S parameter method

Free space method test fixture

18 GHz - 330 GHz

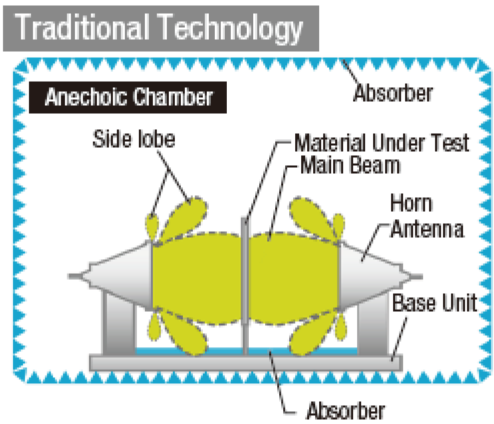
Versatile solution with high reproducibility

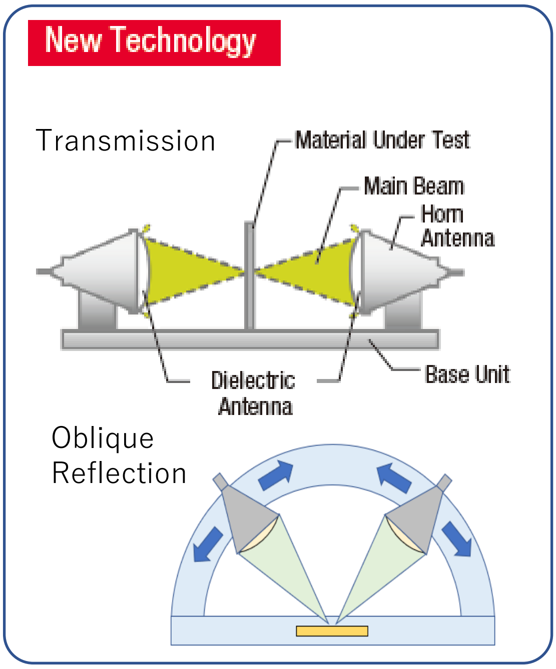
- **No need for anechoic chambers or absorbers, unlike traditional solutions**
- **Easy to move and install lightweight design**
- **1 μm precision antenna positioner that enables accurate measurement**

The free space method is indispensable to material evaluation in microwave, which can flexibly deal with a wide range of applications such as permittivity/permeability measurement and oblique incident reflection measurement. Our solution is revolutionary in that it enables accurate evaluation without anechoic chamber and radio wave absorber. We have also simplified the mechanics significantly for easy operation while maintaining measurement accuracy.
Combined with the Keysight material measurement suite N1500A, efficient and reliable material measurement can be performed.

Advantages of dielectric lens antenna

A proprietary dielectric antenna focuses the signal into the diameter of about 3 wavelengths on the material surface and suppresses the side lobe to less than -30dB. Since unnecessary reflection of electromagnetic waves hardly occurs, you can concentrate on material measurement without worrying about the surrounding electromagnetic environment. Moreover, since the signal is focused, a small sample can be used for measurements.
This high quality antenna system benefits oblique incidence reflection measurement: very small side lobe minimizes unwanted reflection, which results in highly reproducible measurements.





System Configuration Example

- Keysight PNA millimeter wave test system — N5290A (110 GHz)
- Keysight Material Measurement Suite — N1500A
- 1 mm test cables
- Free space 330 GHz — FS-330
- Windows PC

Product Line-up

Model	Description	Frequency	Beam size (3dB width)	Beam side lobe	Focus point
FS-330	Free Space 330 GHz	18-330 GHz	3 λ	-30 dB	280 mm
FS-Eband	Free Space 60-90 GHz	60-90 GHz	3 λ	-30 dB	150 mm

Key options

- FS-330-OR — Oblique incidence
- FS-330-KCF — Kband 2.4 mm (f) connection
- FS-330-RCF — Rband2.4 mm (f) connection
- FS-330-QCF — Qband2.4 mm (f) connection
- FS-330-UCF — Uband1.85 mm (f) connection
- FS-330-VCF — Vband1 mm (f) connection
- FS-330-ECF — Eband1 mm (f) connection
- FS-330-WCF — Wband1 mm (f) connection
- FS-330-KWG — KbandWR42 connection
- FS-330-RWG — RbandWR28 connection
- FS-330-QWG — QbandWR22 connection
- FS-330-UWG — UbandWR19 connection
- FS-330-VWG — VbandWR15 connection
- FS-330-EWG — EbandWR12 connection
- FS-330-WWG — WbandWR10 connection
- FS-330-DWG — WbandWR6 connection
- FS-330-GWG — WbandWR5 connection
- FS-330-JWG — WbandWR3 connection

S parameter method technology overview

It is possible to calculate the permittivity/permeability based on the S parameter of the transmission line including the material to be measured. The method is ideal for evaluating the frequency response of the material. On the other hand, the measurement accuracy is limited by the network analyzer accuracy, and it is often not suitable for low-loss material evaluation. (Resonator perturbation method is effective for evaluating low loss materials.) Combined with the Keysight material measurement suite N1500A, efficient and reliable material measurement can be performed. The N1500A supports a variety of algorithms, among which representative ones are listed below.

N1500A	model	Parameters used	Material Parameters	Summary
Reflection/ Transmission Mu and Epsilon	Nicholson-Ross-Weir (NRW)	S11, S21, S12, S22	ε_r μ_r	Developed by Nicholson and Ross, later applied by Weir to the network analyzer. Discontinuities may occur in low loss samples with thicknesses above half a wavelength. Ideal for evaluating magnetic materials such as ferrite and radio wave absorbers.
Reflection/ Transmission Epsilon Precision	NIST Precision	S11, S21, S22	ε_r	Developed by NIST to calculate the permittivity from the S parameter. Ideal for relatively thick low loss dielectric material samples.
Transmission Epsilon Fast	Fast Transmission	S21, S12	ε_r	Predict the permittivity, then minimize the difference between the predicted S parameters and the measured values into the predefined limits. It is suitable for thick low loss dielectric material especially if reflection measurement includes significant errors.