

WHITE PAPER

Introduction

In today's rapidly-evolving electronics market, the demand for high-precision and reliable components is more critical than ever. As industries push toward greater efficiency and compactness, the need for resistors that can handle high power dissipation and thermal resilience within limited space constraints has become essential.

Market trends indicate a significant shift towards increased power density in electronic components. To meet these high-power demands and improve efficiency, engineers are increasingly designing higher voltage applications with lower currents. This trend aims to keep power output consistent while reducing power loss, costs, and heat generation. Unfortunately, this positive advancement also introduces significant challenges for resistors such as increased inductance, which can lead to delays and slower switching speeds. With these larger loads, managing power and heat dissipation is integral to maintaining circuit performance, reliability and long-lasting operation.

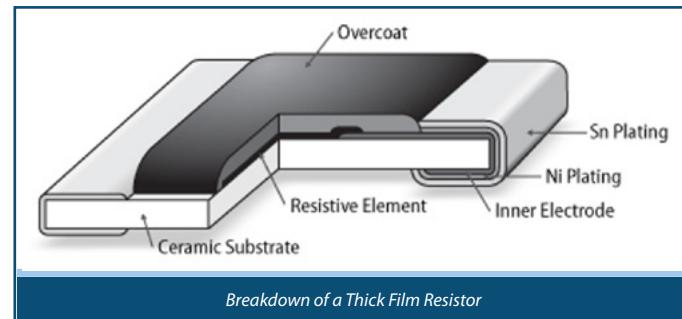
To dissipate large amounts of heat and power, a resistor must excel in pulse handling, offer structural stability to support large heatsinks, and exhibit low thermal resistance to minimize heat buildup under high power conditions.

This white paper presents the challenges the industry faces in designing resistors that can withstand elevated temperatures, higher voltages, and high pulse powers, all while maintaining a compact form factor. It details how Bourns is addressing these performance needs with innovative thick film resistor solutions that provide thermal resilience and reliability in high-power applications.

Overview of Thick Film Resistor Technology

Film resistors are fixed value resistors that are built with a non-conductive core, typically a ceramic substrate, surrounded by a conductive element to control resistance. These resistors are more accurate than carbon film resistors and come in smaller sizes than wirewound resistors. Film resistors are most commonly used in precision applications where stability and noise suppression are needed. The films on thin film resistors are vacuum deposited and have a film thickness of 0.1 microns or less, while thick film resistors have layers that are thousands of times thicker. The film on thin film resistors causes them to have higher costs but results in narrow tolerances, low noise, and low Temperature Coefficients of Resistance (TCR). On the other hand, thick film resistors have a broader range of applications and are more economical than thin films. These resistors gained popularity in the early 1970s and continue to hold a much larger market share compared to thin film resistors.

Thick film resistors are widely implemented in almost every electrical system that has a battery to ensure safety and efficiency in battery management systems. Both types of resistors can operate in similar temperature ranges, but thick film resistors usually have higher resistance options, broader tolerance options, and larger TCR. These resistors are more commonly used in applications that prioritize power dissipation over precision, such as motor drives.



When it comes to power and heat dissipation, thick film resistors are more economical and boast superior performance compared to thin film resistors. With a larger size and thicker film, these resistors have more area to dissipate heat from the circuit and allow for the attachment of larger heatsinks. Thick film resistors will be rated at higher power and can handle larger surges of voltage and current, making them more ideal for high power surge protection.

WHITE PAPER

Meeting Design and Performance Requirements

The Riedon™ PF2270 by Bourns® Thick Film Resistor meets the growing need for higher performance within size constraints providing high power capabilities and enhanced reliability. Compared to traditional wirewound power resistors, the PF2270 Series offers much lower inductance (14 nH) and a smaller form factor in the same power rating, while delivering superior pulse-handling capabilities compared to thin film resistors. This resistor series is engineered as a chassis-mount resistor in a compact design.

These resistors are able to withstand high levels of mounting torque, allowing for increased stability if a heatsink attachment is required. A proper heatsink with stable attachments allows this resistor to reach a power rating of up to 300 W with a very low thermal resistance of $0.23\text{ }^{\circ}\text{C/W}$, enabling it to handle high amounts of power without excessive heating. With included screws for easier mounting, these resistors offer both convenience and reliability, and boast high power capabilities and excellent thermal resilience.

Along with its high-power ratings when attached to the appropriate heatsink and the resistor's large power density, it allows



The Riedon™ PF2270 by Bourns thick film resistor

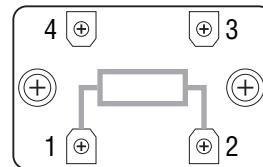
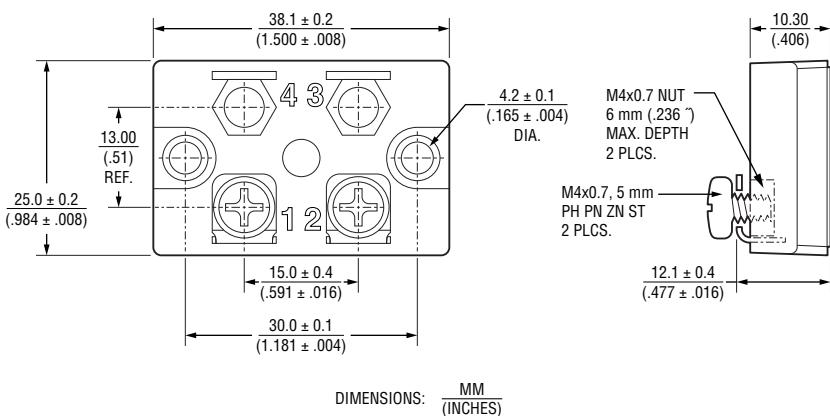
for consistent pulse handling and remains stable during high power surges. Featuring low TCR, this resistor exhibits high stability under harsh thermal conditions, resulting in minimal resistance variation during fluctuating temperatures. This series of resistors also has excellent vibrational stability, making it well-suited for use in high thermal and vibrational stress environments such as industrial motor drives and other industrial machinery. For high power surges where high heat is common, the PF2270 Series Thick Film Power Resistor is an ideal solution offering versatility and stability.

Application Examples

Efficiency and reliability are critical to help ensure maximum electronics performance. The dissipation of heat and power can help protect and maintain that efficiency when unpredictable surges or large amounts of power build up. Without a way to manage these surges and dissipate energy, the entire circuit could be at risk. The dissipation of both power and heat are key requirements for effective surge protection in charging and discharging, motor control, and many other applications that require protection against thermal damage, overvoltage, and overcurrent conditions.

Other applications that need heat and power dissipation include dynamic braking resistors for motor control and bleeder resistors for power supply capacitors. This is where the capabilities of the PF2270 Series are beneficial in safely converting excess electrical energy into heat, preventing damage to equipment. A common occurrence with surge protection is that a large amount of excess energy results in a buildup of heat within the circuit. Using PF2270 Series resistors, with an adequate heatsink attached, allows for the controlled release of thermal energy, protecting the circuit from heat damage. With its powerful heat dissipation performance, this series is an optimal surge protection choice that helps increase the effectiveness and reliability of a wide range of electronic applications.

Physical Data

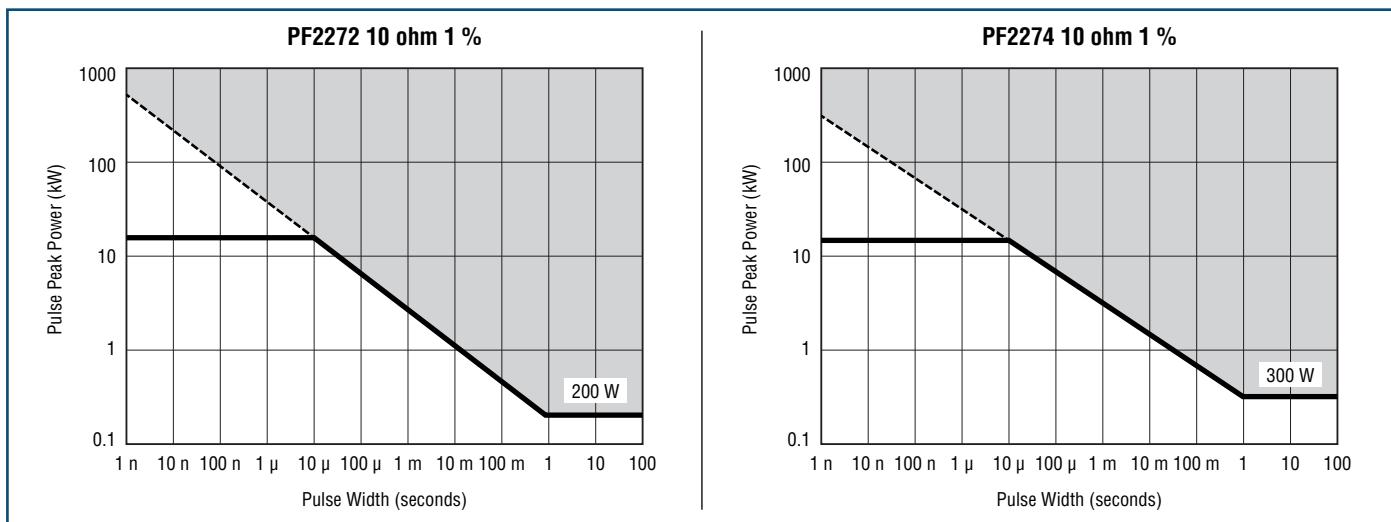


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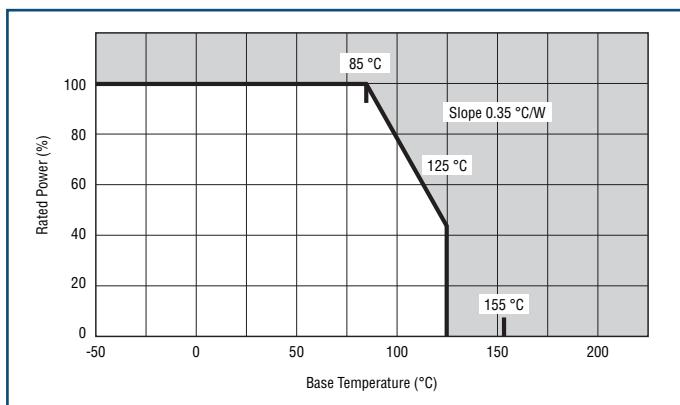
Electrical Data

Characteristic	Model	
	PF2272	PF2274
Power Rating (with heatsink)	200 W	300 W
Power Rating (without heatsink)	5 W	5 W
Resistance Range	0.1 to 100K ohms	0.1 to 1K ohms
Resistance Values	E24	
Thermal Resistance	0.35 °C/W	0.23 °C/W
Tolerances	5 % (1 % optional)	

These graphs showcase peak pulse power for the two models in the series, the PF2272 and the PF2274.



The graph below shows the degradation of the rated power as the temperature of the resistor increases.



Conclusion

The advantage of thick film resistors, specifically the Riedon™ PF2270 Thick Film Power Resistor by Bourns®, is in power and heat dissipation even in harsh electrical environments. The PF2270 Series is thermally resistant, structurally stable, and economical, all in a compact package, making it a great choice for high power applications. Additionally, its advanced features support higher power systems, enabling enhanced reliability and improved efficiency in a growing group of critical applications.

The PF2270 Series also helps to reduce maintenance costs and supports consistent performance. Furthermore, these resistors contribute to environmentally-friendly solutions with their energy-efficient design that minimizes the need for additional thermal management and reduces waste. Adhering to environmental regulations, the series is RoHS* compliant. Because of the PF2270 Series' superior performance and reliability, these devices provide a competitive edge, helping designers enhance safety, while offering increased scalability and ease of integration for a broad variety of applications.