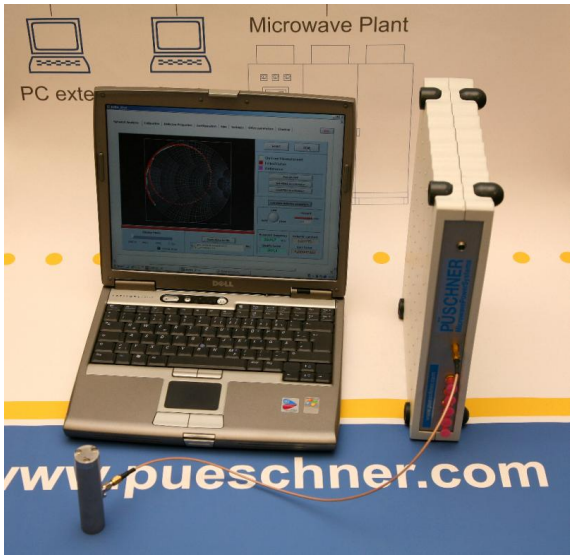
PÜSCHNER
MicrowavePowerSystems

Dielectric Measurement Kit *µWaveAnalyser*

Short Technical Notes



Description of the Equipment

The precise knowledge of the materials' dielectric properties is very important for industrial as well as scientific microwave applications success.

The Portable Dielectric Measurement Kit (PDMK) is a new instrument designed to determine the complex permittivity for a wide range of solid, semi-solid, granular and liquid materials around the ISM frequency of 2.45 GHz. It performs automatically all the necessary control functions, generation and analysis of microwave signals, data processing, dielectric calculation, storage and results presentation.

Although other instruments, the PDMK is able to measure low, moderate and high loss dielectric materials with the same set-up. Plastics, food products, pharmaceutical powders, liquids, etc. are materials that can be measured by the PDMK.

Measurement Principle

The open-ended coaxial cavity is a cut-off section of a coaxial line filled with PTFE, which is placed at one extreme directly in contact with a dielectric Material Under Test (MUT). The energy is launched into the cavity through a small gap between another coaxial line connected to a microwave generator (Fig. 1).

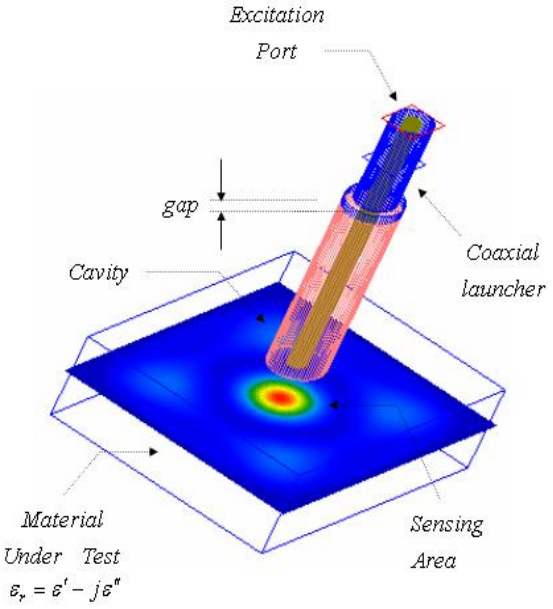


Fig 1. Open-ended coaxial cavity

The electromagnetic fields in the coaxial cavity "fringe" a certain depth into the material under test (depending on the dielectric losses) and the resonant frequency of the cavity is shifted depending on the material's dielectric constant. Fig. 2 shows a measurement example of the open-ended coaxial cavity response to some common materials. As shown, each material responds with a different resonant peak. From these measurements the resonant frequency and quality factor are determined and the complex permittivity is calculated by using an in-house developed procedure.

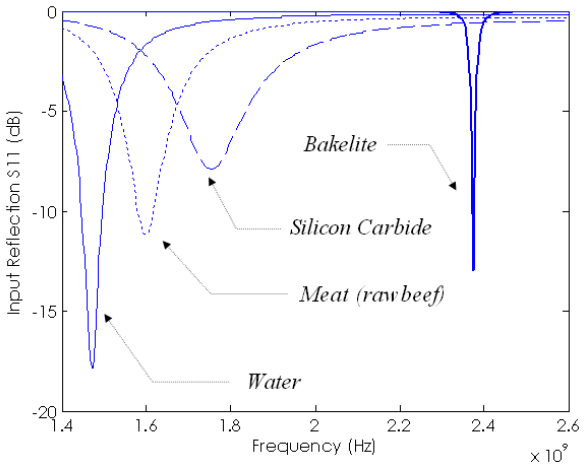


Fig 2. Measurements of some materials

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To read properly the resonant response of the cavity, the coupling of the cavity needs to be adjusted. The designed measurement cavity includes a vertical displacement system which allows modifying the feeding gap up to several millimetres. By means of this procedure, the cavity can be excited with different degrees of coupling (i.e. week couplings with large gaps and strong couplings with very small gaps), thus allowing measurements on complex permittivity of a wide range of materials.

Fig 3. Picture of the measurement cavity

Dielectric Measurement Kit consists of

- A Microwave Analyser composed of a microwave generator, a microwave receiver and an USB data acquisition system.
- An Open-ended Coaxial Probe Cavity (Fig. 3) made of high end stainless steel (gold coating optional)
- A set of calibration loads and reference materials
- Windows XP-PC Analysing Software (Fig. 4) to perform automatically the generation and analysis of microwave signals, data processing, permittivity calculation, storage and results presentation.

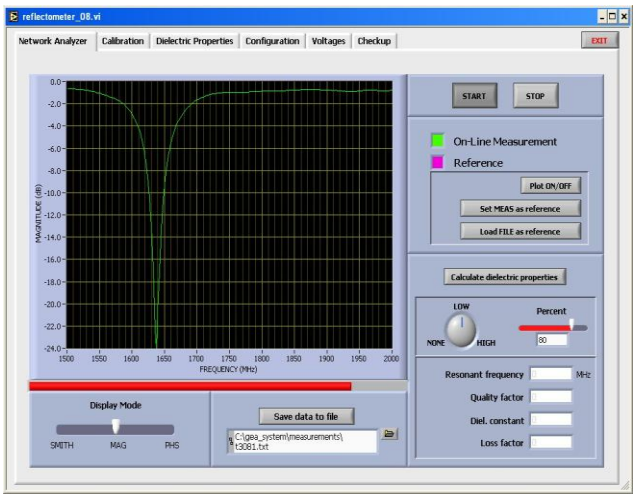

Fig 4. Windows PC Analysing Software

Technical Specifications

- Frequency range: 1.5GHz to 2.6GHz (nominal, limited by MUT properties)
- Dielectric constant: $\varepsilon' < 100$
- Loss factor: $0.001 < \varepsilon'' < 10$
- Accuracy: (does not include the effects of MUT contact or cable flexure) about 1% in real part (dielectric constant) and 2-5 % in the imaginary part (loss factor)
- Material under test assumptions:
  - -"Infinite" in size (Thickness > 1cm)
  - -Diameter > 6.5 cm
  - -Non-magnetic
  - -Isotropic (uniform orientation)
  - -Homogeneous (uniform composition): If the material is not homogeneous, the result is considered of an average value
  - -Solids have a flat surface with gap-free contact on the cavity face.
  - -Granular size (meas. repeatability for granular materials is dependent on density variation). Diameter < 2 mm
- Power supply voltage: 220 volts
- Microwave output: 0 dBm
- Communication with PC: USB
- Speed of communication: 115 kbits/sec

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