

# Bourns® Thick Film Resistive Heaters

## WHITE PAPER

### SATISFYING THE NEED FOR CUSTOMIZED OPEN FRAME RESISTIVE ELEMENT HEATERS

Resistive element or thick film heaters have become necessary design elements in a wide range of medical, consumer, industrial and automotive applications such as battery back-up system heaters, video camera lens defoggers, outdoor enclosure warmers, bio-diesel processing, temperature management for developing photographic films, fluorescent bulb starters, medical equipment mirror heaters, food service equipment and many others. They convert electricity to heat helping to efficiently apply and control heat in a limited area. Therefore, resistive element heaters are optimal solutions for applications that require uniform surface temperatures where the heat needs to be directed very quickly and effectively in a small area, for instance, to a heat circuit environment or to vaporize liquid.

There are two types of heating resistors – convective, which heats the surrounding environment, or radiant that heats other objects using infrared radiation. Applications that need radiant heating require the resistive heater to be placed within the line of sight of the area that is to be heated. Convective heating frequently uses a fan to circulate air over heater resistors to produce the heat required.

The challenge in designing thick film heaters is that they need to provide very fast temperature response and uniformity in a low profile design. Thick film heaters also must meet the space-constrained needs of today's more compact and portable applications, where conventional heaters cannot be used, when heat output needs to be profiled across the surface, or in high watt-density applications. Because of the high diversity of applications that utilize resistive element heaters, there is a widespread need for customized solutions that can specifically meet the requirements of individual applications.

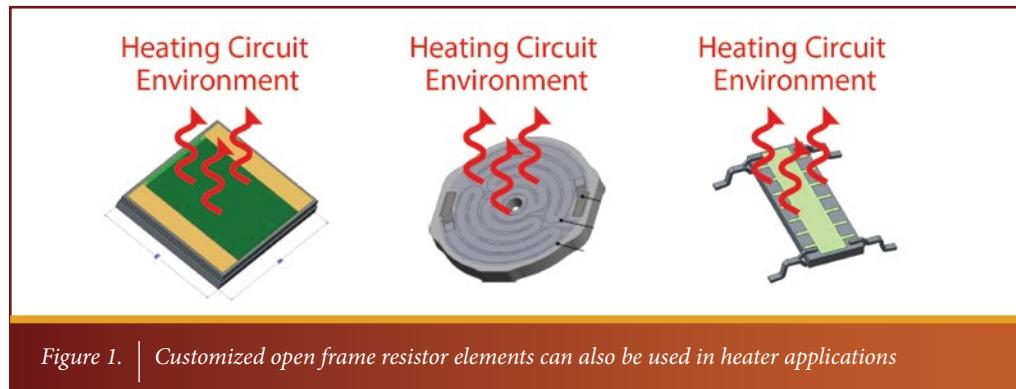


Figure 1. | Customized open frame resistor elements can also be used in heater applications



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## VARIED APPLICATION REQUIREMENTS

Effective resistive element heater designs require that the heat pattern accurately aligns to the specified thermal gradient across the heated surface to meet the individual application specifications. The need to design for multi-zoned wattage or voltage combinations is also a frequent requirement. Typically, applications that use heaters must comply with space restrictions due to higher watt densities and lower profiles in today's higher performance and portable applications. They also call for fast response and ramp-up times and in many applications, must be impervious to expected shock and vibration to operate reliably. The varied nature of applications means that many resistive element heater designs must be based on technology solutions that give designers the flexibility to match the required size and shape while offering the ability to be produced in high volumes or complement specialized application needs. Therefore, the ability to customize open frame resistor elements according to customer requirements has become essential.

## THICK FILM TECHNOLOGY ADVANTAGES

Thick film technology is particularly well-suited for heater applications in that it satisfies multiple requirements. First, it can easily be customized. Thick film resistors are based on screen printing technology that enables manufacturers to easily modify their size and form to specified and space-constrained needs. They also provide very fast temperature response times and high thermal capabilities in a cost-effective solution for low and moderate profile heaters. By utilizing printed thick film technology, applications realize a more efficient spread of heat across the surface of the heater.

Furthermore, the heat generated by the resistive ink screen that is printed, glazed and fired on the ceramic substrate of thick film resistors delivers very good insulation, temperature resistance and mechanical strength. Resistive inks exhibit a slight PTC (Positive Temperature Coefficient) effect. As the temperature of the elements increase, the resistance also increases, lowering current draw and wattage output. This characteristic further enhances the safety of the resistive heater element, and allows for full power when needed at cooler temperatures while conserving energy consumption at higher temperatures.





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## IMPORTANT CONSIDERATIONS

Due to the variety of applications and markets that use resistive heaters, it is important that thick film resistor suppliers offer a broad array of current options, offer elements that meet both AC or DC variable input voltages and comply with UL/CSA recognized component watt densities. They must demonstrate the ability to adapt thick film technology to all types of small and large designs including being able to accommodate round, oval and other non-linear shapes and designs. An added benefit to OEMs is the ability to pre-crease elements in order for them to be wrapped around the surface to be heated, minimizing concerns about film memory and potential delamination.

The type of ceramic plate material is also important to the design. The most commonly used ceramic is aluminum oxide ( $Al_2O_3$ ) known as alumina. It offers excellent thermal conductivity (30 Wm<sup>-1</sup>K<sup>-1</sup>) while being an electrical insulator. It delivers a low coefficient of thermal expansion, and low mass with fast temperature ramp up and cool down. Designers should be aware that various laminates such as foam, mica, FR-4 board and metal are valuable heater options that can be applied to further enhance thermal efficiency and add rigidity or abrasion resistance where needed.

## THICK FILM POWER RESISTOR HEATER SOLUTIONS

Matching the needs of OEM developers, Bourns offers advanced thick film technology design and manufacturing capabilities. The company has a vertically-integrated organization structure with experienced in-house design and proven ceramics production, toolmaking and proprietary resistive ink development capabilities for resistive heaters. Focused on quality, Bourns provides full custom design, packaging and certified TS 16949 manufacturing services. Products can be AEC-Q200 qualified backed by Bourns' worldwide engineering support teams.





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## THICK FILM POWER RESISTOR HEATER SOLUTIONS (Continued)

Providing a comprehensive range of standard products, customers can select from 12,000 part numbers, 53 product families and five different resistive element types. For example, Bourns' standard high power thick film resistor series (Models PWR163, 263, 220, and 221) are ideal resistive element heater solutions. These resistors offer high-power density crucial in satisfying the higher power and small space demands of many applications. They are offered in a TO-220 casing, feature power up to 35 W and a wide resistance range of 1 ohm to 1 megohm. Designers can use them simply inverted with a heat sink and move them from the bottom surface to the top surface of the circuit board.

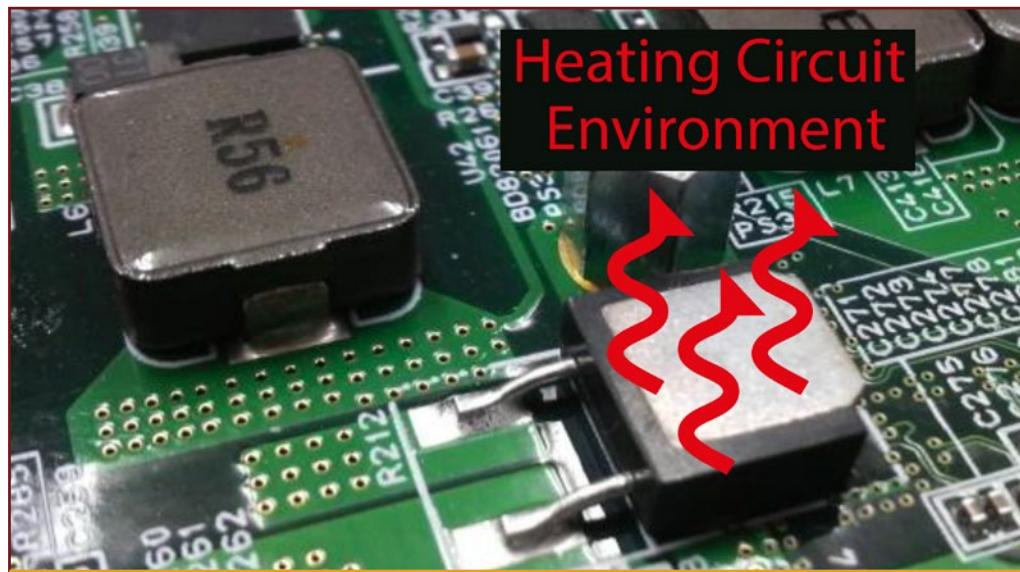


Figure 2. | Power Resistor used as heat sink placed on top surface of a circuit board

Bourns' engineers understand the breadth of requirements that thick film technology must satisfy to be effective in low and mid-sized resistive heater applications. Bourns' standard and customized solutions have been shown to supply effective heating to small areas with fast thermal response times and uniform heat distribution.





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## CONCLUSION

Bourns offers extensive ceramic substrate expertise that has led to advancing insulation resistance and thermal and mechanical strength for its customers. This established experience in offering very flexible customized solutions provides OEM developers a valuable resistive heater supplier who can reliably meet their diverse design and manufacturing requirements.

## ADDITIONAL RESOURCES

Please contact your local Bourns Application Engineer or Bourns Sales Representative for additional information.

Visit Bourns online at:

**[www.bourns.com](http://www.bourns.com)**

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