

Keysight Technologies

Materials Measurement: Phantoms

Application Brief



Overview

Phantoms (designed objects that simulate various constants of biological tissues) have been widely used for antenna characteristic evaluation and specific absorption rate (SAR) measurements for mobile handsets and other wireless communication devices. There are international test standards for SAR measurements to protect human health and safety such as IEC 62209. The test standards require measuring dielectric properties of the phantom material, such as relative permittivity and conductivity, prior to testing SAR.

Phantoms are also increasingly required for a variety of medical research purposes such as microwave imaging to detect breast cancers. It uses the difference of microwave reflectivity between normal tissue and cancer tissue due to different dielectric properties. Researchers need to verify that the dielectric properties of phantom materials are equivalent to that of biological tissues for getting precise test data.

Problem

The dielectric characteristics of liquid phantom tend to be changeable by evaporation and chemical reaction over time. The test standards require the measurement of dielectric properties of phantom material within a certain period of time (e.g. within 24 hours) before SAR testing. For measuring dielectric properties within a short time period, an easy-to-setup, repeatable, and stable test system is required. The required test frequency ranges for medical research purposes are being increased up to 10 GHz and higher.

Solution

The coaxial probe method is best for liquid phantom materials. A typical measurement system consists of a network analyzer or an impedance analyzer, a coaxial probe and software. Keysight offers the whole product solution, the 85070E software with the dielectric probe kit (included), an Keysight network analyzer or the E4991A impedance analyzer. The system provides simple, convenient and non-destructive measurements. The measurement software guides you through setup and measurement, instantly converting S-parameter network analyzer data into a data format of your choice and displaying the results within seconds. Results can be charted in a variety of formats: ϵ_r' , ϵ_r'' , $\tan \delta$ and Cole-Cole. The system can cover from 10 MHz to 50 GHz. The frequency range is decided by analyzer.

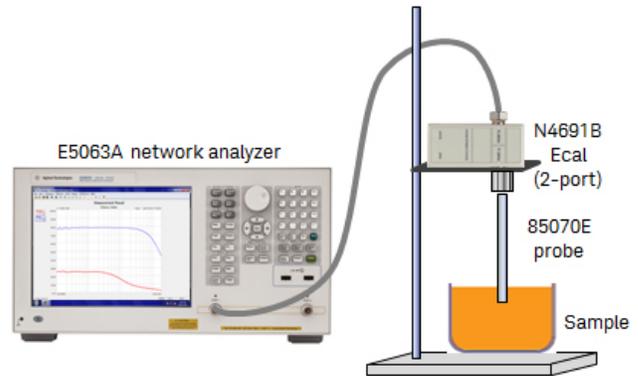


Figure 1. Typical system configuration

You may need to monitor dielectric properties for many hours, even for a very slight change in some cases. The Keysight 85070E software has an electronic calibration refresh feature that recalibrates the system automatically with an ECal module. It eliminates cable instability and system drift that causes measurement errors over long periods of time.

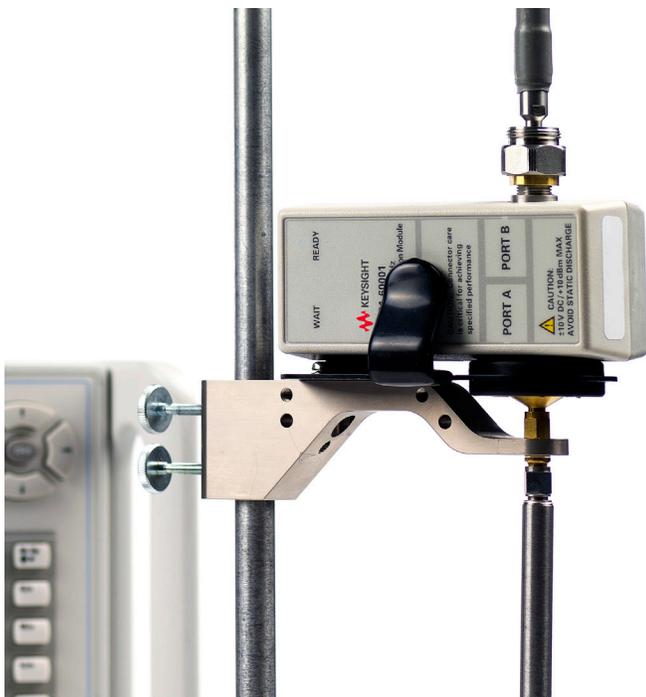


Figure 2. ECal for calibration refresh

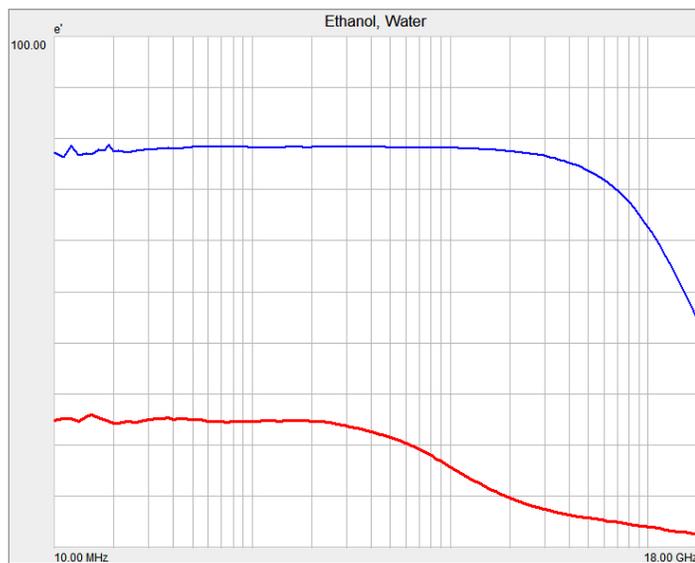


Figure 3. Measurement result example

Conclusion

The coaxial method with a network analyzer or an impedance analyzer is widely used for measuring the dielectric properties of phantom materials. It is critical to maintain the dielectric properties of the phantom equivalent to that of biological tissue for precise simulation. For more information, application notes and white papers are listed under references.

References

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8. IEC 62209-1: 2005, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)
9. IEC 62209-2: 2010, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)

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