

# Intelligent gate driver enhances the lifetime of power converters

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Lie Wang. Credit: Eindhoven University of Technology

Researcher Lie Wang developed an intelligent gate driver for switch components in the power converter, significantly improving power converters' lifetime and reliability.

Power electronics converters penetrate daily life in many places. These electronic converters convert [electrical energy](#), from batteries or the grid, into proper voltages and currents for [electrical appliances](#) like LED lighting, [electric motors](#), processors and data center supplies. However, if power electronics fail, these devices break down. Researcher Lie Wang developed an intelligent gate driver for [switch](#) components in the [power converter](#), significantly improving power converters' lifetime and reliability.

With the increasing pace of global electrification, power electronic converters penetrate further into a wide range of applications, such as automotive, smart grids, traction, [renewable energy](#), aerospace, healthcare and portable equipment. In recent years, an increasing number of power switches have been incorporated in power converters (e.g., converters used for operating the wafer stage in ASML lithography machines or supplying MRI scanners) to increase the processed power and output accuracy.

## **Aging failure**

The power switch is one of the most vulnerable components; therefore, the lifetime of these devices significantly influences the reliability or availability of power electronics converters. One of the failure mechanisms of power switches is aging failure due to [temperature variations](#), which typically takes several years to happen.

For instance, in a fully electric city bus, the power switch cools down at every stop and heats up when accelerating, which generates a temperature swing of up to 50°C. Assuming the city bus runs 12 hours/day and stops every 2.5 minutes, the power switch will last less than 10 years due to these temperature swings.

In ASML's lithography machines, the wafer stage moves at up to 10Hz

with very high speed and acceleration, creating up to 25°C of temperature swing. Here, when operating 24 hours a day, the power switch lifetime will be less than five years. The power switch wear-out caused by the temperature swing is the root cause of the aging problem during normal operation.

## Steps toward more reliable power electronics

Wang's Ph.D. research aimed to develop an intelligent gate driver and the associated control method for power switches to adjust their losses to reduce the temperature swing actively. Besides that, the gate driver provides flexible integration into power converters and operates automatically based on the operation condition, e.g., heavy load or light load. The research results show a lifetime improvement of 53% for power switches in an electric motor drive operating at a high-speed scenario and 42% in a low-speed operation scenario.

This research facilitates steps towards more reliable power electronics converters. In the future, the research will be continued and will lead to better and more reliable [power electronics](#) converters with enhanced lifetime for the power switch components.

Lie Wang defended his PhD-thesis, titled "Thermal stress reduction of power transistors. Model-based dynamic gate driving applied to electric motor drives" on March 10th.

Provided by Eindhoven University of Technology

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