



Eaton lights the way for the automobile industry



Current sense resistor



DR inductor



HCM1A inductor



TVS diode



PTSA resettable fuse

High-power LEDs are efficient and reliable light sources. Until recently, however, LED lighting was primarily used in brake & turn indicators and passenger compartment lighting, as LED drivers could not handle the high lumens required for headlights and running lights. Additionally, these drivers did not support ambient temperatures exceeding +125 °C.

Eaton's portfolio of automotive-grade components includes the DRA/DRAP/DRAQ inductors, HCM1A/HCM1AV2 inductors, HCSA inductors, and Current Sense Resistors (CSRs), which offer higher luminescence for safety and improved energy efficiency at lower costs. These products enable manufacturers to develop high-power LED headlight clusters that perform well at higher currents in a smaller package.

Eaton's PTSA(HT) resettable fuses and TVS diodes are ideal for high-performance, low-cost overcurrent, and overvoltage protection, respectively, in automotive LED modules in the event of short-circuiting, transient voltage or ESD. The PTSA(HT) is AEC-Q200 qualified and suitable for operating temperatures up to 125 °C.

Eaton's CSRs provide reliable and cost-effective current sensing in a wide range of applications throughout modern vehicles. These products consist of various resistive elements, such as metal film, metal strips, and metal shunts. They are offered in 2- and 4-terminal configurations in EIA footprints 1206, 1216, 2726, 4026 to 2512, 3920, and 5930.

DRA/DRAP/DRAQ inductors

Eaton's DRA product line offers automotive electronics engineers one of the industry's most robust selections of automotive-grade inductors with five different mechanical sizes

and high inductance/current ranges. The DRA inductors can be utilized in exterior and interior LED lighting modules, where they can serve as a core component for LED drivers, facilitating smooth voltage regulation and ensuring flicker-free operation of the LEDs. These inductors maintain high power density and effectively handle surge currents, optimizing LED longevity and performance. DRAQ automotive inductors feature coupled windings with a high-power density shielded drum core. DRAQ inductor windings can be connected in series or parallel, offering a wide range of inductance and current ratings. They can be used as a single inductor or in SEPIC, Flyback, or other coupled inductor/transformer applications (1:1 turns ratio).

The DRAP is suitable for applications beyond AEC-Q200 standards and rated for 30 G shock impact resistance in a 4-terminal solution for enhanced reliability. LED applications

include headlamps, tail lamps, and interior lighting. DRA/DRAQ inductors are AEC-Q200 qualified with maximum operating temperatures of +165 °C.

HCM1A/HCM1AV2 inductors

Eaton's HCM1A and HCM1AV2 inductors have tight thermal coupling that ensures efficient heat dissipation under high-current conditions. They are available in a variety of sizes and higher inductance values, allowing automotive designers to utilize higher voltages needed to drive multiple high-power LED arrays for headlights and daytime running lights.

A key application of the HCM1A and HCM1AV2 inductors is automotive infotainment systems. These systems require components that don't contribute to significant energy wastage. The HCM1AV2, with its low core loss, ensures that the system is energy efficient. With the HCM1AV2 family offering a wide range of SMT



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footprints from 4.0 mm to 23.0 mm, automotive designers have the flexibility to choose the right inductor size for their complex circuit design. These high-current power inductors have rugged durability to withstand harsh environmental, electrical, and mechanical conditions. They are suitable for use in headlamps, tail lamps, interior lighting, and LED lighting.

HCSA inductors

Eaton's HCSA is a high-current, coupled inductor for high-performance, higher-power automotive SEPIC applications. Its unique molded construction provides high inductance and operating current capability over a wide operating temperature range. HCSA inductors support the high currents required by the latest automotive LED headlamps. Their soft roll-off characteristics guarantee that the inductance doesn't drop significantly under high currents. This ensures that the headlamps maintain brightness even under demanding conditions. Given that headlamps can generate significant heat, especially when coupled with engine heat and external environmental factors, the wide operating temperature range of Eaton's HCSA inductors (-55 °C to +155 °C) ensures consistent performance.

The HCSA inductors come in a 10 mm x 10 mm x 8 mm footprint and three popular inductance values: 10 µH, 15 µH, and 22 µH. HCSA1V supports high-current SEPIC applications in LEDs up to 11 A, which is desirable for next-generation automotive headlamps.

MPIAV2 inductors

Eaton MPIAV2 automotive inductors are AEC-Q200-qualified products ideal for interior and exterior body electronics and lighting systems, e.g., headlamps, tail lamps, interior lighting, and LED lighting. With high current handling and efficient heat dissipation, MPIAV2 inductors ensure that headlamp and tail lamp systems function optimally, offering bright, consistent lighting while minimizing energy wastage. Mood, ambient, and interactive lighting are now part of many luxury vehicles,

demanding precise control and variable power outputs. Eaton's MPIAV2 inductors enable smooth dimming and control, enabling designers to implement sophisticated lighting sequences or effects that enhance driver/passenger comfort and experience.

With their rugged durability and excellent temperature performance, MPIAV2 inductors ensure that LED systems in vehicles receive a steady current. This not only preserves the lifespan of the LEDs but also ensures they function at optimal brightness and color consistency. Eaton's automotive-grade products provide automotive engineers with greater design flexibility to enhance the driving experience.

TVS diodes

Eaton's TVS Diodes provide overvoltage protection with very fast response times, low clamping voltage, and high peak current capability for a broad range of automotive applications. A key application is load dump transient protection, where a battery becomes disconnected while being charged by the alternator, creating a pulse as high as 120 V with a decay of up to 400 ms. With ultra-fast response times, Eaton's TVS diode will instantaneously clamp the transient voltage to a suitable level to prevent damage to sensitive electronics. Crucially, Eaton's TVS diodes are AEC-Q101 qualified and available in surface mount as well as radial/through-hole footprints. Eaton's TVS diodes utilize silicon avalanche technology for excellent protection against damaging transients, from ESD up to induced lightning.

PTSA(HT) resettable fuses

Modern vehicles offer advanced infotainment, telematics, lighting, and body control modules. A sudden surge can damage delicate components within these systems. Eaton's Bussmann series PTSA/PTSA(HT) positive temperature coefficient (PTC) fuses provide resettable overcurrent protection for automotive applications. In the event of a surge, the internal resistance of the PTSA

fuses increases to effectively limit or stop the flow of current, protecting the circuit and components from damage. Once the overcurrent condition is addressed and the fuse cools, the internal material reverts to its low-resistance state, resetting the fuse. This avoids the need for replacements, unlike standard one-time fuses.

With their quick response, low resistance, and voltage ratings up to 60 V, Eaton's PTSA resettable fuses ensure automotive systems remain protected without hindering their performance. Eaton's PTSA/PTSA(HT) resettable fuses meet AEC-Q200 qualifications for use in various automotive applications, with the PTSA(HT) rated up to +125 °C for high-temperature operation. They are offered in surface-mount footprints ranging from 0805 to 1812 EIA. With a very fast time-to-trip, these products provide designers the flexibility to address various circuit protection needs.

CSR resistors

Eaton's metal plate, metal film, and metal shunt CSRs provide high-accuracy current sensing with low inductance and low noise. Many CSR families are AEC-Q200 qualified for automotive applications such as high-power LED lighting. Consistency in brightness is a pivotal requirement in automotive lighting modules for safety and regulatory reasons. Eaton's CSRs ensure that LEDs draw the right amount of current to maintain the desired brightness. The system can adjust power supply parameters to maintain uniform brightness by constantly measuring the current flowing through the LEDs. By ensuring that LEDs only draw the current they need, CSRs prevent overconsumption of power, leading to improved efficiency in the vehicle.

Overheating is another common problem with high-power LEDs. Eaton's CSRs, with their precise current measurements, can identify potential overheating scenarios by monitoring the current. Combined with

thermal sensors, CSRs can offer a comprehensive solution to regulate the LED's temperature, extending its life.

Eaton's metal plate CSRs are offered in EIA footprints with short and wide terminal configurations, power ratings up to 3 W, and resistances up to nearly 1 ohm. Eaton's metal plate CSR resistors are designed using a metal plate with an epoxy overcoat and end terminations for a low-temperature coefficient of resistance (TCR), low resistance, and high power capability. These products are offered in 0603 to 2512 EIA footprints, with short and wide terminal configurations, power ratings up to 3 W and resistances down to 1 mΩ.

Eaton's metal film resistors are constructed using high-accuracy foil on a substrate for high thermal conductivity, low inductance, and low noise. They are available in footprints ranging from 0603 to 2512 (EIA) in short and wide terminal configurations and offer a wide range of power ratings (up to 3 W) with high current handling capability and resistances (up to 1 Ω). They are AEC-Q200 qualified for automotive and high-reliability applications with operating temperatures of up to +175 °C.

Eaton's current shunt resistors are high-power current sense products with the benefit of simple and linear current measurements. The resistor is placed in line with the current being measured, and the current flow causes a small amount of power to be converted into heat. This power conversion is what provides the voltage signal. Eaton's current shunt resistors are compact and low-profile, with power ratings up to 15 W and resistances down to 0.1 mΩ. They are offered in three different footprints, from 2512 to 5930 EIA, with a low inductance (< 0.1 µH) construction. Applications for Eaton's high-power current shunt resistors include 48 V to 12 V DC-DC converters, On-board chargers, HV Inverters, ADAS, BLDC Motor Drivers, and more.

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