Advertorial

Advancing transformer performance with DC compensation technology

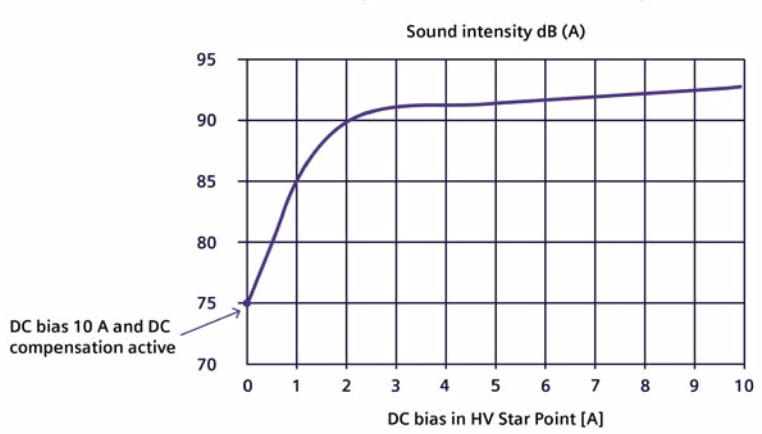




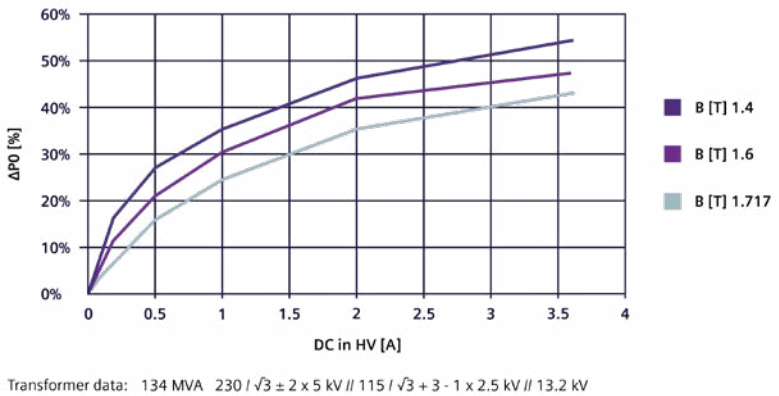
Siemens Energy's DC compensation technology ensures silent transformer operation while preserving grid harmony amid renewable energy integration

The power transmission and distribution landscape is evolving rapidly as the integration of renewable energy sources introduces complex challenges for transformer operations. Among these, mitigating noise pollution in densely populated areas is paramount, given its impact on public health and urban quality of life. The rise of direct current (DC) components in the power grid, a direct consequence of renewable integration, has escalated concerns around acoustic performance in transformers. Traditional mitigation strategies have proven inadequate, prompting the need for innovative solutions. Siemens Energy is leading the charge with its state-of-the-art DC compensation (DCC) technology, ensuring silent transformer operation without impeding DC current flow and preserving grid harmony.

Noise under DC bias uncompensated results acceptance test on transformer



Change of no-load losses vs. DC in HV of 134.4 MVA unit



Transformer data: 134 MVA 230 / √3 ± 2 x 5 kV // 115 / √3 + 3 - 1 x 2.5 kV // 13.2 kV

Combatting DC bias: Technical insights into noise reduction

Modern power transformers are manufactured using highly optimized grain-oriented steel and core stacking technologies. Even modest levels of DC bias can push transformer core magnetization to saturation, resulting in significant noise emission. Stricter environmental noise regulations exacerbate this issue and can cause serious problems with the operation of transformers. Different sources of DC bias are discussed in the technical brochure of the ongoing CIGRE working group A2.57.

Siemens Energy's innovative DC compensation (DCC) technology has been developed to eliminate the adverse effects of parasitic DC bias, thereby enabling transformers to operate with undisturbed efficiency.

Balancing act: How DC compensation reshapes transformer operation

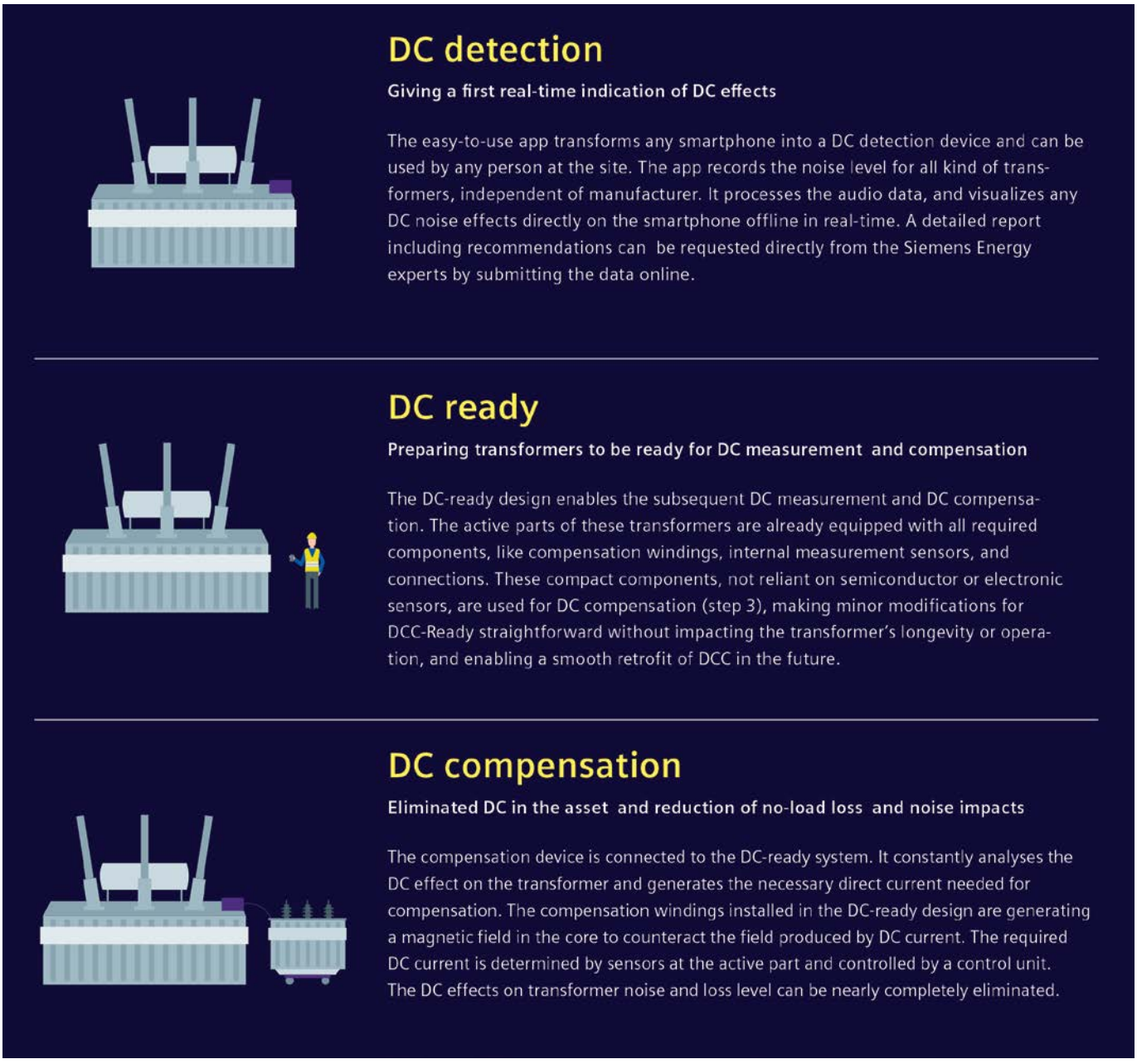
The DC compensation technology effectively addresses the issue of DC bias at the core. By utilizing a robust sensor technique to measure the DC magnetization of the core accurately, the DC compensation system can counteract the DC bias ampere turns by injecting opposing DC ampere turns into a small auxiliary winding located at the core limb. This pioneering technology, known as DC compensation, has been developed with a focus on high robustness and availability without the need for installation of electronics or semiconductors inside the transformer tank. Extensive testing has demonstrated the capability of DCC to completely neutralize the adverse effects of parasitic DC bias, allowing the transformer to operate with normal and undisturbed properties in the field. Furthermore, DC compensation has no adverse impact on the power network, enabling DC bias currents to flow freely across the transformer windings without imposing any blocking voltages. Additionally, it can compensate for unsymmetrical DC bias loading, a unique feature of this technology, and is galvani-

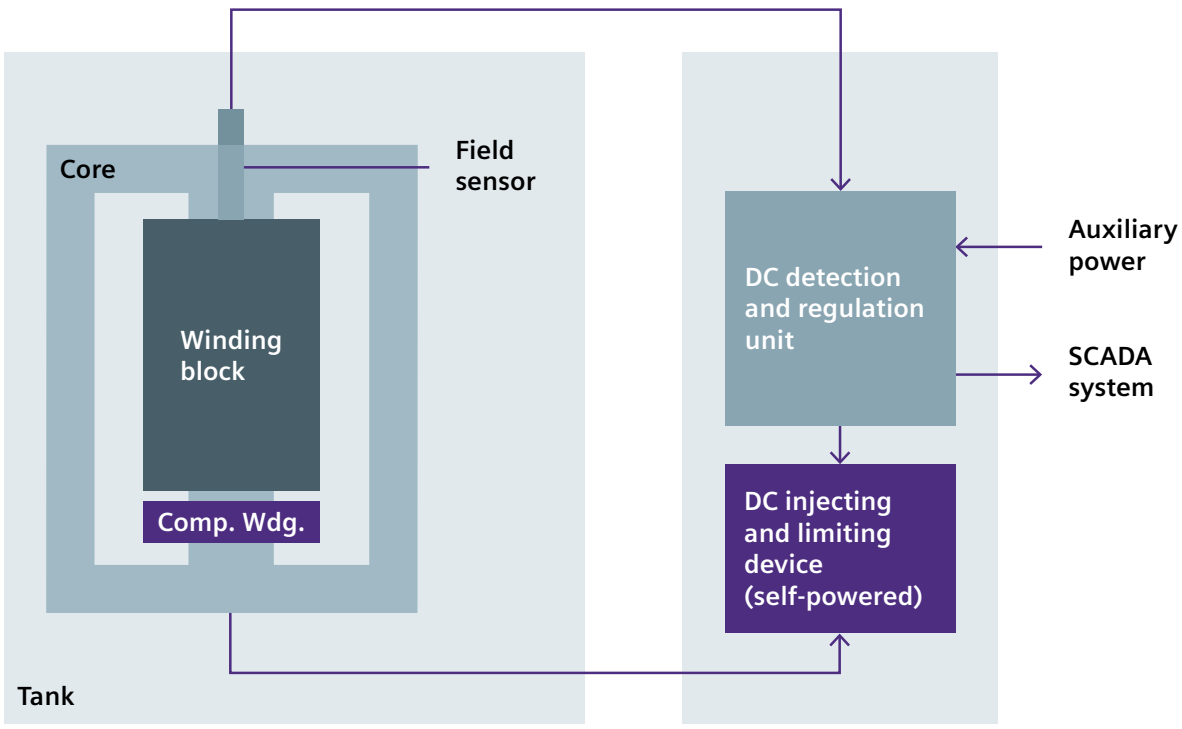
cally decoupled from the power systems, further enhancing its appeal.

Mechatronic marvel: Exploring the inner workings of DC compensation technology

The mechatronic DC compensation system eliminates parasitic DC bias impacts, requiring no semiconductor elements and allowing future retrofitting

DC compensation is effective across all power systems of the transformer, mitigating the impact of parasitic DC bias and obviating the need for costly enclosure of power transformers to meet sound emission standards. This integrated mechatronic system comprises electromechanical and electronic components responsible for DCC sensor signal processing and the regulation of compensating DC ampere turns to counterbalance any DC magnetization of the core. The system can be divided into a DC-ready part, encompassing all preinstallable components at the transformer, allowing for future retrofitting to achieve a fully functional DCC system. The development of DCC-ready equipment prioritizes the use of passive elements, such as the DCC sensor made of silicon steel and copper coils without any semiconductor elements, and the DC compensation winding, a small auxiliary winding situated at the core limb, which requires no replacement or maintenance throughout the transformer's lifespan. Completing the system retrofit involves a Silicon Controlled Rectifier (SCR) controlled reactor for DC injection, sensor signal processing electronics, and controller electronics, with a small





DC ready transformer (left) and upgrade package to a full DC compensation on the right (simplified)

Successful applications, like the integration of DCC in offshore wind park transformers, showcase its ability to resolve noise issues in demanding environments

Programmable Logical Controller (PLC) ensuring comprehensive system operation control. Standardized DCC solutions, tailored to different compensation power requirements, can be selected to address specific DC bias currents, with the flexibility to easily scale up the system for high compensation power and customize it to meet specific needs.

From conceptualization to field application: DCC in practice

Siemens Energy's commitment to advancing transformer technology is evident in the successful real-world applications of DCC. A notable implementation includes the full integration of DCC within 470 MVA transformers at a key connection point for an offshore wind park within the Scottish Power Grid. This application underscores the efficacy of DCC technology in resolving noise issues associated with power transformers in a demanding operational environment.

To explore the transformative potential of DC compensation technology and its tailored solutions for mitigating the impact of parasitic DC bias in power transformers, contact us today to discuss how Siemens Energy can address your specific needs and ensure optimal performance in your power systems.

Author



Peter Hamberger possesses a diverse background in transformer technology. Since joining Siemens Energy Grid Technologies in 1995, he has managed several projects and R&D teams for transformer engineering, numerical modeling and had the responsibility for global R&D for medium power transformers. On the material side, he is a member of the Siemens Energy global commodity team for grain-oriented steel. Following his passion for new solutions, he is currently the senior key expert for power transformers in Siemens Energy.