125 °C / 1000 h	e.g., Tj 150°C / 200(	e.g., Tj 25°C / 10000 h	
Grade 2	Ta 105 °C / 1000 h	e.g., Tj 125°C / 200(	e.g., Tj 25°C / 10000 h	
Grade 3	Ta 85 °C / 1000 h		e.g., Tj 25°C / 10000 h	
Grade 4	Ta 70 °C? / 1000 h		e.g., Tj 25°C / 10000 h	
Use case	12000 h / 15 y			
	Flow A (Appx 7)	**Flow B (Appx 7)**		**Flow C (Appx 7)**
Remarks	-	This approach needs models to be used for projecting on a Mission Profile Validation does not necessarily mean that you have product reliability test results We need to avoid product level validation for 2000, 3000 or 4000h (expectation / requirement) Suitable for commodity products?		This approach needs models to be used or projecting on a Mission Profile (White Paper) Not easy to standardize Advantage: more detailed statement around Mission Profile Capability Product level, or at IP level will only work in direct contact between supplier and user Use reference models and parameters (conservative) to start with, case by case a supplier can use different parameters or refer to an own white paper white paper With lead customers







Deliverable 2: Qualification Requirements per “Class”

A. Some considerations for discussion

1. Should we add group D requirements?
   - Not only focus on die (Si) but also on package and interaction:
   - what mechanisms to cover?

2. Moving away from Q10x concept?
   Introducing ”lifetime budgets”: combination Tj,eff and durations, while :
   - Not exceeding Tj,max in the datasheet, a user can use this in design the application
   - Being aware of max ratings, but what about e.g., voltage and current levels?
   - Being provided from component supplier to user

   Question: How to validate/qualify a budget?
   This could perhaps be linked to standard mission profiles provided by VDE/VDA

AEC and Extended Mission Profiles

Discussion & Questions