Investigating communication breakdown due to self-heating effect in bulk acoustic wave filters

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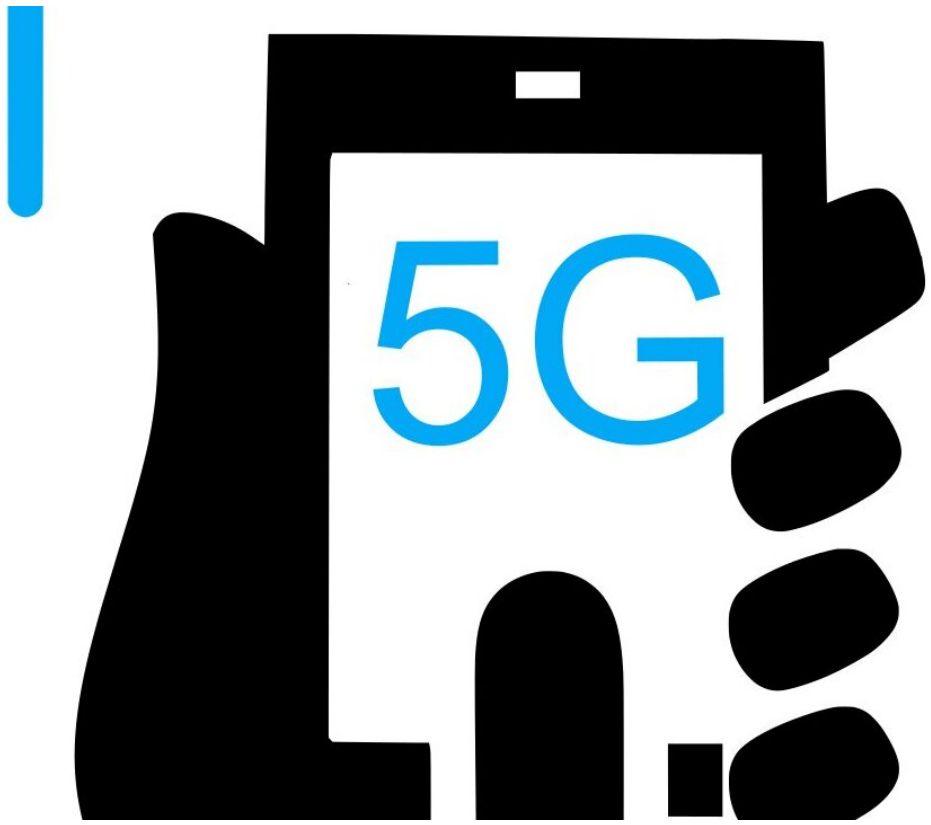

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Bulk acoustic wave (BAW) filters are used in various electronic devices, including smartphones, tablets, Wi-Fi routers, and communication

systems to help produce smooth and reliable high-frequency radio signals for 5G communications. They are thus important in ensuring efficient communication and data transmission.

BAW filters are widely used in the radio frequency front ends of diverse devices, such as magnetoelectric transducer antennae for wireless communication. BAW filters are also used in physical sensors, actuators, and biochemical sensors.

In high-power applications an issue known as the self-heating effect can arise in BAW filters. Self-heating BAW filters when they are powered leads to a degradation in performance known as insertion loss, a fall in signal power. Research in the *International Journal of Nanomanufacturing* has investigated this phenomenon. Mitigating the detrimental effects of self-heating could improve the overall efficiency of a component or device as well as improving durability.

Bin Ruan and Tingting Liu of Southwest University of Science and Technology, in Mianyang, Shaohua Yang, Qinwen, and Weiheng Shao of the China Electronic Product Reliability, and Environmental Testing Research Institute in Guangzhou, and Ming Wu of Pandhus Microsystem Co., Ltd also in Mianyang, China, have investigated self-heating at high-frequency power levels. The team built a dedicated test system to measure the maximum surface temperature and the insertion loss of BAW filters at different power levels.

The relatively simple but important finding from their tests is that as power levels increased, so did heating, and thus, insertion loss. The correlation between higher power and greater insertion loss represents a fundamental trade-off in filter design. As power levels increase, the filter's components may experience greater stress, leading to increased losses.

Armed with this knowledge, it might be possible to use various approaches to mitigate insertion loss while maintaining adequate power handling capabilities. For instance, choosing alternative materials, refining fabrication techniques, and implementing innovative filter configurations might all be used to reduce self-heating and so reduce insertion loss. For instance, incorporating advanced materials with improved thermal properties or refining the geometry of the filter structure might help dissipate heat more effectively, reducing losses at higher power levels.

More information: Bin Ruan et al, Study on the effect of self-heating effect of bulk acoustic wave filter on the interpolation loss in the band, *International Journal of Nanomanufacturing* (2024). DOI: 10.1504/IJNM.2023.136571

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