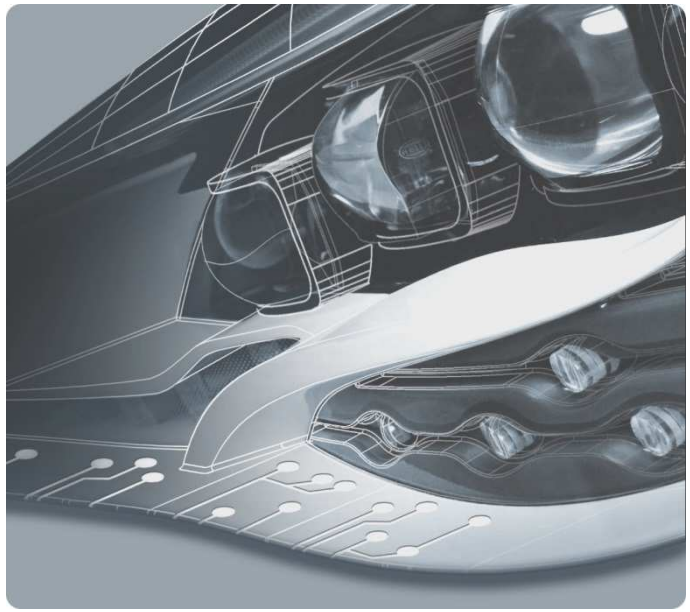

F-7761EN_C (2011-06)

# AEC-Q102
# LED Qualification Review

Uwe Berger, Hella KGaA

Ludger Kappius, Hella KGaA

AEC Workshop Detroit, April 18th 2017

# AEC-Q102 LED Qualification Review

- Status AEC-Q102
- Content of AEC-Q102
- Benefit of AEC-Q102
- Outlook

# AEC-Q102 LED Qualification Review

## Status – Thank you !


**Acknowledgment**

Any document involving a complex technology brings together experience and skills from many sources. The Automotive Electronics Council would especially like to recognize the following significant contributors to the revision of this document: (in alphabetical order)

**Sustaining Members:**

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| Alfred Zhang | Delphi Corporation |
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| Serge Rudaz | Lumileds |
| Hiroaki Kuroda | Nichia |
| Saori Mitsuhashi | Nichia |

# AEC-Q102 LED Qualification Review

## Status – AEC-Q102 ready to be published


- Dedicated for discrete optoelectronic semiconductors.
  - LED (visible & IR)
  - Laser
  - Photo Diodes
  - Photo Transistors
- Valid for exterior and interior automotive application

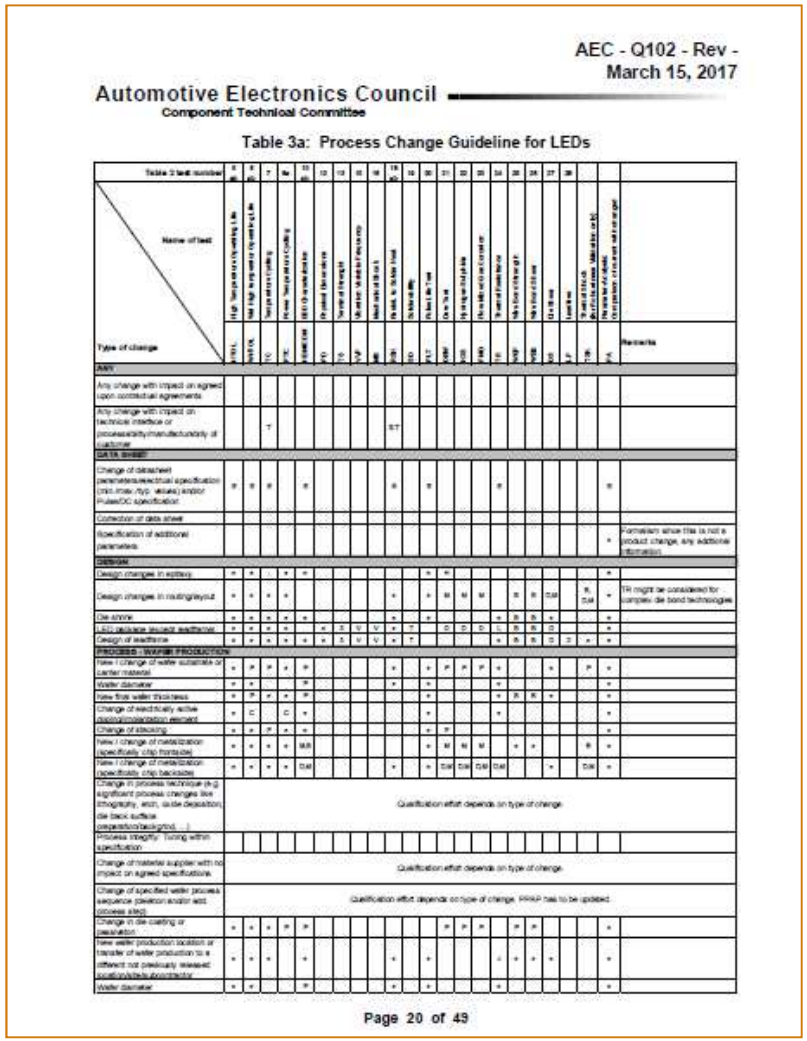
# AEC-Q102 LED Qualification Review

## Content - Test Setup

| Test # AEC-Q102 | | 1 | 2 | 3 | 4 | 5a | 5b | 5c | 6a | 6b | 6c | 7 | n.a. | n.a. | n.a. | 8a | 8b | 9 | 10a | 10b | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TEST | PC | EV | PV | HTOL1 | HTOL2 | HTRB | WHTOL1 | WHTOL2 | H³TRB | TC | TSK | TCHT | WBI | PTC | IOL | LTOL | HBM | CDM | DPA | PD | TS | CA | VVF | MS | HER | RSH | SD | PLT | DEW | H2S | FMG | TR | WBP | WBS | DS | WG |
| AEC-Q101 (LED) | | x | x | x | x | x | | | x | | x | x | | x | x | x | | | x | x | x | x | x | x | x | x | x | x | x | | | | x | x | x | x | x |
| IEC 60810 | | x | x | x | x | x | x | | x | x | | x | x | | | x | | | x | (MM) | x | x | | | x | x | | x | x | x | x | x | x | x | | | |
| AEC-Q102 | LED | x | x | x | x | x | x | | x | x | | x | | | | x | | | x | x | x | x | x | | x | x | | x | x | x | x | x | x | x | x | x | x |
| | Laser | x | x | x | x | x | x | | x | x | | x | | | | x | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| | PD & PT | x | x | x | x | | | x | | | x | x | | | | | x | | x | x | x | x | x | | x | x | | x | x | | x | x | x | | x | x | x | x |

- Basis: AEC-Q101 rev. D
- Closer look to the test board assembly
- Detailed definition of failure criteria
- Enhanced criteria for pre- and post-stress tests to detect latent failures
  - Test not only at room but simple light / no light also at high & low temperature
  - Alternative: failure detection during stress test
- Documents for communication (CDCQ; qualification plan, test report)

# AEC-Q102 LED Qualification Review
## Content – Process Change Guideline



AEC - Q102 - Rev -
March 15, 2017

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Table 3a: Process Change Guideline for LEDs

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- Process Change Guideline for
  - LED
  - Laser
  - Photo Diodes
  - Photo Transistors

*new*

- Based on ZVEI DeQuMa

ZVEI: Die Elektroindustrie => www.zvei.org

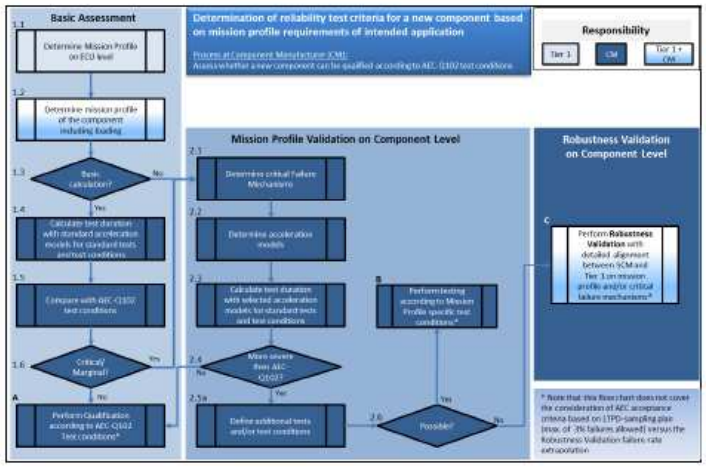
# AEC-Q102 LED Qualification Review

## Content - Robustness Validation

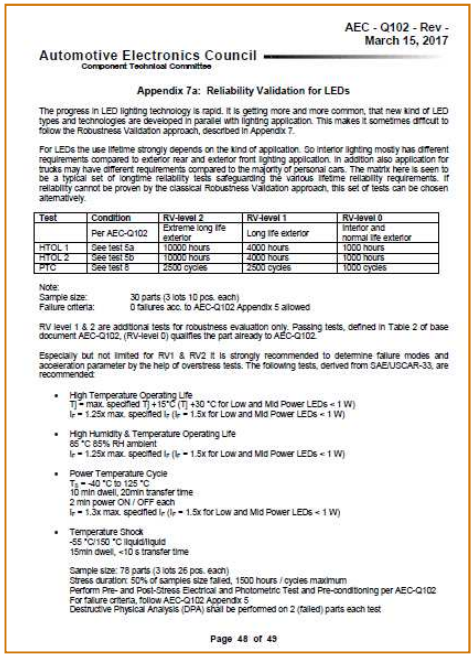
Robustness Validation approach for LEDs

Acceleration models for
- Operation
- Thermomechanical
- Humidity

(see AEC-Q100/101)




Additional alternative



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**Appendix 7a: Reliability Validation for LEDs**

The progress in LED lighting technology is rapid. It is getting more and more common, that new kind of LED types and technologies are developed in parallel with lighting application. This makes it sometimes difficult to follow the Robustness Validation approach, described in Appendix 7.

For LEDs the use lifetime strongly depends on the kind of application. So interior lighting mostly has different requirements compared to exterior rear and exterior front lighting application. In addition also application for trucks may have different requirements compared to the majority of personal cars. The matrix here is seen to be a typical set of longtime reliability tests safeguarding the various lifetime reliability requirements. If reliability cannot be proven by the classical Robustness Validation approach, this set of tests can be chosen alternatively.

| Test | Condition | RV-level 2 | RV-level 1 | RV-level 0 |
|---|---|---|---|---|
| | Per AEC-Q102 | Extreme long life exterior | Long life exterior | Interior and normal life exterior |
| HTOL 1 | See test 5a | 10000 hours | 4000 hours | 1000 hours |
| HTOL 2 | See test 5b | 10000 hours | 4000 hours | 1000 hours |
| PTC | See test 8 | 2500 cycles | 2500 cycles | 1000 cycles |

Note:
Sample size: 30 parts (3 lots 10 pos. each)
Failure criteria: 0 failures acc. to AEC-Q102 Appendix 5 allowed

RV level 1 & 2 are additional tests for robustness evaluation only. Passing tests, defined in Table 2 of base document AEC-Q102, (RV-level 0) qualifies the part already to AEC-Q102.

Especially but not limited for RV1 & RV2 it is strongly recommended to determine failure modes and acceleration parameter by the help of overstress tests. The following tests, derived from SAE/USCAR-33, are recommended:

- High Temperature Operating Life
  $T_j$ = max. specified $T_j$ +15°C ($T_j$ +30 °C for Low and Mid Power LEDs < 1 W)
  $I_F$ = 1.25x max. specified $I_F$ ($I_F$ = 1.5x for Low and Mid Power LEDs < 1 W)
- High Humidity & Temperature Operating Life
  85 °C 85% RH ambient
  $I_F$ = 1.25x max. specified $I_F$ ($I_F$ = 1.5x for Low and Mid Power LEDs < 1 W)
- Power Temperature Cycle
  $T_S$ = -40 °C to 125 °C
  10 min dwell, 20min transfer time
  2 min power ON / OFF each
  $I_F$ = 1.3x max. specified $I_F$ ($I_F$ = 1.5x for Low and Mid Power LEDs < 1 W)
- Temperature Shock
  -55 °C/150 °C liquid/liquid
  15min dwell, <10 s transfer time

Sample size: 78 parts (3 lots 26 pos. each)
Stress duration: 50% of samples size failed, 1500 hours / cycles maximum
Perform Pre- and Post-Stress Electrical and Photometric Test and Pre-conditioning per AEC-Q102
For failure criteria, follow AEC-Q102 Appendix 5
Destructive Physical Analysis (DPA) shall be performed on 2 (failed) parts each test.

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# AEC-Q102 LED Qualification Review
## Content - Robustness Validation: RV Level

### Appendix 7a: Reliability Validation for LEDs

The progress in LED lighting technology is rapid. It is getting more and more common, that new kind of LED types and technologies are developed in parallel with lighting application. This makes it sometimes difficult to follow the Robustness Validation approach, described in Appendix 7.

For LEDs the use lifetime strongly depends on the kind of application. So interior lighting mostly has different requirements compared to exterior rear and exterior front lighting application. In addition also application for trucks may have different requirements compared to the majority of personal cars. The matrix here is seen to be a typical set of longtime reliability tests safeguarding the various lifetime reliability requirements. If reliability cannot be proven by the classical Robustness Validation approach, this set of tests can be chosen alternatively.

| Test | Condition | RV-level 2 | RV-level 1 | RV-level 0 |
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| | Per AEC-Q102 | Extreme long life exterior | Long life exterior | Interior and normal life exterior |
| HTOL 1 | See test 5a | 10000 hours | 4000 hours | 1000 hours |
| HTOL 2 | See test 5b | 10000 hours | 4000 hours | 1000 hours |
| PTC | See test 8 | 2500 cycles | 2500 cycles | 1000 cycles |

Note:
Sample size: 30 parts (3 lots 10 pcs. each)
Failure criteria: 0 failures acc. to AEC-Q102 Appendix 5 allowed

RV level 1 & 2 are additional tests for robustness evaluation only. Passing tests, defined in Table 2 of base document AEC-Q102, (RV-level 0) qualifies the part already to AEC-Q102.

# AEC-Q102 LED Qualification Review
## Content - Robustness Validation: USCAR-33

Especially but not limited for RV1 & RV2 it is strongly recommended to determine failure modes and acceleration parameter by the help of overstress tests. The following tests, derived from SAE/USCAR-33, are recommended:

- High Temperature Operating Life
  Tj = max. specified Tj +15°C (Tj +30 °C for Low and Mid Power LEDs < 1 W)
  $I_F$ = 1.25x max. specified $I_F$ ($I_F$ = 1.5x for Low and Mid Power LEDs < 1 W)

- High Humidity & Temperature Operating Life
  85 °C 85% RH ambient
  $I_F$ = 1.25x max. specified $I_F$ ($I_F$ = 1.5x for Low and Mid Power LEDs < 1 W)

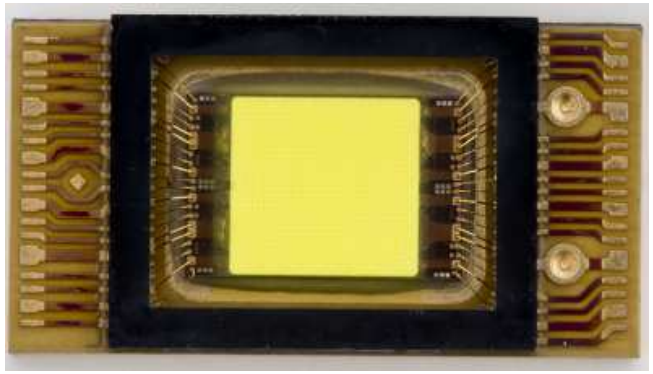
- Power Temperature Cycle
  $T_S$ = -40 °C to 125 °C
  10 min dwell, 20min transfer time
  2 min power ON / OFF each
  $I_F$ = 1.3x max. specified $I_F$ ($I_F$ = 1.5x for Low and Mid Power LEDs < 1 W)

- Temperature Shock
  -55 °C/150 °C liquid/liquid
  15min dwell, <10 s transfer time

  Sample size: 78 parts (3 lots 26 pcs. each)
  Stress duration: 50% of samples size failed, 1500 hours / cycles maximum
  Perform Pre- and Post-Stress Electrical and Photometric Test and Pre-conditioning per AEC-Q102
  For failure criteria, follow AEC-Q102 Appendix 5
  Destructive Physical Analysis (DPA) shall be performed on 2 (failed) parts each test

# AEC-Q102 LED Qualification Review
## Benefit of AEC-Q102

- Acceptance of AEC qualification norms
- Knowledge of 60+ companies
- Focus on automotive needs
- Covering all automotive application
- Homogenity of requirements for all electronic components
- Ready for new technologies in automotive lighting

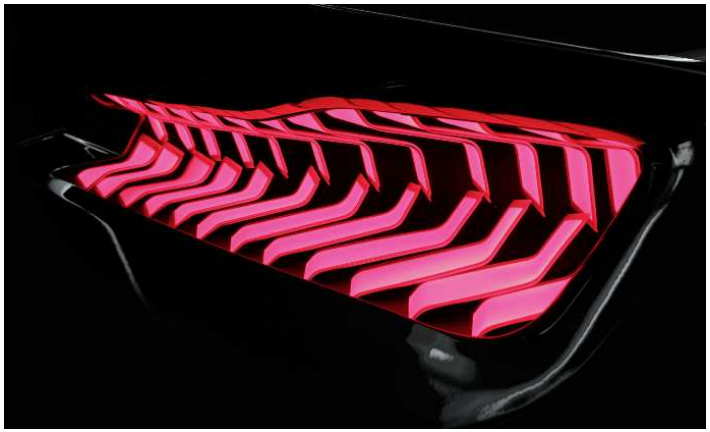


Source: www.hella.com

| | |
|---|---|
| Component | AEC-Q100<br>AEC-Q102<br>AEC-Q… |
| Modul | AEC-Q104 |

# AEC-Q102 LED Qualification Review
## Outlook – Further Fields of Interest

- OLED
- Displays



Source: www.hella.com


Source: www.bhtc.com

- Relationship AEC / IEC
- Alignement of photometric testing method
- AEC general: soldering tests, CDM
- Zero Defect (see AEC-Q004 Draft)
- Combination tests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