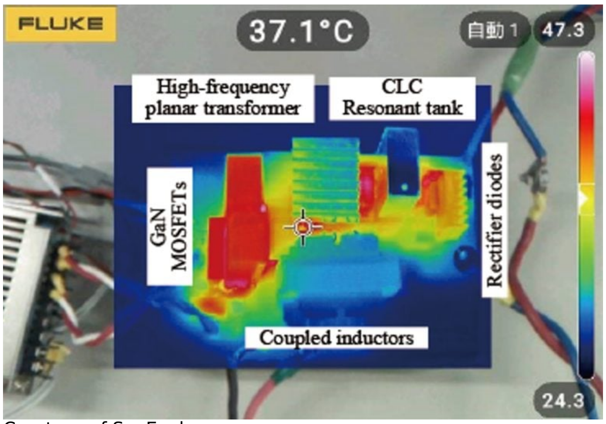
Japanese Researchers Unveil Highly Effective Power Converter

Posted by [Okachinepa] 05/07/2024

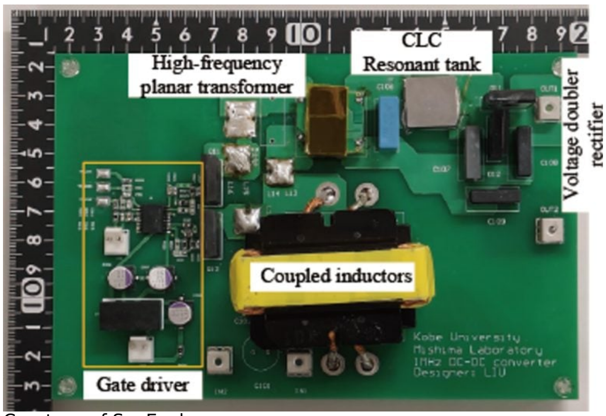


Courtesy of SynEvol
Credit:Mishima Tomokazu

Kobe University has created a new electrical power converter design that offers much higher efficiency at lower cost and less maintenance. This direct current voltage boost converter is expected to have a significant influence on the advancement of electronic and electric components across a range of industries, including information technology, mobility, healthcare, and power generation.

One essential component unites all systems that use solar or vibration energy to power cars that run on hydrogen or power medical equipment. Low-voltage direct current input is transformed into high-voltage direct current output by this so-called "boost converter." It is ideal for it to use as few parts as possible for lower maintenance and expense, while also operating at maximum efficiency and producing no heat or electromagnetic noise, because it is such a fundamental and ubiquitous component. Boost converters' primary function is to swiftly switch between two circuit states—one for energy storage and the other for energy release.
The gadget as a whole can be made smaller by using smaller components due to faster switching. But doing so also produces more heat and electromagnetic noise, which lowers the power converter's efficiency.

Mishima Tomokazu, a power electronics researcher at Kobe University, and his team made great strides toward creating a novel direct current power conversion circuit. They were able to combine high-frequency switching—roughly ten times greater than previously—with "soft switching," a method of lowering electromagnetic noise and power losses from heat dissipation. They also managed to reduce the number of components, which kept costs and complexity down.



Courtesy of SynEvol
Credit:Mishima Tomokazu

There is a small moment when the switch is not fully closed when the circuit switches between two states, and during that moment, there is both a voltage and a current across the switch. This indicates that the switch dissipates heat during this period by functioning as a resistor. This dissipation increases with the frequency at which a switch state changes. According to Dr. Mishima, soft switching is a technique that minimizes heat loss by ensuring that switch transitions occur at zero voltage. This has traditionally been accomplished by "snubbers," which are parts that provide alternate energy sinks throughout the transition phase, causing energy losses in the process.

The innovative circuit design and assessment by the Kobe University team were published in the IEEE Transactions on Power Electronics journal. Their success can be attributed to their usage of "resonant tank" circuits, which have far lower losses since they can store energy during the switching phase. Furthermore, they employ a component-saving design known as a "planar transformer," which is incredibly tiny and has excellent thermal performance in addition to using flat components printed onto a circuit board.

Additionally, Mishima and his associates constructed a circuit prototype and assessed its functionality. We verified that, for an MHz drive with a high voltage conversion ratio, our snubberless design has significantly less electromagnetic noise and a high energy efficiency of up to 91.3 percent. Additionally, this ratio is more than 1.5 times larger than that of current designs. Nonetheless, scientists want to boost efficiency even more by lowering the magnetic components' power dissipation.

Given how commonplace electrical gadgets are in our daily lives, direct current power supply with a high voltage multiplier ratio must operate with great efficiency and low noise. Applications in electric power, renewable energy, transportation, information and telecommunications, and healthcare will benefit greatly from this Kobe University development. "The current development is a 100W-class small-capacity prototype, but we aim to expand the power capacity to a larger kW-class capacity in the future by improving the electronic circuit board and other components," Mishima says in explaining their future intentions.
