Detailed Specification Summary Table for Precharge Resistor

Attribute	Value	Unit / Standard	Detailed Description / Significance
Part Number	HSA5025RJ	—	TE Connectivity power resistor with 25 Ω nominal resistance.
Resistance Value	25	Ohms (Ω)	Fixed resistance used to limit inrush current during precharge.
Voltage Rating (RMS)	1250	Volts RMS (V)	Maximum continuous AC voltage the resistor can withstand without dielectric breakdown or arcing. Suitable for 450V DC bus applications.
Power Rating	50	Watts (W)	Maximum continuous power it can dissipate safely. For transient or pulse loads, higher power can be handled momentarily depending on thermal mass and heat sinking.
Current Rating	Not explicitly rated	Amps (A)	Not given, but calculable via $I=\sqrt{P/R}=\sqrt{50/25}\approx 1.41$ A for continuous use. Larger pulsed currents are acceptable for short durations.
Temperature Range	-55 to +200	°C	Operating temperature range. Suitable for extreme automotive environments including cold starts and high heat under hood.
Temperature Coefficient	~±100	ppm/°C	Typically for wirewound resistors like this; resistance changes slightly with temperature.
UL Flammability Rating	UL94-V0	UL94 Standard	High flame resistance. Self-extinguishing within 10s with no dripping — critical for safety in high-voltage environments like BDU.
Pulse Load Capability	High (short duration)	—	Can tolerate much higher power temporarily for pulse events (like precharge), depending on thermal profile and time constant.
Thermal Time Constant	Depends on cooling & mounting	—	Affects how long the resistor can sustain high energy before temperature becomes critical.

Convection Type	Compatible with natural or forced	—	Based on your use-case; natural convection may be sufficient, but forced cooling enables higher duty cycles.
Mechanical Mounting	Aluminum housed (chassis mount)	—	Rugged aluminum housing for bolting onto heat sinks or enclosures for thermal dissipation.
Dimensions (Approx.)	50 × 16 × 16	mm	Approximate package size; important for packaging in battery pack or BDU enclosure.
Weight	34.27	grams (g)	Important for mechanical design, PCB/busbar loading, or overall vehicle weight minimization.
Cost per Unit	11.63	CAD	Budgetary information per resistor; useful for BOM and cost tradeoffs if considering alternate vendors or specs.
Manufacturer	TE Connectivity	—	Trusted industrial supplier known for automotive-grade components.

Calculation of Total Heat Capacity

1. Total Mass

The resistor weighs 34.27 grams, which is:

$$34.27\ \text{g} = 0.03427\ \text{kg}$$

---

2. Material Composition Assumption

We assumed the resistor is made of:

- 85% aluminum (housing)
- 15% nichrome (resistive wire)

So:

- Aluminum mass = $0.85 \times 0.03427 = 0.02913\ \text{kg}$
- Nichrome mass = $0.15 \times 0.03427 = 0.00514\ \text{kg}$

---

3. Specific Heat Capacities

- Aluminum: 900 J/kg·K
- Nichrome: 450 J/kg·K

---

4. Heat Capacity Calculation

Heat capacity is calculated as:

$$\mathrm{C}=\mathrm{m}\cdot\mathrm{c}$$

$$C=m\cdot c$$

Where:

- C is heat capacity (J/K)
- m is mass (kg)
- c is specific heat (J/kg·K)

So:

- Aluminum: $0.02913\times900=26.22$ J/K
- Nichrome: $0.00514\times450=2.31$ J/K

---

5. Total Heat Capacity

$$\mathrm{Ctotal}=26.22+2.31=28.53\ \mathrm{J/K}$$

So, the total heat capacity, C = 28.53 J/K.

Temperature Rise Calculation

Equations are found in the Desmos graph: https://www.desmos.com/calculator/pkvstp023l

For the **450V battery system**, this resistor is **well within safe voltage range**.

If used in **precharge**, the power rating and resistance value give:

I = 450V / 25Ω = 18 A(initial inrush)

P = I^2 * R = (18)^2 * 25 = 8100 W (transient)

Since 8100 W is **pulse power**, not continuous, it is okay if the precharge is <100 ms.