How thermography can be used to ensure you get an optimised, reliable design – first time, every time

When designing an inductive component, an essential consideration is the change in temperature. Heat can impact the performance and efficiency of the component in operation, with aging, endurance and life span affected detrimentally.

Within the component, changes in core magnetisation and power losses from the winding cause temperatures to increase. The maximum operating temperature and current are closely related, and are key parameters of a component's specification. The maximum DC current is expressed as the rated current (Ir), also known as the nominal current (In). The design's viability is initially determined through calculations and simulations, with physical testing taking place at the prototype stage.

Heat may be hidden initially and cause issues over time

The challenge at the prototype stage is to find the design's true maximum temperature point. For this, engineers need to create the worst-case scenario conditions eg material tolerances, production impact etc, before they attempt to take accurate temperature measurements of the hottest points. The prototype may need to operate at the rated current (Ir) for several hours before the maximum temperature is realised.

Thermocouples are a popular choice for measuring temperature, offering an accurate measurement; however, there is no guarantee that the hottest point of the design is being measured, even if several measurements are taken in multiple locations over a period of time.

Compounding the challenge of temperature measurement is the design housing. Removed, testers have more opportunity to measure temperature, but this negates any heating or cooling effects from the housing, thus providing inaccurate readings. With the housing in place, it can be extremely difficult, if not impossible, to pinpoint the exact part of the design being measured, especially for complex or compact designs.

Figure 1: Core with winding under normal camera

Figure 2: Thermography visualises the design's thermal performance

Thermal imaging provides instant, multi-point, temperature measurement

Thermal imaging technology enables the tester to see through solid objects to identify and measure temperature at multiple locations. Thermography allows engineers to visualise how each element of the prototype is performing at the maximum rated current (Ir) in real time, measuring the hottest point of each component with or without housing in place. The tester can quickly see if one element is starting to heat up its surroundings, and extend the test period if required.

Efficient, error free development

In the thermal image illustration below, a hot spot can be clearly seen in the copper wire coil in the top-right-hand corner. Even if several readings are taken across the design with a thermocouple, it is likely the design would be found acceptable, with more than 60% of the design operating in the region of 41-45°C.

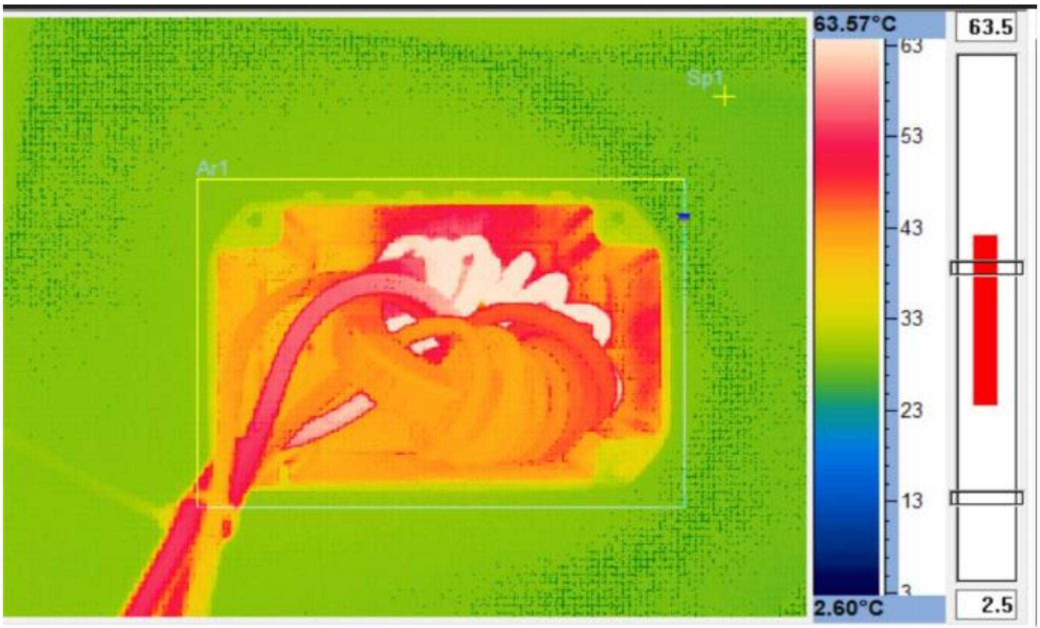

Figure 3: Thermography reveals the hottest part of the design and shows how the higher temperatures are starting to heat the core and housing.

Thermography instantly identifies that parts of the copper winding behind the core are operating at a much higher temperature, causing higher power consumption and reduced efficiency. This additional heat increases the stress on the copper wire, magnetic core, surrounding components and housing, reducing their overall lifespan. Prolonged exposure to heat could result in a temporary change in properties of the core, reducing performance. Under extreme conditions, it could cause a permanent change or even the destruction of the core or housing.

Intelligent insight enables faster time to market and more reliable designs

This level of insight is only available through thermal imaging, allowing the tester to see not only the hottest point in a component, but how this is also affecting the surroundings. By only using a thermocouple, it is entirely possible that this component would have been approved for full-scale production, only for it to fail in the field with an end user with longer periods of use.

With thermography we can see the winding is radiating heat at a much higher temperature than the rest of the design. The core and housing have also started to heat up, but with this visual insight we can now make adjustments to the design, knowing exactly where the issue is.

The result is a more refined development process, with engineers able to make more intelligent design decisions. Products are also more likely to be more reliable, efficient and have longer life spans, with excessive heat spots identified and rectified ahead of production.