author:
stan breitlow, chief system designer

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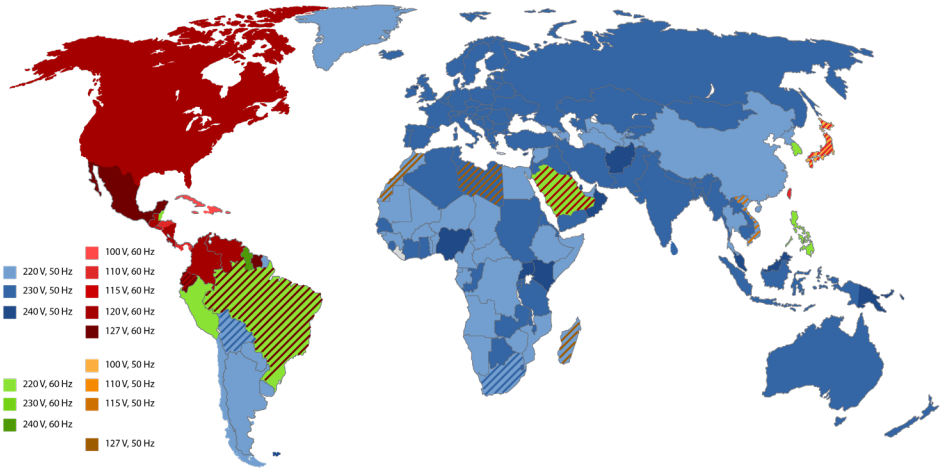
New Alternatives in Power Conversion for Electric Heaters

Summary:

All appliances have some form of power conversion. Generally speaking, electric heaters have been behind the curve when it comes to power conversion technology. Traditionally, they are controlled by pulsing the power received, using what amounts to a rapid on/off switch. While this allows a heater to operate at a given set temperature, it is receiving the full voltage when turned on, which can cause damage over time in some cases. Other solutions, such as phase-angle controllers and DC power supplies, have their own issues when it comes to noise, space requirements and cost. Watlow's innovative power conversion technology can smoothly adjust power up or down, as needed, which opens up possibilities for better heating and sensing in an array of specialized applications.

What is Power Conversion, and Why is it Needed?

Power conversion is familiar in most consumer technologies, such as laptops, gaming consoles and other low-voltage DC electronics. These typically use AC adapters to convert to DC and supply the required voltage.



When it comes to heating devices, however, a different approach traditionally has been used. The goal with a heater is not to attain a given DC current but to maintain a given temperature. This is done using a switching device that turns the power on and off rapidly.

Usually, this kind of switching or cycling is not an issue. But in some cases—when heaters are small or have ceramic components, or where control of multiple heaters is needed—it is not ideal to have the device on with full voltage, let alone have it switching between states. This happens, for example, when precise heating is needed in medical devices, or rapid heating is needed to test microchips in the semiconductor industry.

The issue here gets worse when constructing devices for an international market. Heaters often have very specific voltage requirements, but the power sources can vary from country to country. In today's global economy, there is a great need to normalize this power for use with heaters built for the voltage requirements of any country.

In short, power conversion is an old idea, but current technologies in the market are not well suited for some applications.

The Problem with Current Power Conversion Solutions

Power conversion is essential for any heater, whether in an in-home medical device or a large-scale industrial process. But as heaters are getting smaller and more intricate, more attention must be paid to how power is supplied to them. There are four types of cases where inadequate power conversion can lead to problems:

Fragile Heaters Become Damaged

Switching a higher-voltage power source on and off creates wear and tear on devices. As this happens, smaller, more fragile heaters are more likely to fail over time. While a phase angle controller can be used to output a lower average value, these tend to be incredibly noisy and difficult to measure.

High Voltage Cracks Ceramic Heaters

Ceramic heaters are used in a number of applications, from manufacturing wafers and testing microchips in semiconductor manufacturing to medical testing equipment. Frequently, these heaters are made with molybdenum, which expands and contracts at the same rate as the ceramic. But molybdenum changes resistance with temperature. Thus, hitting a ceramic-molybdenum heater with a high voltage when it is cold can cause the device to crack or even burst. This can become an expensive problem—for example, when a semiconductor manufacturer frequently has to replace millions of dollars worth of cracked pedestals over the course of a year.

Control Requires Expensive, Complex Solutions

In a system with multiple heaters requiring different amounts of power, it is common to connect a bundle of heaters to the same circuit. The heaters that require the most power take the brunt of the power source's high voltage, while the smaller heaters get what is left.

The problem with this solution is the lack of control and fidelity. Control can be recovered by stepping the power down with transformers or installing a power supply. But these options are bulky and expensive and add to the complexity of a system that is already precariously maintained.

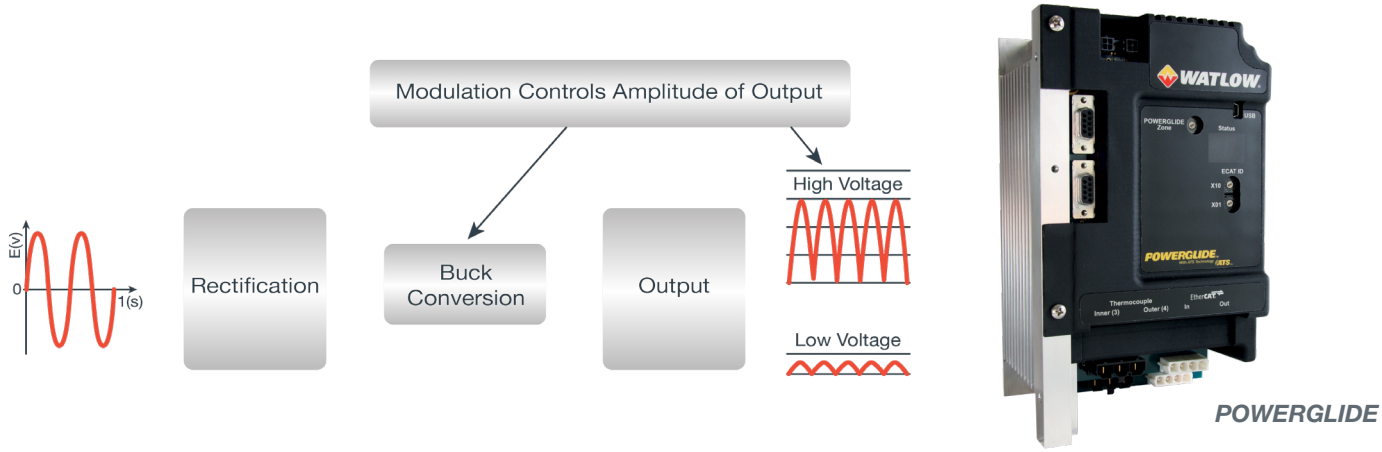
Available Voltage Varies Across the Globe

Suppose a heater is embedded in an at-home medical device, such as a home dialysis machine, and that machine is sold and sent to homes globally. It must be able to work flawlessly, whether connected to a 100-volt power source in Japan or a 240-volt power source in Germany. With appropriate power conversion, a single heater can be designed for the lowest voltage expected as incoming voltage can be brought down from whatever the local standard happens to be.

New Power Conversion Technology for Heaters

Power conversion is commonly achieved through the use of phase-angle controllers, transformers and power supplies. But as we have seen, these solutions can either damage heaters, or take up large amounts of space or make it incredibly hard to measure and control the power flow.

Watlow's power conversion technology solves these issues by providing just the function needed—the ability to bring voltage up or down smoothly—without having to introduce a bulky power supply. Watlow® controllers, such as ***POWERGLIDE®***, are capable of modulating the amplitude of the output voltage, allowing the voltage to step down from 208 volts to as low as 20 volts.



POWERGLIDE

Lowering the voltage in this way is a great way to drive low-impedance heaters. It can reduce the power distribution rating with smaller fuses and wires, which saves money and space. It can also protect ceramic heaters from breaking.

Watlow's power conversion technology also achieves high power quality without the high cost and added space of a DC power supply. No longer do devices have to be engineered around power quality issues; smooth, stable power changes are possible across a huge variety of outputs, and noise is reduced drastically.

This power conversion technology is a foundational part of ***Watlow's Adaptive Thermal Systems®*** (***ATS™***) technologies. ***ATS*** technologies represent an innovative approach to controlling thermal performance, combining sensing, heating and control technologies. Systems designed with ***ATS*** technologies are proving to be easier to implement across a number of designs, and allow for better efficiency and control. Power conversion plays a key role in this, as controlling the power coming into heating elements allows designers to choose heaters that are particularly suited to an application without worrying about the power being fed into them.

Added Benefit: Constant Power and Two-Wire Control

Resistance changes a lot with temperature, which means it can serve as a proxy for temperature measurement. This allows for innovations in heater sensing for some applications—for example, control of a pedestal used in semiconductor manufacturing can be done directly via a high-TCR heater filament wire, rather than a thermocouple and a discrete sensor.

Doing so, however, requires a constant flow of power, which is not possible to attain by pulsing the power. With a ***POWERGLIDE*** controller, the power is always on, and so resistance measurement is always possible.

Added Benefit: Normalized Power

Watlow's power conversion technology is able to produce the ideal amplitude for heaters, regardless of which country they were designed in or where they are now used. To take the previous example of a home dialysis machine: A liquid heater can be introduced that produces the exact temperature change needed, and the power into that heater can easily be converted into the exact voltage required for the heater to run at that temperature.

It would not matter what the output voltage is in any given country, as the power converting technology would normalize power at the load.

Takeaways

Power conversion is an essential element of many consumer devices and industrial applications. Yet most current power conversion technology is not well suited to cases where sensors are fragile, have ceramic components, use multiple different heaters or have to ensure safe operation across the globe. Power supplies, phase-angle controllers and step-down transformers all have their limitations, too.

Watlow's power conversion technology provides a simplified solution capable of turning power up and down, rather than on and off. With use of the ***POWERGLIDE*** and ***EZ-ZONE® RMT*** controllers, Watlow's power conversion technology creates smooth power that extends the lifespan of industrial heating equipment.

EZ-ZONE RMT

POWERGLIDE

Further information is available at: www.watlow.com