



# OPERATION MANUAL

Waveguide sample holder fixture

WSF Series

EM LABS INC.

March 28, 2021

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First Edition: March 28, 2021

# 1. Product Overview

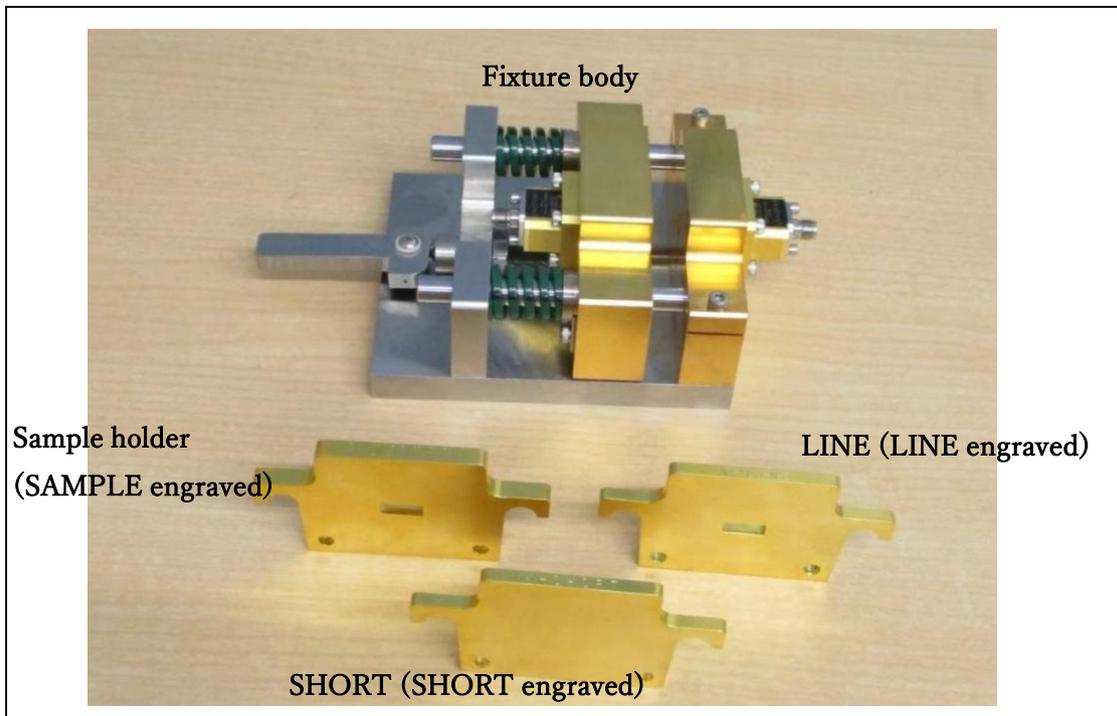
This section outlines the product.

Waveguide Sample holder Fixture (WSF series) is designed to connect to the Keysight network analyzers and measure complex relative permittivity and permeability using the S-parameter method of Keysight N1500A Material measurement suite. Four models are provided corresponding to the frequency bands. This product includes LINE and SHORT for TRL calibration.

## Product specifications

Model Number	WSF-X	WSF-P	WSF-K	WSF-R
Frequency (GHz)	8.2-12.4	12.4-18	18-26.5	26.5-40
Waveguide Standard	WR90	WR62	WR42	WR28
Holder inner dimensions (mm)	22.86 x 10.16	15.80 x 7.90	10.67 x 4.32	7.11 x 3.56
Holder length (mm)	7.5	5	3.5	2.5
Connectors	2.92 mm (f)			

## Appearance of the fixture and accessories



## Basic operation

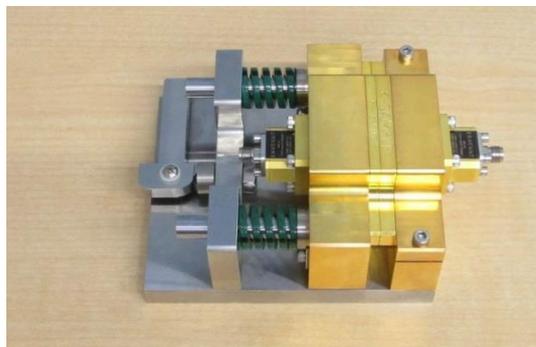
Lever position at release



Lever position when the sample holder is inserted



Lever position when SHORT / LINE and sample holder are inserted



## 2. Measurement

This section describes the basic procedure for measuring permeability and permeability using this product with Keysight N1500A material measurement suite. For details of the N1500A functions, refer to its manual.

### Sample preparation

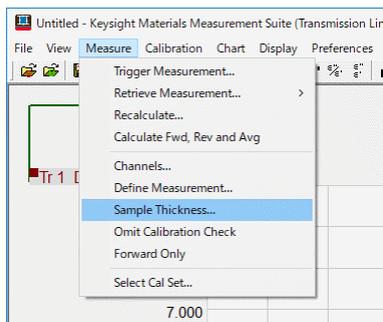
It is necessary to process the sample into a rectangular parallelepiped to fit in the sample holder. The gap between the holder and the sample causes measurement error. Since the sample thickness is required for the calculation of permeability and permeability, it is important to know the thickness accurately.

### About sample size

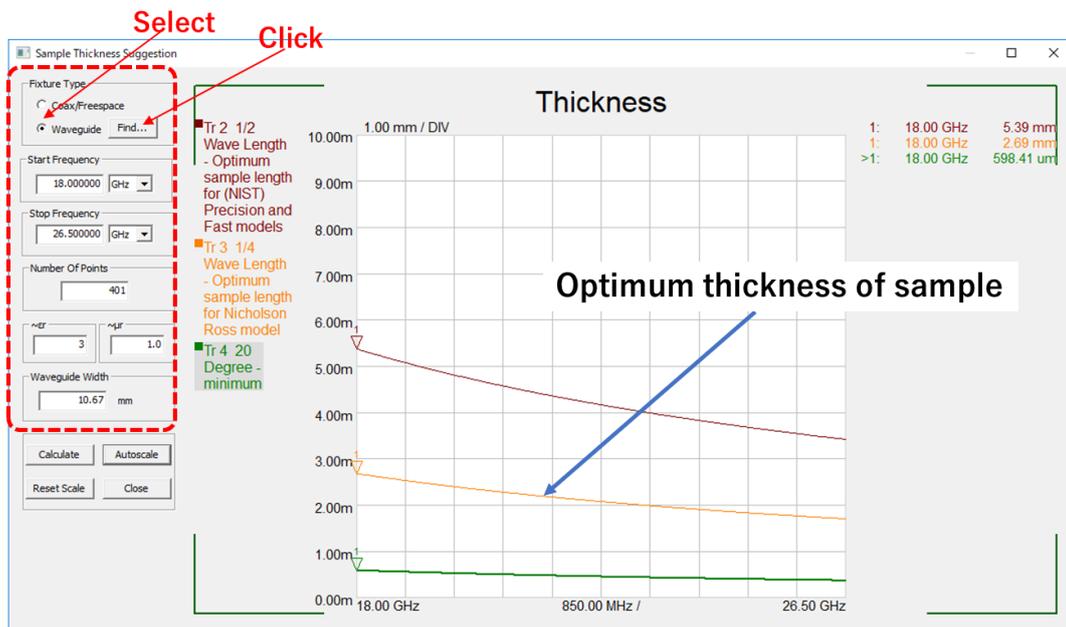
The holder inner dimensions are listed in the product specifications (the size tolerance:  $\pm 0.01$  mm). Process the sample so that there are minimum gaps between the holder and the sample. (N1500A has a function to input the size of the gap and correct the measured value, but basically you should process the sample so that minimum void is generated.)

The optimum thickness of the sample depends on the measurement frequency and the characteristic of the sample. You can use [Sample Thickness Suggestion] function of N1500A to find the appropriate value as follows.

### 1. Open the Sample Thickness Suggestion screen



### 2. Select Fixture Type:Waveguide and click [Find].



3. Select the X band.
4. Enter  $\epsilon_r$  and  $\mu_r$ .
5. Press [Calculate].

#### About size measurement

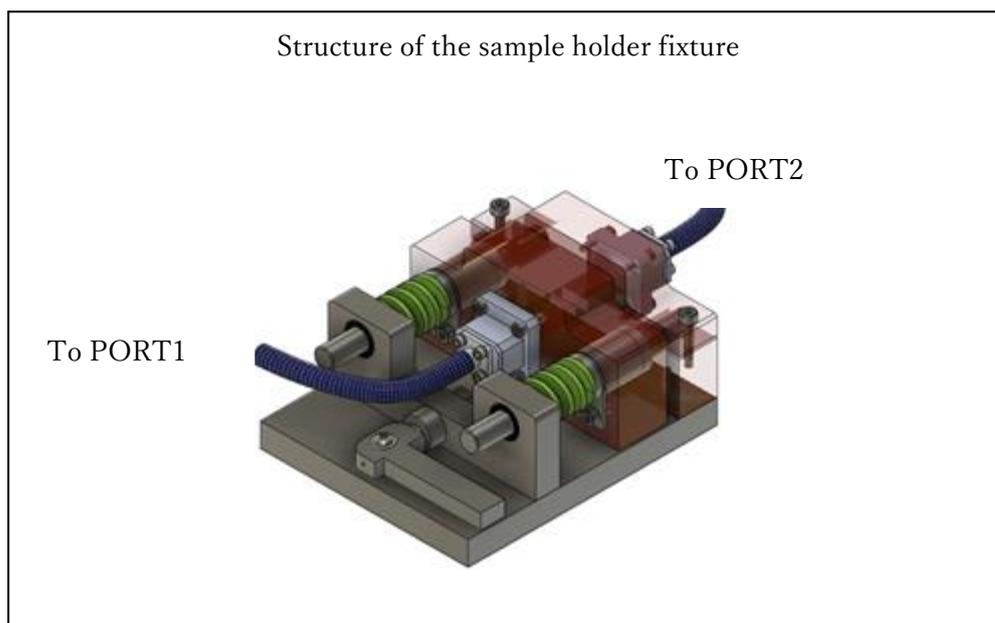
It is recommended to measure and record the sample thickness in advance of measuring permittivity and permeability. Accuracy of the thickness is necessary because the error in the value directly causes the error in permittivity and permeability measurements. Although it depends on the sample size and shape, it is generally recommended to measure about 3 points with a micrometer and use the average value.

## Measurement setup

Check the followings before starting N1500A Material Measurement Suite.

### How to connect the sample holder to the network analyzer

Connect the lever side of the fixture body to PORT1 of the network analyzer and connect the other to PORT2.



### Measurement preparation

Before you start the measurement, make sure you have the following ready:

- The network analyzer has been warmed up enough. (Follow the recommended warm-up time of the network analyzer.)
- The sizes of the samples have been measured and recorded.

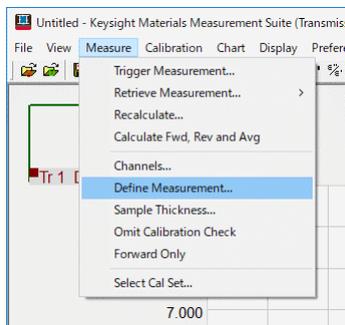
## N1500A measurement procedure

The flow of permittivity and permeability measurement is as follows.

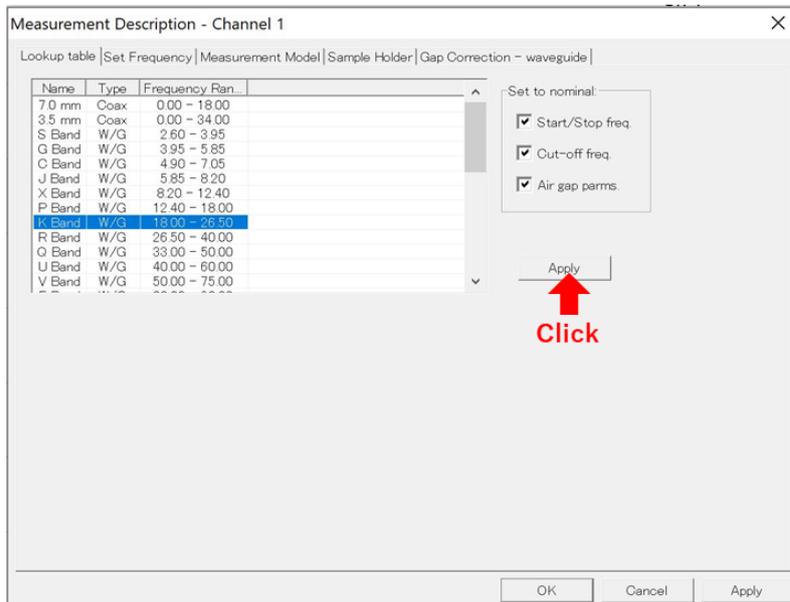
1. Setting measurement conditions
  2. 2-port calibration
  3. S-parameter measurement
  4. Conversion to permittivity/permeability
- More details of each step are described below.

### Setting measurement conditions

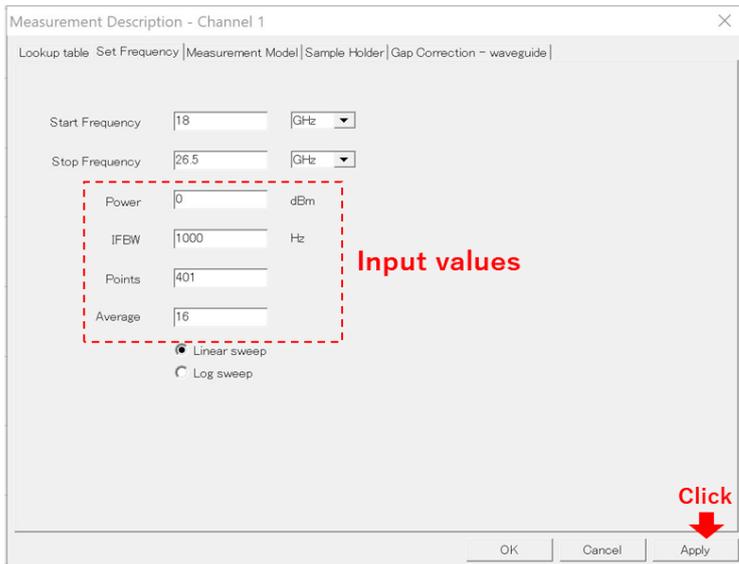
1. Open [Define Measurement] screen.



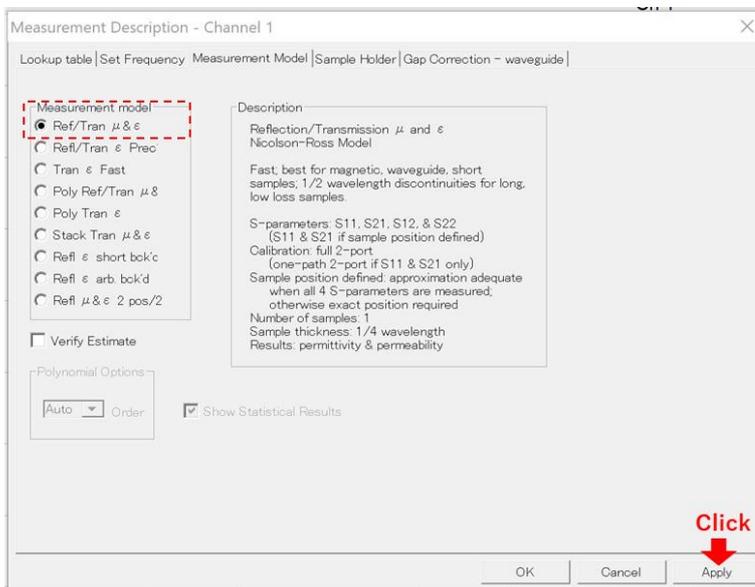
2. On | Lookup table | tab, select the band for the fixture you use and click [Apply] (the figure is an example of K-band). Thus, the measurement frequency is set.



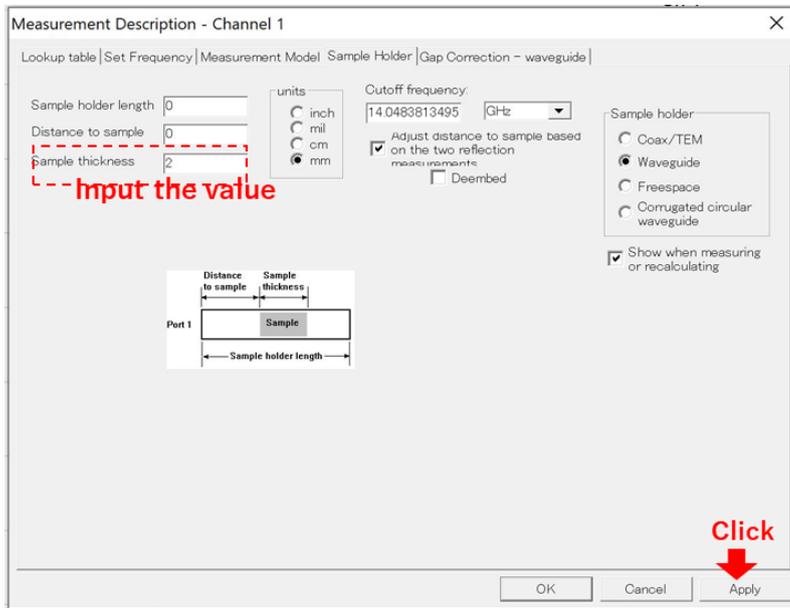
3. On | Set Frequency | tab, set other measurement conditions (output power, IF bandwidth, number of measurement points, number of averages).



4. On | Measurement Model | tab, select [Ref / Tran  $\mu$  &  $\epsilon$ ] for Permittivity / Permeability Measurement.



5. Enter the sample thickness on | Sample Holder | tab. (The cutoff frequency and holder type have been automatically entered in step 2)  
(It is recommended to check “Adjust distance to sample based on the two reflection measurements”).)

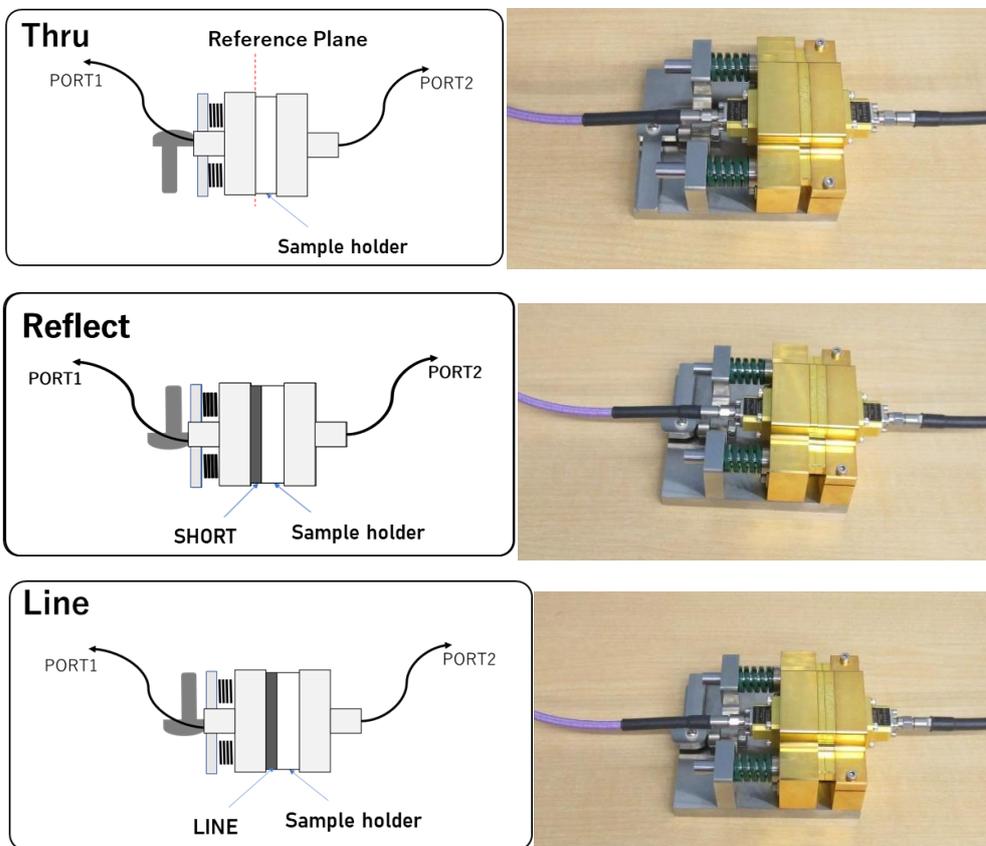


## 2-port calibration

Perform TRL calibration using SHORT and LINE. The fixture setting for Thru/Reflect/ Line measurement is shown in the figure below. For the operation of calibration, refer to the manual of the analyzer.

### NOTE

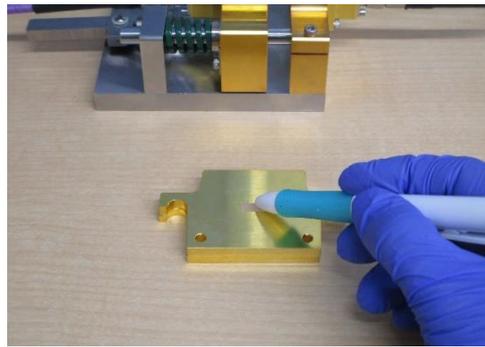
The system calibration is required when the analyzer settings of the frequency, output power, IF bandwidth, or number of measurement points have been changed.



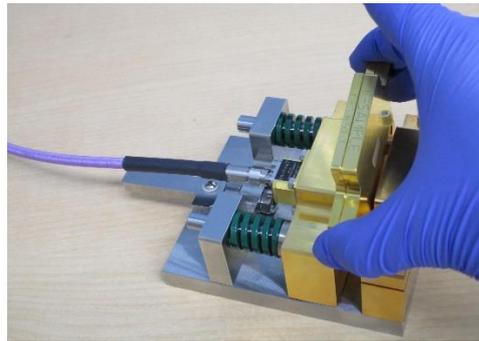
## S-parameter measurement and conversion to permittivity / permeability

Measure the S-parameters with the sample inserted in the sample holder. Make sure that the sample is closely fitted to the reference plane. (We provide a method how to set the sample below.)

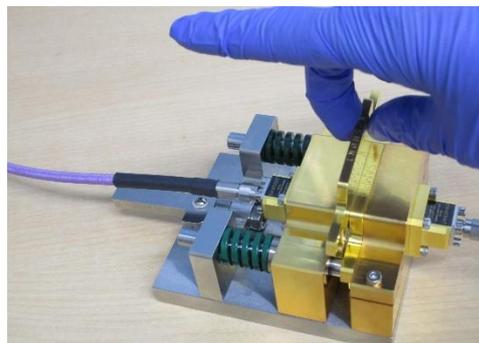
Place the sample holder on SHORT and push the sample in the holder firmly.



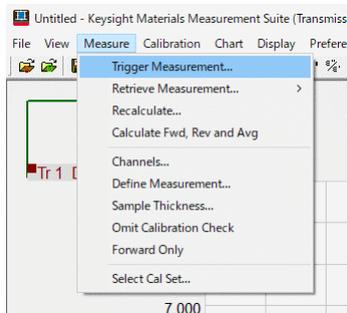
Insert the sample holder and SHORT into the fixture body while stacking.



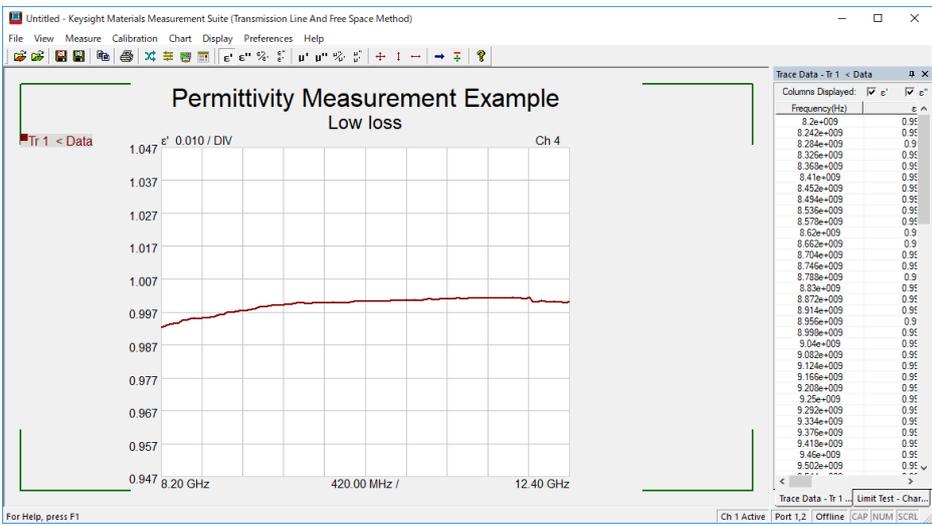
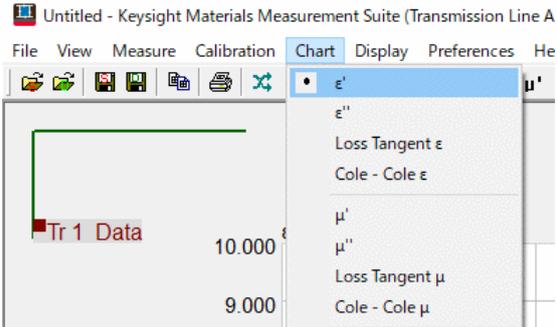
Gently withdraw only SHORT.



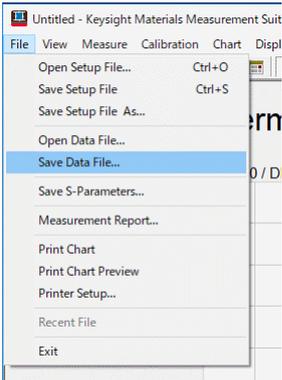
After inserting the sample holder with the sample into the fixture body, close it with the lever. Trigger from N1500A (click [Trigger Measurement]) to perform S-parameter measurement.



When measurement is completed, click [Chart] and then click the required parameter to display. The figure shows an example of displaying the permittivity  $\epsilon'$ .



The measurement result can be saved with the [Save ..] function.



#### NOTE

When measuring multiple samples in succession with the same fixture, repeat:

- Setting the sample thickness (see "Setting the sample thickness" on page 10.)
- Measurement (see "S-parameter measurement and conversion to permittivity / permeability" on page 11.)

### 3. Maintenance and Repairs

This section explains daily maintenance and troubleshooting.

#### Daily cleaning

Dirt on the fixture may affect the measurement. Clean the non-woven fabric with a small amount of alcohol. It is recommended to clean at the end of measurement. At that time, visually check that there is no scratch on the surface where the sample is mounted. If you find any visible scratch, we recommend repair.

#### Repair

For repair, contact us directly from our website.

<https://www.emlabs.jp>