

Selecting the Right Resistor for Your Application

As AI datacenters continue to grow, the need to ensure the reliability and longevity of their equipment in potentially harsh environments also increases. Sulfur-containing compounds, such as hydrogen sulfide (H_2S) and sulfur dioxide (SO_2), can be present in industrial areas or locations with poor air quality. When these compounds come into contact with traditional silver-based resistors, it can cause a chemical reaction that can result in the formation of non-conductive material known as silver sulfide (Ag_2S), also called “flowers of sulfur.” Flowers of sulfur are highly detrimental to resistors. Over time, they can lead to corrosion and irregularities of the metal surfaces of a resistor. This can cause weakened connections and increased resistance values, ultimately causing malfunction or failure of the resistor, potentially causing downtime, and affecting the performance of AI algorithms and applications.

Several circumstances can lead to sulfur exposure in AI datacenters. Those located in urban or industrial areas are particularly at risk due to higher instances of air pollution. In India, a rapidly growing hub for AI datacenter development, the levels of sulfur dioxide (SO_2) tend to be higher than average due to emissions from its extensive industrial sector. These elevated SO_2 levels increase the risk of sulfur exposure for datacenters in the region.

Battery failures can also potentially release sulfur into the environment and cause sulfur contamination of traditional silver resistors. Lead-acid batteries, for example, can release hydrogen sulfide (H_2S) gas if they overcharge or overheat. Lithium-ion batteries can also release sulfur dioxide (SO_2) gas if they are damaged or experience a thermal runaway event.

There are several potential consequences if a contamination event were to occur. Whole circuits could fail due to the presence of a contaminated resistor. Additionally, components that are not suffering from sulfur exposure could experience increased stress as they try to compensate for the contaminated part, leading to increased wear. If the failed resistor is part of a critical system, its failure could lead to data loss or corruption. Replacing the compromised part may lead to significant system downtime and loss of revenue.

Anti-sulfur resistors are designed to resist the effects of sulfur exposure, ensuring that they maintain their performance and reliability over time, even in environments where sulfur contamination is a concern. By using anti-sulfur resistors, AI datacenters can minimize the risk of unexpected failures, downtime, and performance issues, helping to ensure the smooth operation of their systems.

While regular maintenance and monitoring of components can also help detect and prevent potential failures before they occur, to truly mitigate the risk of resistor failures due to sulfur contamination, it is important to use anti-sulfur resistors, as they are specifically designed to resist the effects of sulfur exposure and maintain their performance over time. Selecting the right type of resistor for the specific application and environment will help to avoid issues like open failures. While resistors may seem like low-cost components, their failure can lead to significant issues, including system downtime and data loss. Investing in the right type of resistor, such as anti-sulfur thick film resistors or current sense resistors, can help prevent these problems and ensure the reliability of the system.

Current Sense Resistors:

- **Construction:** Current sense resistors are typically constructed using metal foil or metal plate elements, such as manganese-copper or nickel-chromium alloys.
- **Anti-Sulfur Properties:** Thin Film Technology Corp.’s current sense resistors are inherently anti-sulfur because they do not use silver in their



construction. This makes them suitable for environments where sulfur exposure is a concern.

- **Cost:** TFT leverages streamlined, high volume manufacturing to provide affordable, competitive prices for all its current sense resistors. Combined with the long-term reliability and durability provided by the CSR's anti-sulfur properties, this leads to both a reduced up front cost and long-term savings for the customer.
- **Applications:** Current sense resistors are primarily used for sensing and measuring electrical current in circuits, particularly in power management and control applications. They are commonly found in power supplies, motor control systems, battery management systems, and electronic load testers.

Thin Film Resistors:

- **Construction:** Thin film resistors are made by depositing a thin resistive film onto a ceramic substrate using a sputtering process. They typically use materials like nickel-chromium or tantalum nitride.
- **Anti-Sulfur Properties:** Thin film that uses silver in its construction is susceptible to sulfur contamination. Thin Film Technology Corp. offers thin film resistors that are inherently resistant to sulfur as they do not use silver in their construction. The materials used in these thin film resistors are not as susceptible to sulfur corrosion.
- **Cost:** Thin film resistors are generally more expensive than thick film resistors due to the complexity of the manufacturing process and the materials used. However, they offer high precision and stability, making them suitable for high-performance applications.
- **Applications:** Thin film resistors that are inherently anti-sulfur are ideal for applications where precise resistance values, stability, and low noise are critical. They are commonly used in precision electronics, aerospace, medical devices, and instrumentation.



Thick Film Resistors (Anti-Sulfur):

- **Construction:** Thick film resistors are made by depositing a resistive paste onto a ceramic substrate and then firing it to form the resistor element. They typically contain silver as the conductive material.
- **Anti-Sulfur Properties:** To make thick film resistors anti-sulfur, manufacturers may add palladium to the resistor paste and apply a protective outer layer. This helps prevent sulfur from reacting with the silver, reducing the risk of open failures.
- **Cost:** Thick film resistors are generally cost-effective due to their mass production and relatively simple manufacturing process. Anti-sulfur thick film resistors offer the protection needed for harsh environments while still maintaining a low cost compared to other options.
- **Applications:** Anti-sulfur thick film resistors are suitable for environments where exposure to sulfur-containing contaminants, such as hydrogen sulfide (H_2S), is a concern. They excel in industries such as automotive, industrial automation, telecommunications, and renewable energy, where equipment operates in harsh conditions.



By using anti-sulfur resistors, which are designed to resist the effects of sulfur exposure, AI datacenters can help ensure that their equipment maintains optimal performance over time, even in environments where sulfur contamination is a concern. This helps minimize the risk of unexpected failures and downtime in their datacenters, which is crucial for maintaining the reliability and efficiency of their AI systems.