

Cavity resonator method to measure the complex permittivity of low-loss dielectric plates

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NATIONAL FOREWORD

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**Cavity resonator method to measure the complex permittivity
of low-loss dielectric plates**
(IEC 62562:2010)

Méthode de la cavité résonante pour
mesurer la permittivité complexe des
plaques diélectriques à faibles pertes
(CEI 62562:2010)

Hohlraumresonanzverfahren zum Messen
der komplexen Permittivität von
verlustarmen dielektrischen Platten
(IEC 62562:2010)

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Foreword

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CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Measurement parameters.....	5
3 Theory and calculation equations.....	6
3.1 Relative permittivity and loss tangent.....	6
3.2 Temperature dependence of ϵ' and $\tan \delta$	9
3.3 Cavity parameters.....	9
4 Measurement equipment and apparatus.....	10
4.1 Measurement equipment.....	10
4.2 Measurement apparatus for complex permittivity.....	11
5 Measurement procedure.....	12
5.1 Preparation of measurement apparatus.....	12
5.2 Measurement of reference level.....	12
5.3 Measurement of cavity parameters: D , H , σ_r , α_c , $TC\rho$	12
5.4 Measurement of complex permittivity of test specimen: ϵ' , $\tan \delta$	14
5.5 Temperature dependence of ϵ' and $\tan \delta$	14
Annex A (informative) Example of measured result and accuracy.....	15
Bibliography.....	18
Figure 1 – Resonator structures of two types.....	6
Figure 2 – Correction term $\Delta\epsilon'/\epsilon'_a$	8
Figure 3 – Correction terms $\Delta A/A$ and $\Delta B/B$	8
Figure 4 – Schematic diagram of measurement equipments.....	10
Figure 5 – Cavity resonator used for measurement.....	11
Figure 6 – Photograph of cavity resonator for measurement around 10 GHz.....	11
Figure 7 – Mode chart of cavity resonator.....	12
Figure 8 – Resonance peaks of cavity resonator.....	13
Figure 9 – Resonance frequency f_0 , insertion attenuation IA_0 and half-power band width f_{BW}	13
Figure 10 – Resonance frequency f_0 of TE_{011} mode of cavity resonator with dielectric plate ($D = 35$ mm, $H = 25$ mm).....	14
Figure A.1 – Measured temperature dependence of f_1 and Q_{uc}	16
Figure A.2 – Resonance peaks of cavity resonator clamping sapphire plate.....	16
Figure A.3 – Measured results of temperature dependence of f_0 , Q_u , ϵ' and $\tan \delta$ for sapphire plate.....	17
Table A.1 – Measured results of cavity parameters.....	15
Table A.2 – Measured results of ϵ' and $\tan \delta$ for sapphire plate.....	17

CAVITY RESONATOR METHOD TO MEASURE THE COMPLEX PERMITTIVITY OF LOW-LOSS DIELECTRIC PLATES

1 Scope

The object of this International Standard is to describe a measurement method of dielectric properties in the planar direction of dielectric plate at microwave frequency. This method is called a cavity resonator method. It has been created in order to develop new materials and to design microwave active and passive devices for which standardization of measurement methods of material properties is more and more important.

This method has the following characteristics:

- the relative permittivity ϵ' and loss tangent $\tan \delta$ values of a dielectric plate sample can be measured accurately and non-destructively;
- temperature dependence of complex permittivity can be measured;
- the measurement accuracy is within 0,3 % for ϵ' and within 5×10^{-6} for $\tan \delta$;
- fringing effect is corrected using correction charts calculated on the basis of rigorous analysis.

This method is applicable for the measurements on the following condition:

- frequency : $2 \text{ GHz} < f < 40 \text{ GHz}$;
- relative permittivity: $2 < \epsilon' < 100$;
- loss tangent : $10^{-6} < \tan \delta < 10^{-2}$.

2 Measurement parameters

The measurement parameters are defined as follows:

$$\epsilon_r = \epsilon' - j\epsilon'' = D / (\epsilon_0 E) \quad (1)$$

$$\tan \delta = \epsilon'' / \epsilon' \quad (2)$$

$$TC\epsilon = \frac{1}{\epsilon_{\text{ref}}} \frac{\epsilon_T - \epsilon_{\text{ref}}}{T - T_{\text{ref}}} \times 10^6 \quad (1 \times 10^{-6}/\text{K}) \quad (3)$$

where

D is the electric flux density;

E is the electric field strength;

ϵ_0 is the permittivity in a vacuum;

ϵ' and ϵ'' are the real and imaginary components of the complex relative permittivity ϵ_r ;

$TC\epsilon$ is the temperature coefficient of relative permittivity;

ϵ_T and ϵ_{ref} are the real parts of the complex relative permittivity at temperature T and reference temperature T_{ref} ($= 20 \text{ }^\circ\text{C}$ to $25 \text{ }^\circ\text{C}$), respectively.