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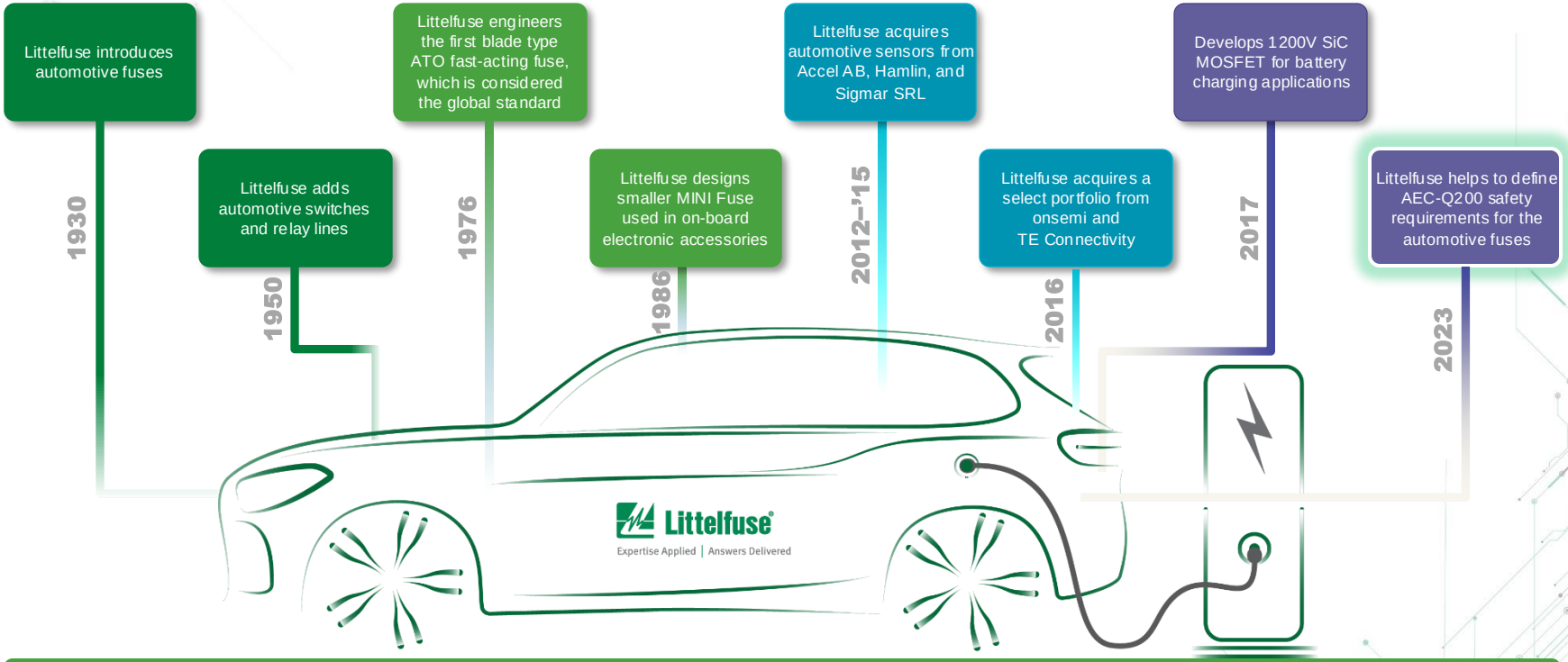
# AEC-Q200 Specification for Automotive Applications

Automotive



REV1023

# Littelfuse has a long history of defining safety needs and developing components for automobiles




Littelfuse has contributed to the development of the **AEC-Q200 Rev E Standard** released in March 2023



# Advanced electronics are driving innovation in multiple automotive applications

**Infotainment & communication**

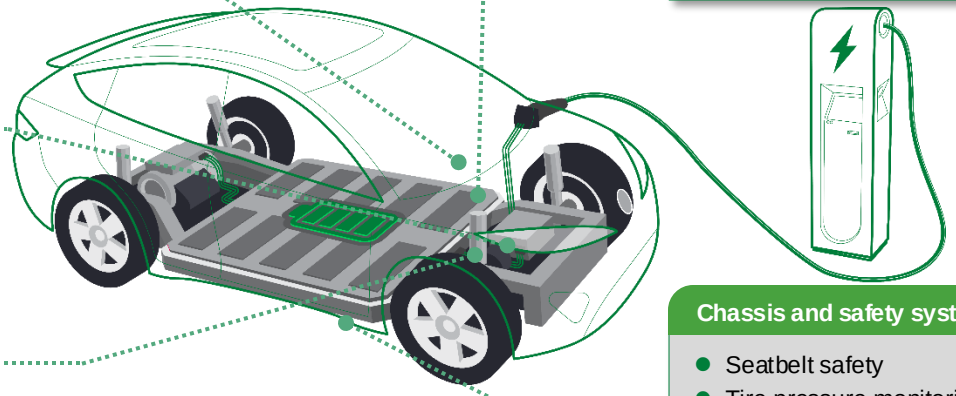
- Smart infotainment
- Navigation
- Multipurpose camera
- Telematics box

**Network systems & body electronics**

- CAN, LIN
- USB, Wireless
- Keyless entry
- Lighting control

**Advanced Driver Assistance System**

- V2X Communication
- Radar
- eCall
- Sensor fusion



**Power train**

- Battery management system
- On-board charger
- Traction motor inverter
- DC-DC converter

**Chassis and safety system**

- Seatbelt safety
- Tire pressure monitoring
- Battery disconnect
- Fuel level detection

We satisfy the need for reliable, high-quality **circuit protection products** for safety and reliability

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# Introduction to Automotive Electronics Council (AEC)

*Body for establishing standards for reliable, high quality electronic components*

## Key highlights

The Automotive Electronics Council (AEC) was originally established in the 1990s by Chrysler, Ford, and GM to establish common part-qualification and quality-system standards.

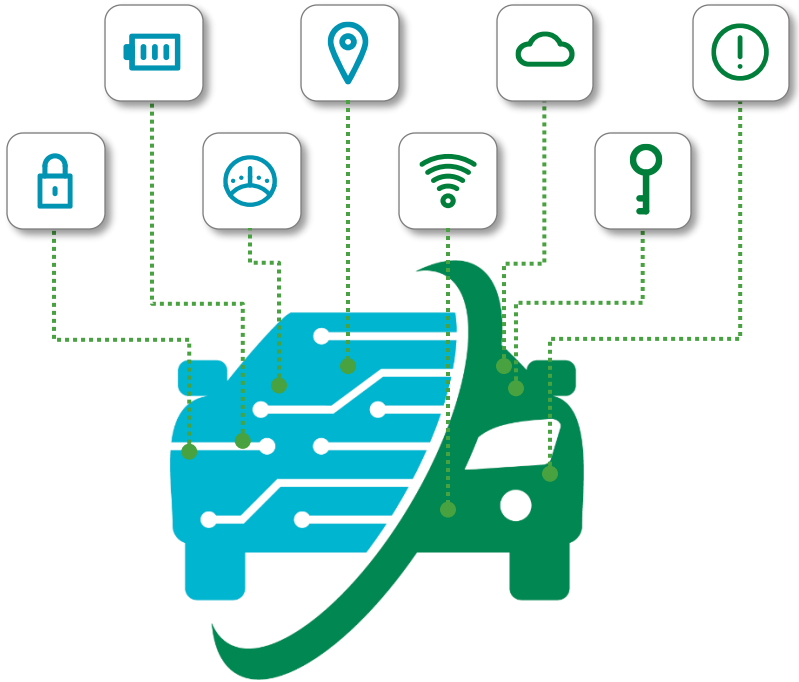
From its inception, the AEC has consisted of two committees: the Quality Systems Committee and the Component Technical Committee.

Components meeting the specifications listed by the Component Technical Committee are suitable for harsh automotive environments.

**Different AEC-Q Standards:**

- **AEC-Q100**−Failure Mechanism-Based Stress Test Qualification for Integrated Circuits
- **AEC-Q101**−Failure Mechanism-Based Stress Test Qualification for Discrete Semiconductors
- **AEC - Q102**−Failure Mechanism-Based Stress Test Qualification for Discrete Optoelectronic Semiconductors in Automotive Applications
- **AEC - Q103**−Failure Mechanism-Based Stress Test Qualification for Sensors in Automotive Applications
- **AEC - Q104**−Failure Mechanism-Based Stress Test Qualification for Multichip Modules (MCM) In Automotive Applications
- **AEC-Q200−Stress Test Qualification for Passive Components**

## Proliferation of electronics in today's vehicles

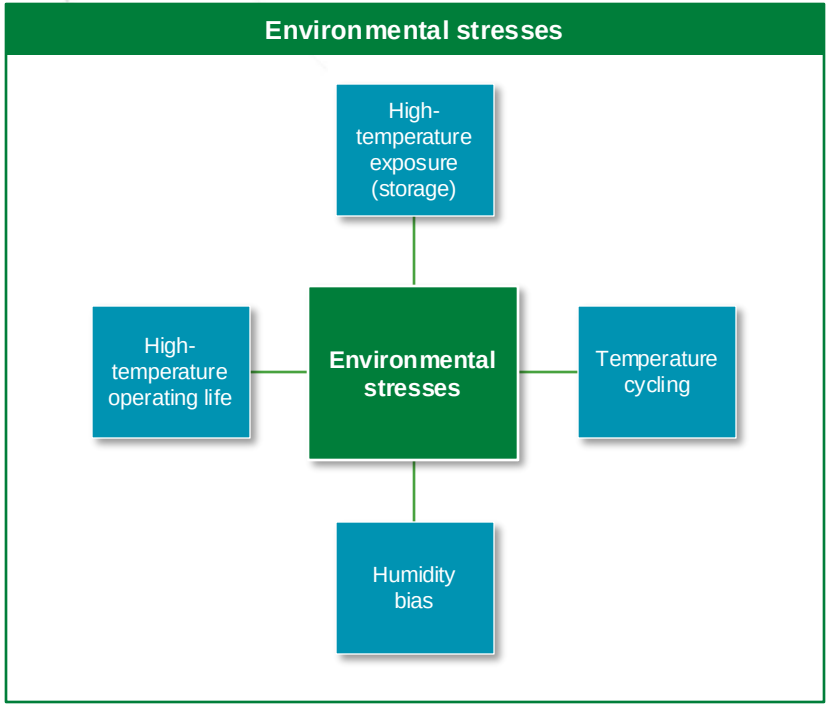


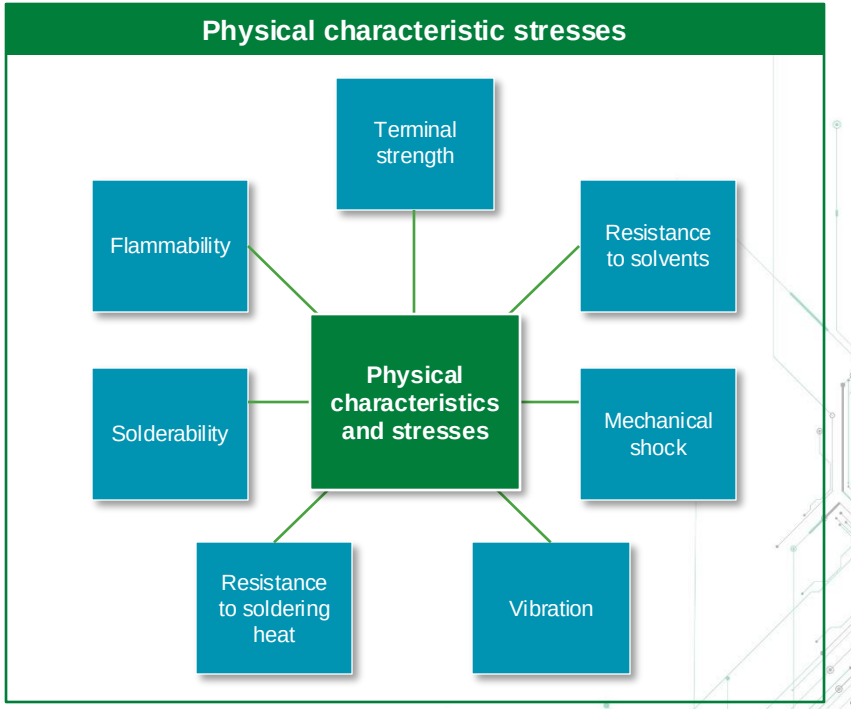


# AEC-Q200 Rev D: Stress test qualification for passives

*Resistor, capacitor, inductor, transformer, resonator, crystal, PTC, NTC, thermistor, and varistor*




Two main tests: Environment stresses and physical characteristics stresses

# New AEC-Q200 Rev E (released on March 20, 2023) adds reliability qualifications for fuses

## Key highlights

The AEC-Q200 Rev E expands its scope to provide a single standard that manufacturers can use to design and test fuses for the automotive market.

Fuses provide necessary overcurrent protection for all the circuits in a vehicle, and fuses should meet the rigorous standards for use in automotive equipment that other passive components must meet.

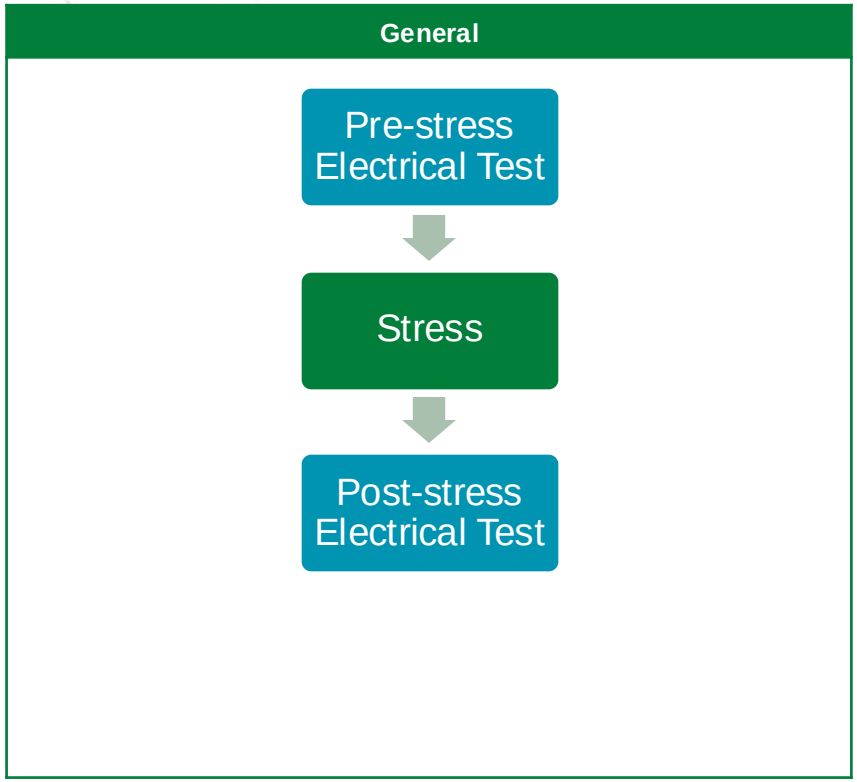
**Littelfuse has contributed to the development of Revision E and the framework for defining the test requirements for fuses.**

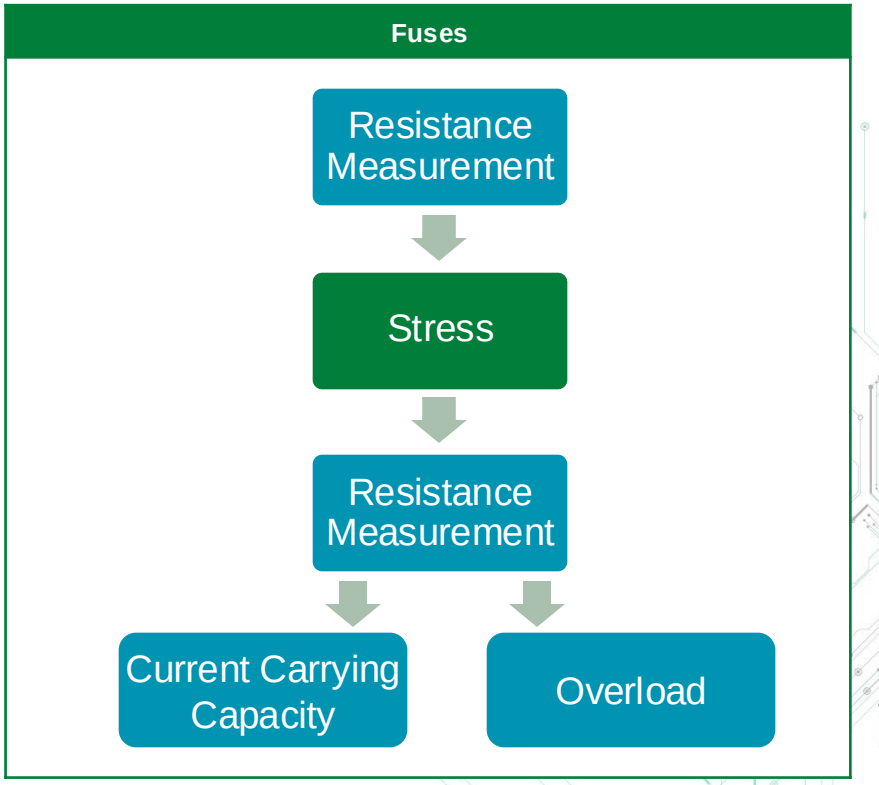
Design engineers developing systems for automotive vehicles will be able to select AEC-Q200 Qualified fuses that have been subjected to an extensive set of tests to ensure a rugged and reliable product.

## AEC-Q200 E qualification fuse stress tests

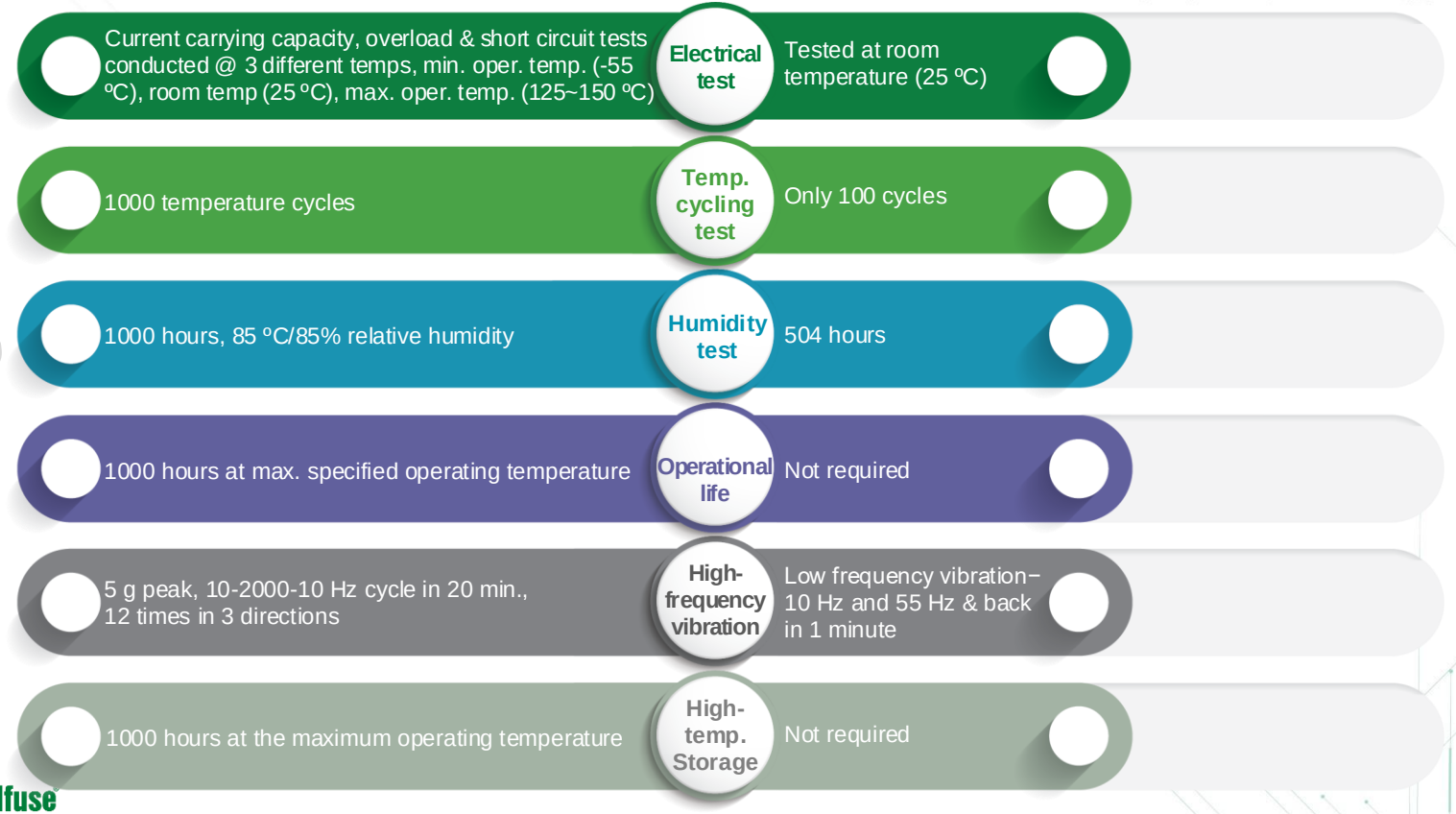
| Stress | No. | Reference |
|---|---|---|
| Pre- and post-stress electrical test | 1 | UL 248, IEC 60127, or User Specification |
| High-temperature exposure (storage) | 3 | MIL-STD-202, Method 108 |
| Temperature cycling | 4 | JESD22-A104 |
| Humidity bias | 7 | MIL-STD-202, Method 103 |
| High-temperature operating life | 8 | MIL-STD-202, Method 108 |
| External visual | 9 | MIL-STD-883, Method 2009 |
| Physical dimensions | 10 | JESD22-B100 |
| Terminal strength (for axial and radial THT components) | 11 | MIL-STD-202, Method 211 |
| Resistance to solvents | 12 | MIL-STD-202, Method 215 |
| Mechanical shock | 13 | MIL-STD-202, Method 213 |
| Vibration | 14 | MIL-STD-202, Method 204 |
| Resistance to soldering heat | 15 | MIL-STD-202, Method 210 |
| Solderability | 18 | J-STD-002 |
| Electrical characterization | 19 | UL 248, IEC 60127, or User Specification |
| Flammability | 20 | UL 94 or IEC 60695-11-5 |
| Board Flex (SMD) | 21 | AEC-Q200-005 |
| Terminal strength (SMD) | 22 | AEC-Q200-006 |

# AEC-Q200 Methodology



# AEC-Q200 test plan vs. typical validation test plan

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# Littelfuse internal qualification tests were already aligned with the AEC-Q200 Rev. E

## Internal test results in the datasheet

| | |
|---|---|
| **Materials** | **Body:** Glass-Reinforced Epoxy<br>**Terminations:** Cu/Ni/Sn (100% Pb-free) |
| **Moisture sensitivity level** | IPC/JEDEC J-STD-020, Level 1 |
| **Thermal shock** | JESD22-A104C |
| **Biased humidity** | MIL-STD-202, Method 103,<br>Test Condition D w/ exemptions |
| **High temperature storage** | MIL-STD-202, Method 108,<br>Test Condition D w/ exemptions |
| **High temperature operational life** | MIL-STD-202, Method 108, Test Condition D |
| **Mechanical shock** | MIL-STD-202, Method 213 |
| **High frequency vibration** | MIL-STD-202, Method 204 |
| **Resistance to solvents** | MIL-STD-202, Method 215 |
| **Resistance to soldering heat** | MIL-STD-202, Method 210 |
| **Salt fog** | MIL-STD-202, Method 101 |
| **Moisture resistance** | MIL-STD-202, Method 106 |
| **Terminal strength** | AEC-Q200-006 |
| **Board flex** | AEC-Q200-005 |
| **Solderability** | JESD22-B102E Method 1 |
| **Pulse testing** | Device specification |
| **Electrical characterization** | Conducted at minimum, ambient, and maximum temperatures |

## 483A Series Datasheet

**Product Characteristics**

| | |
|---|---|
| **Materials** | **Body:** Glass-Reinforced Epoxy<br>**Terminations:** Cu/Ni/Sn (100% Pb-free) |
| **Moisture Sensitivity Level** | IPC/JEDEC J-STD-020, Level 1 |
| **Thermal Shock** | JESD22-A104C |
| **Biased Humidity** | MIL-STD-202, Method 103,<br>Test Condition D w/ exemptions |
| **High Temperature Storage** | MIL-STD-202, Method 108<br>Test Condition D w/ exemptions |
| **High Temperature Operational Life** | MIL-STD-202, Method 108, Test Condition D |
| **Mechanical Shock** | MIL-STD-202, Method 213 |
| **High Frequency Vibration** | MIL-STD-202, Method 204 |
| **Resistance to Solvents** | MIL-STD-202, Method 215 |
| **Resistance to Soldering Heat** | MIL-STD-202, Method 210 |
| **Salt Fog** | MIL-STD-202, Method 101 |
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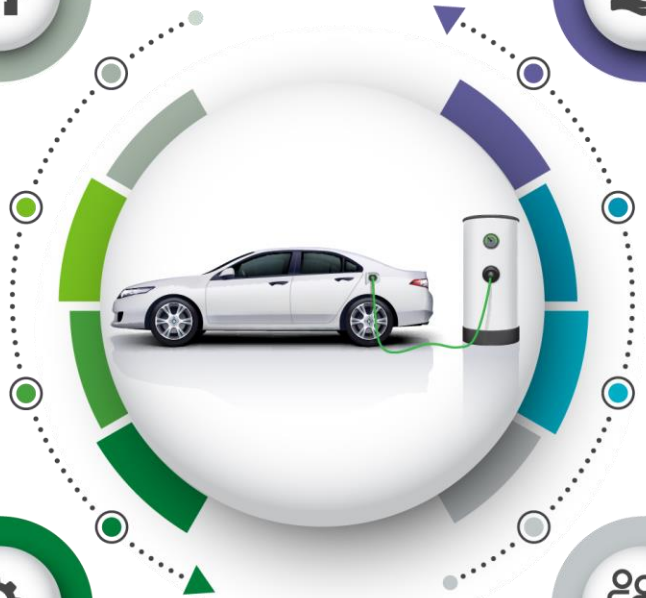
| **Terminal Strength** | AEC-Q200-006 |
| **Board Flex** | AEC-Q200-005 |
| **Solderability** | JESD22-B102E Method 1 |
| **Pulse Testing** | Device Specification |
| **Electrical Characterization** | Conducted at minimum, ambient, and maximum temperatures |



# Littelfuse is one of the first suppliers of AEC-Q200 Qualified fuses

- Littelfuse invents the FIRST automotive fuse in 1930
- Member of the AEC Technical Committee
- First to market with AEC-Q200 Qualified fuses
- Global manufacturing facilities certified ISO 9001, ISO 14001, and IATF 16949



- Contributed to the development of Revision E
- Internal qualification aligned with the new AEC-Q200 requirement
- Wide array of AEC-Q100, AEC-Q101, and AEC-Q200 components to choose from
- Application expertise

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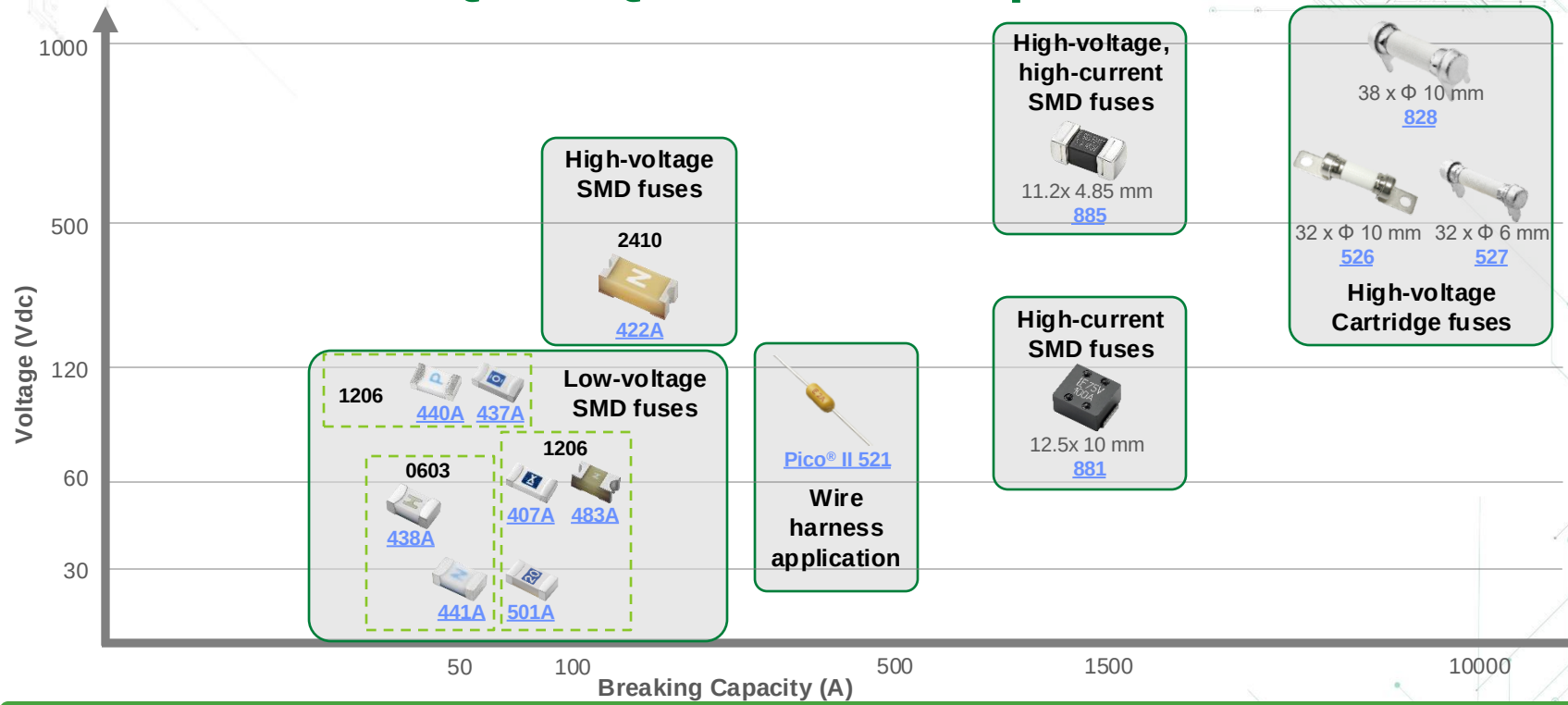
# Littelfuse AEC-Q200 Qualified fuse portfolio




To learn more about Littelfuse's **AEC-Q200 Qualified fuses** portfolio, click here

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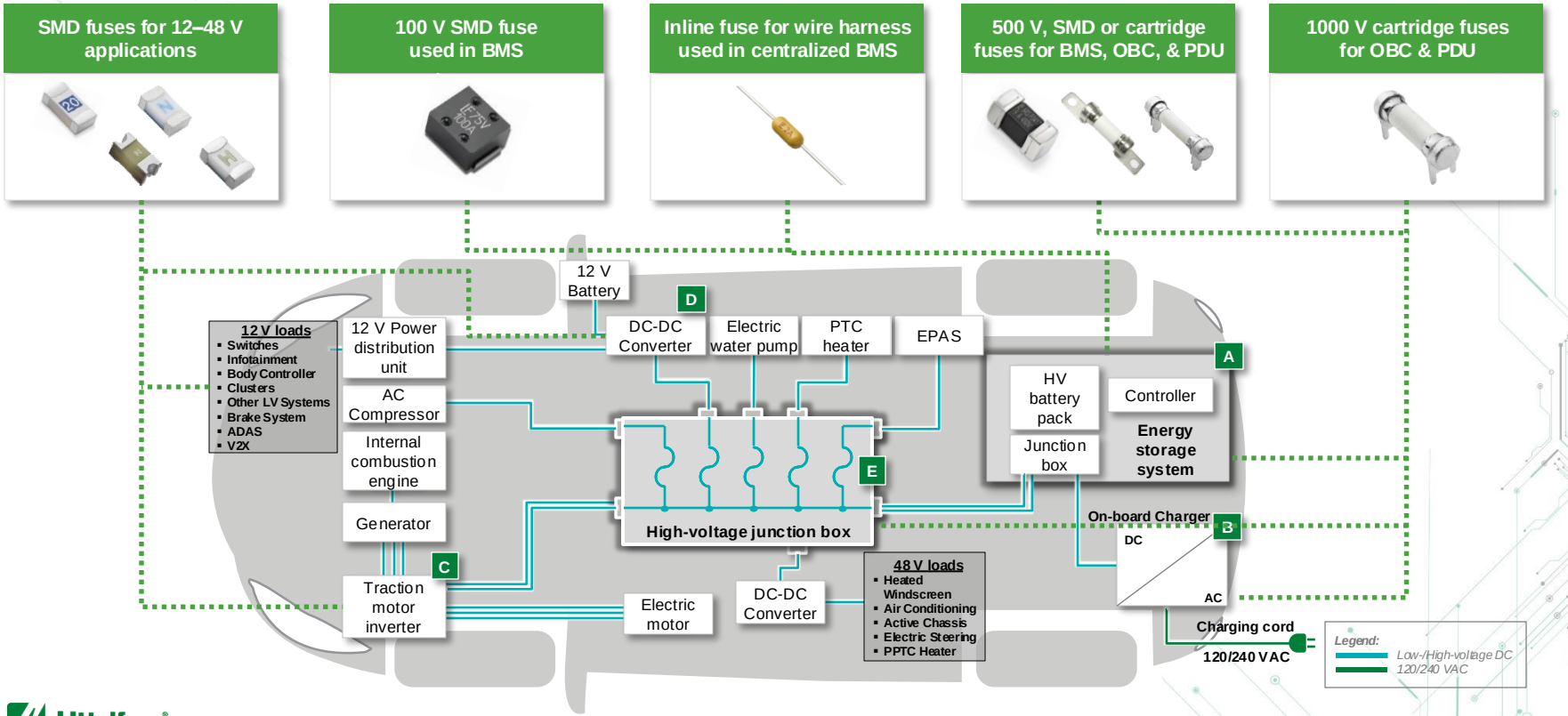
# AEC-Q200 Qualified fuses in automotive applications

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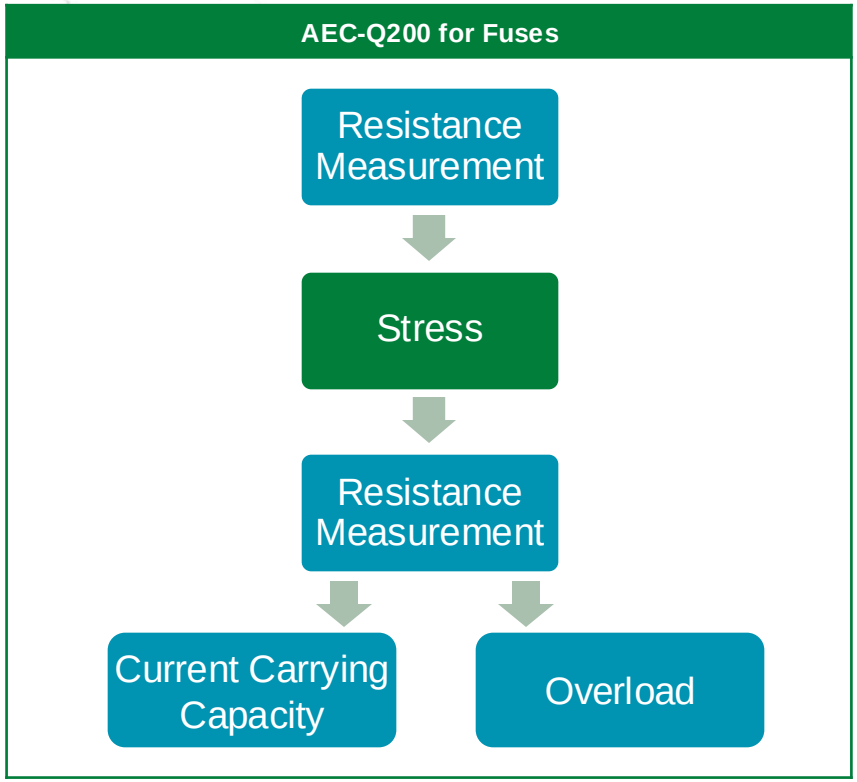
# AEC-Q200 vs. ISO 8820

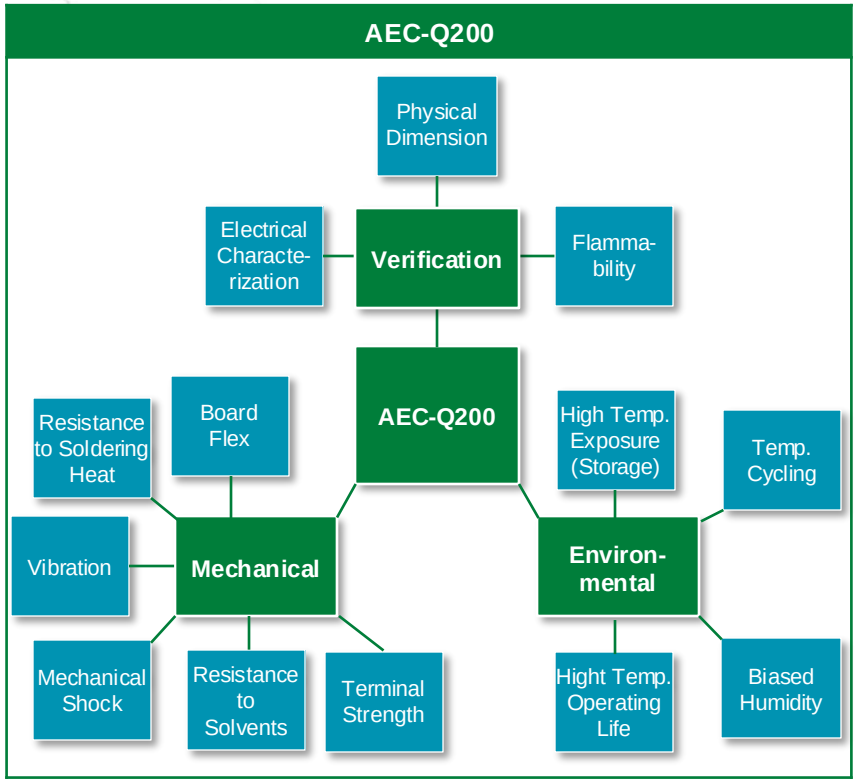
# AEC-Q200 vs. ISO 8820

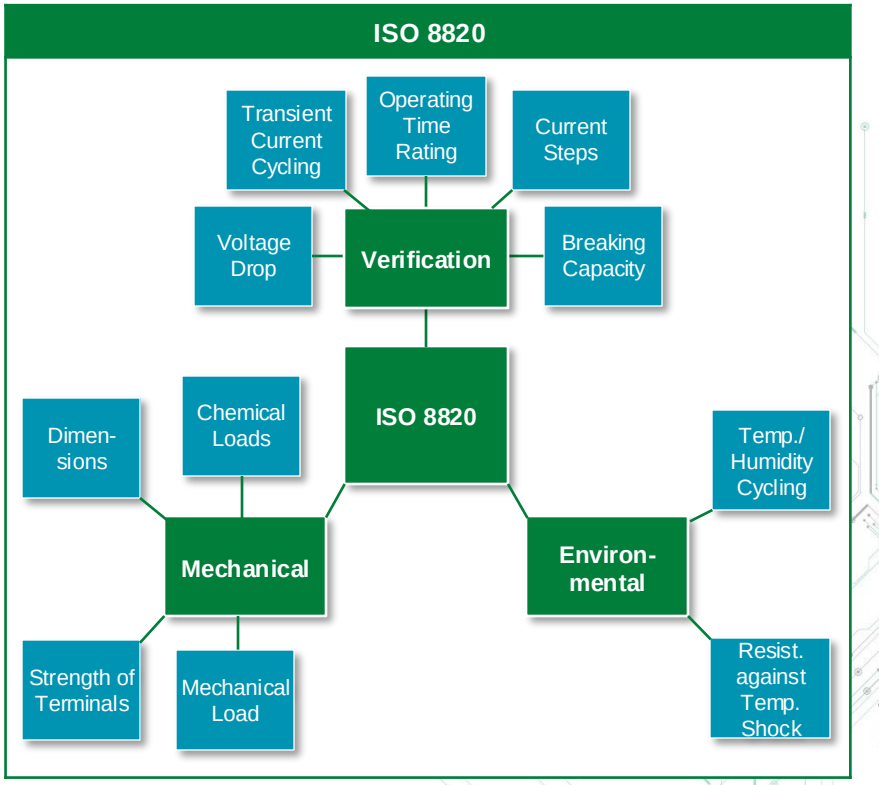
| | AEC-Q200 | ISO 8820 |
|---|---|---|
| **Governing body** | Automotive Electronics Council (AEC) | International Standards Organization |
| **Scope** | Stress test qualification for passive components | Fuse-links for DC systems of road vehicles |
| **Components coverage** | ▪ MOVs<br>▪ PTCs<br>▪ Fuses | Consists of 10 parts. ISO 8820-1 is the general requirements document while the others are specific to certain fuse-designs |

# AEC-Q200 vs. ISO 8820 test methodology




# AEC-Q200 vs. ISO 8820 test requirements





# AEC-Q200 test requirements

## Verification

**Electrical Characte-rization**
- Min. Ambient Temp.
- Room Ambient Temp.
- Max. Ambient Temp.
- AEC requires 30 samples vs. LF requires 30 samples from 3 lots

**Physical Dimension**
- 30 Samples
- Verify physical dimensions meet applicable component specification
- Pre/post not required

**Flammability**
- Verify material is V-1, V-0 or 5VA
- If not V-1, V-0 or 5VA, conduct Needle Flame Test per IEC 60695-11-5
- Pre/post not required

## Mechanical

**Terminal Strength (THT)**
- For leaded (THT) fuses only
- Test Condition A for Pull-test
  - 5 pounds force axis of term. (5-10 secs)
- Test Condition C for wire-lead bend test
  - 3 cycles of 1 or ½ pound force

**Terminal Strength (SMD)**
- SMD only
- Force increased to 17.7N
- Duration 60 sec

**Resistance to Solvents (4 Solvents)**
- By vol., 1 part IUPAC to 3 parts mineral spirits
- EC-7R (Bioact)
- By vol., 42:1:1 of $H_2O$, PGME, MEA
- IUPAC

**Mechanical Shock**
- THT and SMD: Condition C (100g peak value, 6 msec duration, Half-sine waveform, 12.3 ft/sec velocity, 6 shocks pulses in 3 planes)

**Vibration**
- 5g peak
- 20 minutes
- 10 Hz to 2,000 Hz
- 12 cycles in each 3 directions
- Mounted per specification

**Resistance to Soldering Heat**
- **THT**: Cond. B: Solder dip (tinning), Cond. C & D: Wave solder (top/bottom side), 260ºC, 20s dwell time, 1 cycle
- **SMD**: Cond. K: Infrared/convection reflow, 260ºC, 30s dwell time, 3 cycles

**Board Flex (SMD)**
- SMD only
- Force enough for 2 mm board bend distance
- Duration 60 sec

## Environmental

**High Temp. Exposure (Storage)**
- Unpowered
- Chamber Temperature: max ambient temp. or max storage temp. (whichever is higher)
- Duration: 1,000 hrs

**Temp. Cycling**
- Unpowered
- Number of Cycles: 1,000
- Lower Chamber Temp.: min ambient temp.
- Upper Chamber Temp.: max ambient temp.
- Dwell Time: 15 minutes min
- Transition Time: 1 minute max

**Biased Humidity**
- 10% of In
- Duration: 1,000 hrs
- 85 ºC, 85% relative humidity

**High Temp. Operating Life**
- At re-rated In
- Duration: 1,000 hrs.
- Max operating temp.

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# ISO 8820 test details

## Verification

### Voltage Drop
- Verify energy consumptions of fuse-link which creates temp. rise
- At 23 ± 5 ºC, rated current
- Record Voltage Drop (VD)−not exceed values in subsequent ISO 8820 parts

### Transient Current Cycling
- Ability to withstand transient pulses
- At 23 ± 5 ºC); pulse given in subsequent ISO 8820 parts; 50,000 cycles
- Meet operating time rating test

### Operating Time Rating
- Ability to function during overloads
- At 23 ± 5 ºC; at overloads specified in subsequent ISO 8820 parts
- Meet operating time within limits of subsequent ISO 8820 parts

### Current Steps
- Ability to withstand prolonged heating due to low-level overloads
- At 23 ± 5 ºC; apply fuse current till temp. stabilization; increase by 2.5% current rating till temp. stabilization
- Fuse-element melts & current is interrupted

### Breaking Capacity
- Ability to withstand the breaking current
- At 23 ± 5 ºC; apply fuse-link breaking capacity at rated voltage; after interruption, hold rated voltage for 30s
- No permanent arcing, no ruptures to fuse surface, fuse-link shall be removable

## Mechanical

### Dimensions
- Verify dimensions as required in subsequent ISO 8820 parts

### Chemical Loads
- Fuse-links resistance to chemicals: (Diesel fuel, Bio-diesel fuel, Gasoline, etc.)
- Cotton cloth moistened with each fluid Wipe five times with force of 5N
- After test, marking shall remain legible, and color remain recognizable

### Strength of Terminals
- Fuse-links withstand of insertion & removal
- Force value depends on fuse-link construction
- Force value found in subsequent ISO 8820 parts

### Mechanical Load
- Verify fuse-links resistance to chemicals: (Diesel fuel, Bio-diesel fuel, Gasoline, etc.)
- Cotton cloth moistened with each fluid. Wipe five times with force of 5N
- After test, marking shall remain legible, and color remain recognizable

## Environmental

### Temperature/ Humidity Cycling
- Verify fuse-link operates under environmental stresses
- Number of cycles: 10
- Duration of a single cycle: 24 hours
- Cycle consists of:
  - 4 hours at standard conditions
  - 0.5 hour transition maximum
  - 10 hours at 55 ºC/95-99%RH
  - 2.5 hour transition maximum
  - 2 hours at -40 ºC
  - 1.5 hour transition maximum
  - 2 hours at 120 ºC
- After cycling, fuse-link must meet operating time rating

### Resistance against Temperature Shock
- Verify fuse-link operates under environmental stresses
- Number of cycles: 48
- Duration of a single cycle: 40 minutes
- Cycle consists of:
  - 20 minutes at -40 ºC
  - 15 seconds maximum transition time
  - 20 minutes at 100 ºC
  - 15 seconds maximum transition time
- After cycling, fuse-link must meet operating time rating

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# Fuse selection criteria

# Fuse Selection Parameters

| No. | Question | Answer |
|---|---|---|
| 1 | **Normal operating current** | The maximum current that the fuse will experience during normal operation of the application |
| 2 | **Application voltage (AC or DC)** | The voltage level of the line that the fuse is protecting; this is also the voltage that the fuse will have to safely support after it has opened |
| 3 | **Ambient temperature** | The temperature in the area surrounding the fuse |
| 4 | **Maximum available fault current** | The maximum current that the fuse will experience during normal operation of the application |
| 5 | **Current Pulses**<br>▪ **Shape**<br>▪ **Magnitude**<br>▪ **Duration**<br>▪ **Quantity of the pulses** | Surge Currents, Inrush Currents, Start-up Currents, and Circuit Transients |
| 6 | **Overload current** | Amplitude and length of time in which the fuse must open |
| 7 | **Other** | ▪ Mounting requirements – Through hole, SMT, Fuse holder, Physical size limitations<br>▪ Agency Approvals required, such as UL, CSA, VDE, METI, MITI or Military |

# Fuse selection process: Summary of steps to select fuse


**Understand the application and circuit parameters** – V, I, Temp, Max fault, Time to damage, Size, Package, Accessories

**Determine minimum current rating of fuse**
(fuse re-rating, thermal de-rating)

$$Ir\ Min = \frac{In\ Max}{FDR \times TDR}$$

**Determine Pulse $I^2t$** value of the application

**Pulse $I^2t$** = $Ip^2 \times t$


Determine minimum **Nominal melting $I^2t$** value of the application

Fuse Min **$I^2t$** rating = Pulse $I^2t$ / rating factor

**Compare calculated and actual nominal melting $I^2t$ values to ensure fuse will not suffer nuisance opening**. If there are multiple fuses qualified for the application, use secondary characteristics (size, voltage rating, etc.) to determine best solution

Check T-C curve

IMPORTANT!! Even though care may be used during the fuse selection process, it is recommended that application-level testing be performed to verify coordination of fuses to the circuit conditions

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# AEC-Q200 Qualified cartridge fuse portfolio

| Parameter | 828 | 526 | 527 |
|---|---|---|---|
| **Product Photo** |  |  |  |
| **Footprint/Height** | 38 x Φ 10 mm | 32 x Φ 10 mm | 32 x Φ 6 mm |
| **Voltage Rating** | 1000 VDC | 500 VAC/VDC | 500 VAC |
| **Interrupting Rating** | 10 kA @ 1000 VDC | 10 kA @ 500 VAC/VDC | 10 kA @ 500 VAC |
| **Amperage Rating** | 15 A ~ 30 A | 30–60 A | 30–50 A |
| **Operating Temperature** | -55 °C to +125 °C | -55 °C to +125 °C | -55 °C to 125 °C |

## Key highlights

- AEC-Q200 Qualified
- Rated from 500 VDC/VAC–1000 VDC with an interrupting rating of 10 kA and 15−60 A nominal current rating in a small package
- Compact body size (6 x 32 mm, 10 x 32 mm, 10 x 38 mm)

# AEC-Q200 Qualified surface mount fuses

| Parameter | 885 | 881 |
|---|---|---|
| **Product Photo** |  |  |
| **Footprint/Height** | 10.86 mm x 4.78 mm | 12.5 mm x 10 mm |
| **Voltage Rating** | 500 VDC | 100 VDC |
| **Interrupting Rating** | 1500 A @ 350 VDC | 1500A @ 75VDC |
| **Amperage Rating** | 1 A–5 A | 60A ~ 125 A |
| **Operating Temperature** | -55 °C to 105 °C | -55 °C to 100 °C |

## Key highlights

- AEC-Q200 Qualified
- High DC voltage up to 500 VDC and interrupting current rating up to 1500 A
- Compact body size (10.86 x 4.78 mm)

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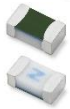
# AEC-Q200 Qualified surface mount thin film chip fuses

| Parameter | 441A | 501A | 407A | 438A | 440A | 483A | 437A | 422A |
|---|---|---|---|---|---|---|---|---|
| Product photo |  |  |  |  |  |  |  |  |
| Footprint/ height | 0603 | 1206 | 1206 | 0603 | 1206 | 1206 | 1206 | 2410 |
| Voltage rating | 32 VDC | 32 VDC | 24–63 VDC | 24–63 VDC | 50–125 VDC | 75 VAC/VDC | 32–125 VDC | 125–250 VAC/VDC |
| Interrupting rating at rated voltage | 50 A | 150 A | 50 A | 50 A | 50 A | 50 A | 50 A | 50–100 A |
| Amperage rating | 2–6 A | 10–20 A | 1–8 A | 0.25–6 A | 0.250–8 A | 0.75–2 A | 0.25–8 A | 0.75–5 A |
| Operating temperature | -55 ºC to 150 ºC | -55 ºC to 150 ºC | -55 ºC to 150 ºC | -55 ºC to 150 ºC | -55 ºC to 150 ºC | -55 ºC to 125 ºC | -55 ºC to 150 ºC | -55 ºC to 125 ºC |

## Key highlights

- AEC-Q200 Qualified
- Wide range of fuse selections (24–250 VAC/VDC) and amperage ratings (0.25–20 A)
- Compact body size (0603, 1206, and 2410)

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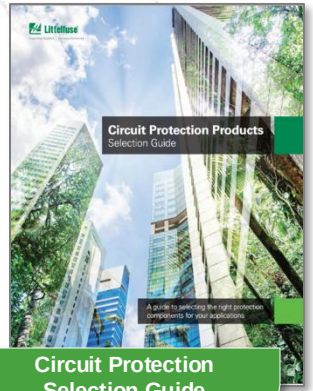
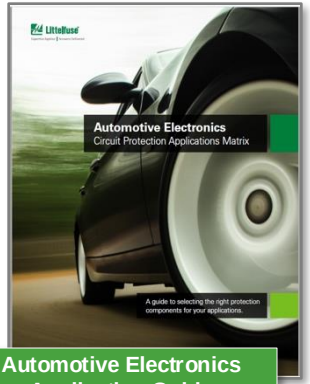
# Additional information can be found on Littelfuse.com

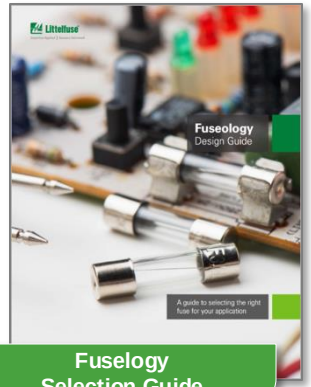
Explore the world of Littelfuse with the electronics eCatalogs (ecatalogs.littelfuse.com)




Circuit Protection Selection Guide




Automotive Electronics Application Guide

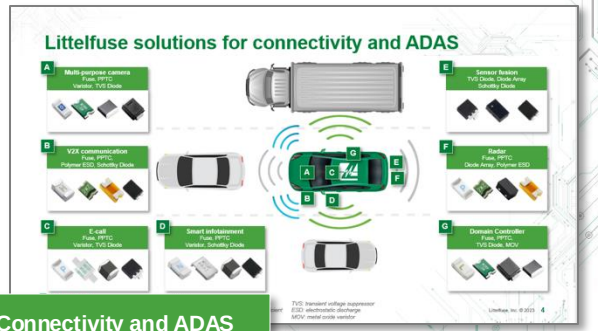



Fuselogy Selection Guide


ESD Protection Selection Guide

Click on images for more information


Powertrain Spotlight




Connectivity and ADAS

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# Local resources supporting our global customers


*Legend*

- *Sales*
- *R&D*
- *Manufacturing*

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# Your partner for tomorrow's electronic systems

**Broad product portfolio**

We are an industrial technology manufacturing company empowering a sustainable, connected, and safer world

**Application expertise**

Our engineers partner directly with customers to help speed up product design and meet unique needs

**Global customer service**

Our global customer service team will work with you to anticipate your needs and ensure a seamless experience


**Compliance & regulatory expertise**

We help customers in the design process to account for requirements set by global regulatory authorities

**Testing capabilities**

We help customers get products to market faster and offer certification testing to global regulatory standards

**Global manufacturing**

We offer high-quality manufacturing that is committed to the highest quality standards

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