Anritsu Advancing beyond

Material Measurement Solutions – Focusing on 5G and 6G

Background

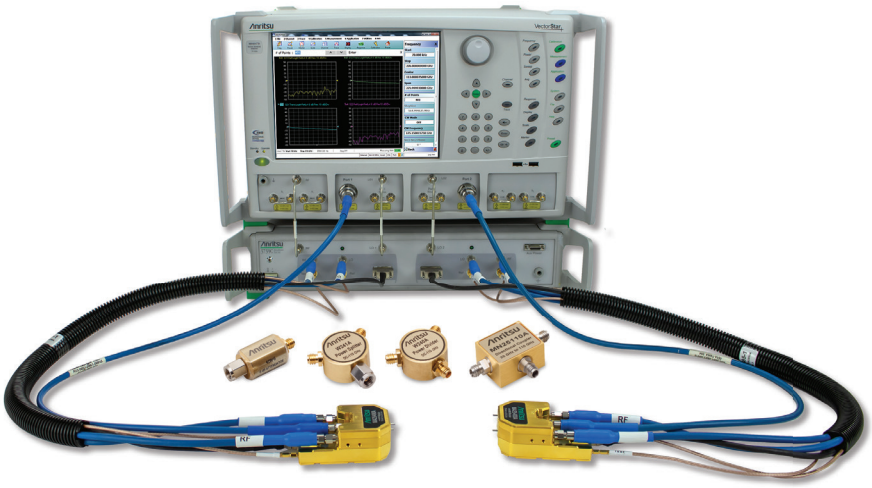
The exponential growth in demand for high-bandwidth applications such as IoT, cloud computing, machine learning, multimedia streaming, and more, has triggered the need for development of new technologies that provide high bandwidth and higher data speeds with reliability for communication networks. 5G, and recently 6G, technologies will progressively use higher frequencies on the order of 100 GHz and beyond to the THz range to achieve data rates on the order of terabits-per-second.

Requirements

Developments in testing of devices, electronic circuits, and materials that would be used in 6G technology will require the test and measurement equipment to be used in the terahertz region. Since the frequencies would be extremely high, special materials might be required that are not commonly used in today's electronic world. Teflon and graphene, and others, are some examples of the materials that are being tested for their performance when interacting with extremely high frequencies in the D-band and beyond.

For 6G, as the frequencies go higher, apart from the obvious advantage of wider modulation bandwidth and higher data speeds available, it comes with some fundamental issues of signal penetration and free-space path losses. From a communications perspective, it would mean that the operators will have to install a very large number of base stations to provide coverage to every street and household. This solution is not cost effective, hence other alternatives are being proposed. One such alternative is the reflective intelligent surfaces that are passive devices but can deflect/reflect the higher frequency signals in a desired direction. This means that if these surfaces are installed over every traffic/road/communication sign, a large area could be covered with only one to two base stations.

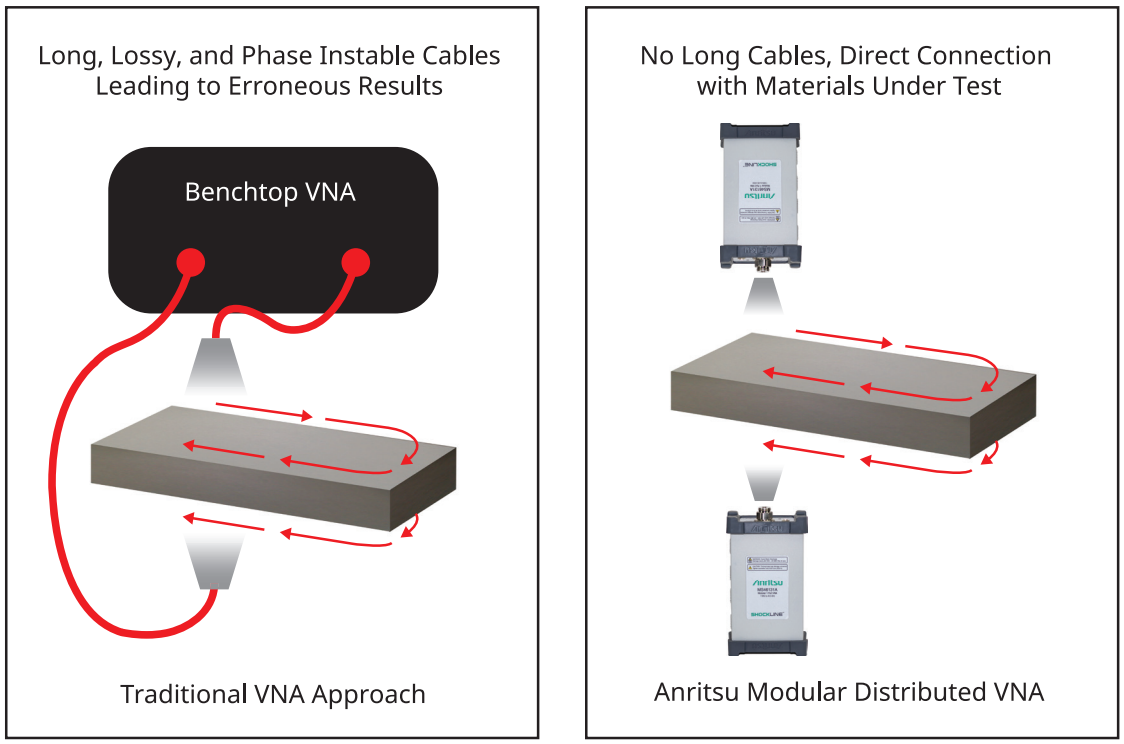
These intelligent surfaces are made with a special conductive ink coating that can reflect the high frequency 5G/6G signals. The ink is made up of a special material that needs to be characterized for its permittivity Dk and Df, loss Tangents etc. For characterizing these special materials, vector network analyzers are required to operate from extreme low frequencies to high frequencies (to 220 GHz and beyond) in a single sweep or in a banded fashion up to 1.1 THz.



Since the materials are expected to have extremely low dissipation factors and other superior dielectric properties, and apart from characterizing the material at the desired frequencies, the response at first and second harmonics must also be characterized. Thus, a requirement for a broadband VNA that covers the fundamental and harmonics is required.

Testing Requirements

Some other measurements that are related to 5G and even commercial 6G technologies (yet to be decided for the frequency band) require that the two VNA ports are to be separated in distance to make material measurements (Dk, Df, Loss tangents, and others) over a larger area of the materials. This is especially useful for material measurement testing in production environments where the thin sheets of these materials need to be tested quickly and efficiently over the longer distances. Up until now, the only solution was to have a benchtop VNA with long test-lead cables attached to horn antennas which are arranged in a north south direction (or north/north direction, if the material properties to be calculated were based on reflections). This was not a problem at lower frequencies where phase variations with movement of the cables was not significant. However, with higher frequencies, moving the long test-lead cables produce fluctuations in the phase that leads to erroneous results for the material.



Anritsu provides a two port VNA solution that can be placed out over longer distances (2m, 5m, 10m, and beyond) to make the measurements easier. Anritsu also has collaboration with several third parties for providing the right fixtures and software for measuring the complete material characteristics.

Conclusion

Material measurement is going to become an even more important measurement to be performed on all devices that will carry high frequency signals. Characterizing the materials for their electrical loss properties and phase deviation is going to play a very crucial role for 5G and especially for 6G devices and applications. Although banded measurements have always been used for material testing, 6G technology implementations for material modeling require a broadband VNA solution to characterize the response of the material not only at the frequency of operation, but also for harmonic content as well. There are several solutions available from Anritsu to fully characterize high-frequency materials. For more information, please visit www.anritsu.com

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