# SMD Current Sense: AEC-Q200 vs. Vishay Qualification

*By Bryan Yarborough*

The Automotive Electronics Council (AEC) was started in the early 1990s to represent the interests of the automotive industry and to capture supplier attention. This led to the development of a specification for standard tests to assure high quality, reliable electronic components that could perform in harsh automotive environments. The qualification standards made it possible for suppliers to understand the industry's requirements and develop products to meet its needs. They were initially developed for the semiconductor industry with AEC-Q100, and then for passive components with AEC-Q200.

The standard testing for resistor components from AEC-Q200 Table 7 is compared to the Vishay Dale current sense product qualification in the table below to highlight their differences. The qualification testing exceeds the AEC-Q200 standard, ensuring superior performance and reliability for our automotive customers that are in the highest tier of the industry. The blue text indicates test conditions that exceed the AEC-Q200 standard.

**AEC-Q200 VS. VISHAY QUALIFICATION**

| STRESS | NO. | QUALIFICATION PLAN PER AEC-Q200 REV. D | | QUALIFICATION PLAN (INTERNAL) | |
|---|---|---|---|---|---|
| | | REFERENCE SPECIFICATION METHOD / CONDITION | TEST CONDITIONS PER AEC-Q200 | REFERENCE SPECIFICATION METHOD / CONDITION | TEST CONDITIONS PER VISHAY |
| Pre- and post-stress electrical test | 1 | User spec. | Test is performed except as specified in the applicable stress reference and the additional requirements in Table 7 | | |
| High temperature exposure (storage) | 3 | MIL-STD-202 method 108 | 1000 h at T = 125 °C. Unpowered. Measurement at 24 h ± 4 h after test conclusion | MIL-STD-202 method 108 | 2000 h at 170 °C |
| Temperature cycling | 4 | JESD22 method JA-104 | 1000 cycles (-55 °C to +125 °C). Measurement at 24 h ± 4 h after test conclusion. 30 min maximum dwell time at each temperature extreme. 1 min maximum transition time | MIL-STD-202 method 107 condition F | -55 °C to 150 °C, dwell time = 15 min, 2000 cycles |
| Moisture resistance | 6 | MIL-STD-202 method 106 | t = 24 h/cycle. Note: steps 7a and 7b not required, 0 % power, no polo, 65 °C, measurement at 24 h ± 2 h after test | MIL-STD-202 method 106 | Same as AEC-Q200 |
| Biased humidity | 7 | MIL-STD-202 method 103 | 1000 h at 85 °C / 85 % RH. Note: specified conditions: 10 % of operating power. Measurement at 24 h ± 4 h after test conclusion | MIL-STD-202 method 103 | Same as AEC-Q200 |
| Operational life | 8 | | | MIL-STD-202 method 108, condition F | 2000 h at 70 °C (datasheet qualification). Steady state, $T_a$ = 70 °C at rated power. Measurements at 24 h ± 2 h after test |
| | 8.1 | MIL-STD-202 method 108 | Condition D steady state. $T_a$ = 125 °C at rated power. Measurement at 24 h ± 4 h after test conclusion | MIL-STD-202 method 108 | 2000 h at 125 °C |

TECHNICAL NOTE

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| | | REFERENCE SPECIFICATION METHOD / CONDITION | TEST CONDITIONS PER AEC-Q200 | REFERENCE SPECIFICATION METHOD / CONDITION | TEST CONDITIONS PER VISHAY |
| External visual | 9 | MIL-STD-883 method 2009 | Electrical test not required. Inspect device construction, marking, and workmanship. | MIL-STD-883 method 2009 | All resistors inspected to visual criteria of Vishay ICP document. ICP documents meet MIL-STD-883, method 2009, plus additional internal requirements |
| Physical dimension | 10 | JESD22 method JB-100 | Verify physical dimensions to the applicable device detail specification. Note: user(s) and suppliers spec. Electrical test not required | JESD22 method JB-100 | Same as AEC-Q200 |
| Resistance to solvents | 12 | MIL-STD-202 method 215 | Note: add aqueous wash chemical - OKEM clean or equivalent. Do not use banned solvents | MIL-STD-202 method 215 | Same as AEC-Q200 |
| Mechanical shock | 13 | MIL-STD-202 method 213 | Fig. 1 of method 213. Condition C | MIL-STD-202, method 213, Fig. 1, SMD, condition C | Same as AEC-Q200 |
| Vibration | 14 | MIL-STD-202 method 204 | 5 *g* for 20 min 12 cycles, each of 3 orientations. Note: use 8 in x 5 in x 0.031 in PCB with 7 secure points on one long side and 2 secure points at the corners of opposite sides. Parts mounted within 2 in from any secure point. Test from 10 Hz to 2000 Hz | MIL-STD-202, method 204, condition D | 20 *g* for 20 min 12 cycles, each of 3 orientations |
| Resistance to soldering heat | 15 | MIL-STD-202 method 210 | Condition B, no pre-heat of samples. Note: single wave solder - Procedure 2 for SMD and Procedure 1 for leaded with solder within 1.5 mm of device body | MIL-STD-202 method 210, condition K | Resistance readings taken after initial mounting and then reflow 3 x with final readings |
| Thermal shock | 16 | Not required for Table 7 of AEC-Q200 | | | Refer to Note 1 of section "Vishay Notes to AEC-Q200" |
| ESD | 17 | AEC-Q200-002 or ISO/DIS 10605 | | AEC-Q200-002 | Same as AEC-Q200 |
| Solderability | 18 | J-STD-002 | For both leaded and SMD. Electrical test not required. Magnification 50 x. Conditions: Leaded Method A at 235 °C, category 3. SMD a) Method B, 4 h at 155 °C dry heat at 235 °C b) Method B at 215 °C category 3 c) Method D category 3 at 260 °C | J-STD-002 | Same as AEC-Q200 |




For technical questions, contact: www2bresistors@vishay.com

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| STRESS | NO. | QUALIFICATION PLAN PER AEC-Q200 REV. D | | QUALIFICATION PLAN (INTERNAL) | |
| | | REFERENCE SPECIFICATION METHOD / CONDITION | TEST CONDITIONS PER AEC-Q200 | REFERENCE SPECIFICATION METHOD / CONDITION | TEST CONDITIONS PER VISHAY |
| Electrical characterization | 19 | User spec. | Parametrically test per lot and sample size requirements, summary to show min., max., mean, and standard deviation at room as well as min. and max. operating temperatures | MIL-STD-304 | Value to be read at -65 °C, 170 °C, and 25 °C for electrical characterization, unless otherwise specified on the datasheet. Tolerance is established with a 1.33 CPk limit based on results, unless otherwise required. Temperatures set per datasheet |
| Flammability | 20 | UL 94 | V-0 or V-1 are acceptable. Electrical test not required | UL 94 | Materials certified to V-0 or V-I per UL 94 independently and do not require testing for released components |
| Board flex | 21 | AEC-Q200-5 | 60 s minimum holding time | AEC-Q200-005 2 mm min | Tolerance and quantity set per ICP-618 |
| Terminal strength (SMD) | 22 | AEC-Q200-6 | | AEC-Q200-006 force of 1.8 kg for 60 s | Tolerance and quantity set per ICP-618 |
| Flame retardance | 24 | AEC-Q200-1 | | AEC-Q200-1 | Refer to Note 2 of section "Vishay Notes to AEC-Q200" |

## AEC-Q200 NOTES

Pre-stress electrical tests also serve as electrical characterization.

Interval measurements for 1000 h tests required at 250 h and 500 h.

**Significant Characteristics:**

1. DC resistance
2. Temperature coefficient of resistance

## VISHAY NOTES TO AEC-Q200

Pre-stress electrical tests also serve as electrical characterization. Interval measurements for 2000 h tests required at 250 h, 500 h, and 1000 h. Quantity set per ICP-618. Temperature and tolerance set per datasheet.

1. Thermal shock: thermal shock is not required by AEC-Q200 for Table 7F. Temperature cycling is represented by thermal shock because of test similarity and severity
2. Flame retardance: the exception note for the AEC-Q200 flame retardance is based on a test that applies 9 V for 1 h and increases 1 V every hour to 32 V and is not allowed to exceed 350 °C. The all-metal welded construction is so robust that it will not fuse the way that a thick film part would. It will exceed the temperature limits. This test would be more applicable to resistance values much higher than current sense resistors. The table below displays the current and power that would be applied to the part under these test conditions of 9 V for one hour.

   The following constitutes a failure:

   a. A flame over 3.0 s duration

   b. An explosion

   c. A temperature above 350 °C sustained for over 10 s

   Flame retardance test: www.aecouncil.com/Documents/AEC_Q200-001B.pdf.

   At 9 V the part is substantially overpowered. Power = $V^2$ / R = 81 / 0.01 Ω = 8100 W (for 1 h). Rated power for 0.25 W. The robust all-metal welded construction does not readily fuse, which would stop the test. The resistance element at this resistance value is 0.0089 in thick (0.226 mm) and is capable of withstanding high temperatures (1100 °C fusing temperature) and so violates item c above by having a temperature greater than 350 °C for over 10 s.

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## BENEFITS FOR CHOOSING VISHAY AS YOUR DESIGN PARTNER

## VISHAY CAPABILITIES

### Supply Chain Reliability

1. Vishay has been expanding production capacity in more than one location, which provides supply chain robustness when disruption occurs, such as pandemic and environmental disasters
2. Vishay controls more of the supply chain than other competitors, such as welding and machining processes, which enables us to have more control over quality and demand changes
3. Vishay is a key supplier of current sense products to most of the top-tier automotive companies that require performance, quality, and capacity to meet the needs of these types of customers

### Design Support

1. AEC-Q200 / PPAP
   a. Some competitors are only qualified to the base requirements of AEC-Q200 and are not able to support full PPAP documentation and production controls. PPAPs require substantial documentation and expertise of processes, product performance, and quality programs
   b. Experience of supporting Tier 1 automotive customers with consistent quality
   c. Vishay Dale's Power Metal Strip® standard testing for product performance exceeds AEC-Q200 (refer to table above)
2. Quality monitoring of production parts ensures ongoing compliance and performance
3. Our broad portfolio of current sense products covers a much wider range of resistance values, footprint configurations, and power ratings than our competitors, which provides us with much greater flexibility as a qualified supplier to designers
4. Vishay's laser trim process allows flexibility to four significant figures when specifying custom resistance values without being a custom part number
5. Vishay extensively supports designs with qualification data, technical papers, design tools (such as JouleWizard), and product-specific performance to provide engineers with the information that they need to design their products to their maximum capabilities with fewer design iterations