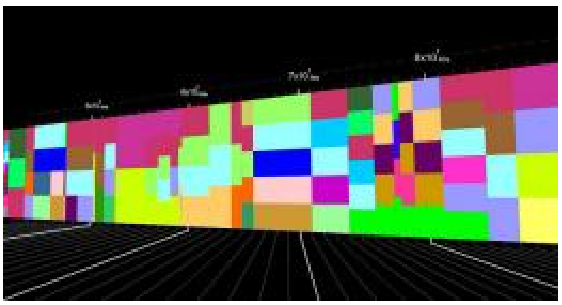
New ceramic chip antennas offer better performance, reliability

September 19 2011, By Lee Swee Heng



Representation of the services that use our electromagnetic radiospectrum, ranging from 10Khz "radio navigation" to 100Ghz "inter-satellite communication" Credit: pushandplay

Wireless devices such as mobile phones rely on the radio spectrum to send and receive data. There is growing interest in using a worldwide unlicensed spectrum around 60 gigahertz for future wireless applications, but conventional ceramic chip antennas have limited performance at this frequency. Junfeng Xu and Xianming Qing at the A*STAR Institute for Infocomm Research and co-workers have now developed a ceramic chip antenna that exhibits stable performance in this spectrum. The antenna has a relatively wide bandwidth of 17.1% and a gain of up to 22.1 decibels.

Bandwidth and gain are two of the key indicators for assessing the performance of an antenna. An antenna’s bandwidth specifies the range of frequencies over which its performance does not suffer due to poor impedance matching, and the gain measures the antenna's ability to convert input power into radiowaves in a specified direction. An ideal antenna must not only be compact and lightweight, but also have a wide bandwidth and high gain, leading to high efficiency.

Conventional antennas have a narrow bandwidth of typically less than 10%, and often require expensive components that present difficult manufacturing challenges, such as embedded air cavities. Instead of re-examining these individual components to improve the performance of the ceramic chip antenna, the researchers focused on three aspects of the overall antenna design.

The design of the radiating elements of the ceramic chip antenna consisted of a compact 8 × 8 cavity array, each made of five vertically stacked layers. The radiating elements alone had a large bandwidth of 23%. The inputs to different portions of the antenna were delivered symmetrically, avoiding distortions in radiation patterns and reductions in bandwidth. The researchers also optimized the connection between an external waveguide at the antenna input and an internal waveguide that delivers the signal to the radiating elements for transmission. The use of an internal waveguide increased the radiative efficiency of the antenna, and the transition element of the connection had a large bandwidth of 19%.

The final size of the constructed antenna was just 47 mm × 31 mm (see image), and a transmission loss of less than 2.5 decibels over an operating bandwidth of 17.1%. The antenna displayed a stable radiation pattern over this operating bandwidth, with a main lobe pointing desirably to the broadside of the antenna. The potential applications of the new ceramic chip include a variety of high-speed and license-free wireless devices, and Xu comments that there are plans to apply the new technology to even higher frequencies above 110 gigahertz.

More information: Xu, J., et al. Bandwidth enhancement for a 60 GHz substrate integrated waveguide fed cavity array antenna on LTCC. *IEEE Transactions on Antennas and Propagation* 59 826–832 (2011). dx.doi.org/10.1109/TAP.2010.2103018

Provided by Agency for Science, Technology and Research (A*STAR)