EM labs

OPERATION MANUAL

CR Series split cylinder resonator

EM LABS INC.

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Table of Contents

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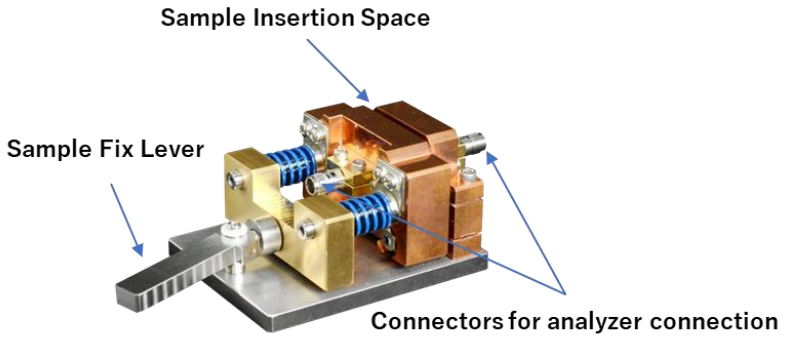
1. Product Overview

This section outlines the product.

CR series split cylinders are designed to be used with a network analyzer and measure complex relative permittivity of dielectric materials. In order to accurately measure low permittivity and low loss materials, the loss of the resonator is designed and manufactured extremely small. In addition, since the sample can be easily inserted/removed, you can efficiently measure samples. Measurement can proceed according to the instructions of the permittivity measurement software.

Appearance and structure of the resonator

As shown in the figure below, the part where the resonator is split into two is the sample insertion space. There are two coaxial connectors on the side for connecting the network analyzer. By inserting the measurement sample, then tilting the fixing lever, the sample is firmly fixed, which enables reproducible measurement.



Product specifications

Model number	Resonance characteristic			Connector type
	Frequency (GHz)	Un-loaded Q	Mode	
CR-710	10	20,000	TE011	2.92 mm(f)
CR-720	20	14,000		
CR-724	24	14,000		
CR-728	28	14,000		
CR-735	35	10,000		
CR-740	40	10,000		
CR-750	50	7,000		2.4 mm(f)
CR-760	60	6,000		1.85 mm(f)
CR-780	80	6,000		1 mm(f)

Operating temperature: 0 to 40℃ (non-condensing)

Accessories

There is no accessory. Proper coaxial cables are required for analyzer connection according to the network analyzer to be used.

2. Measurement

This section provides measurement tips.

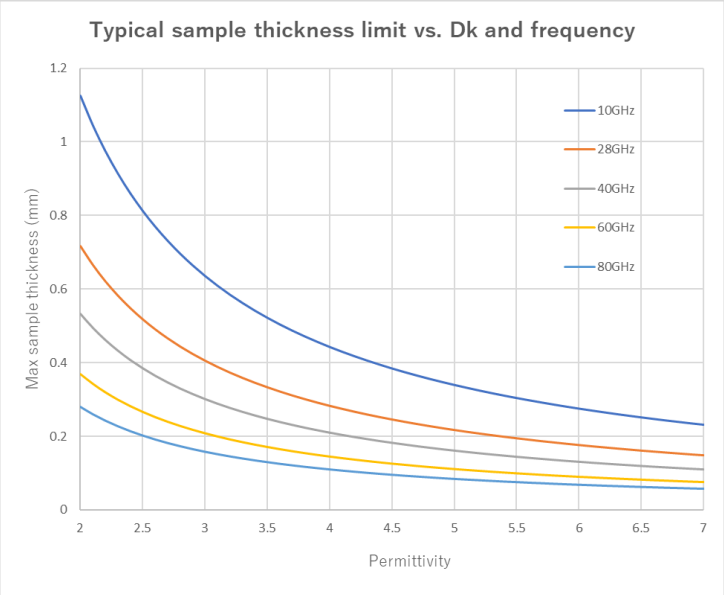
Sample preparation

It is necessary to prepare the measurement sample into a plate shape according to the fixture to use. Since the thickness of the sample is used to calculate permittivity, it is important to accurately measure the thickness. Also, in order to accurately measure the thickness, it is ideal that the sample is flat and uniform. It is the first step of accurate measurement to properly prepare the sample.

About sample size

The optimum thickness of the sample depends on the dielectric properties of the sample and the resonator to be used, but 100 μm is a good starting point. In addition, it is necessary to cut the materials properly so that it fits well in the fixture. The higher the frequency and the higher the permittivity, the thinner the sample needs to be. For example, a lower permittivity (2.5) material with 100 μm thickness is appropriate up to 80 GHz.

The following chart shows typical maximum measurable thickness vs. permittivity and frequency. Please note that the sample may need to be significantly thinner if the material has relatively high loss ($\tan\delta > 0.01$). It is recommended to prepare a sample as thin as possible if the measurement software cannot find resonance, and thus cannot measure.



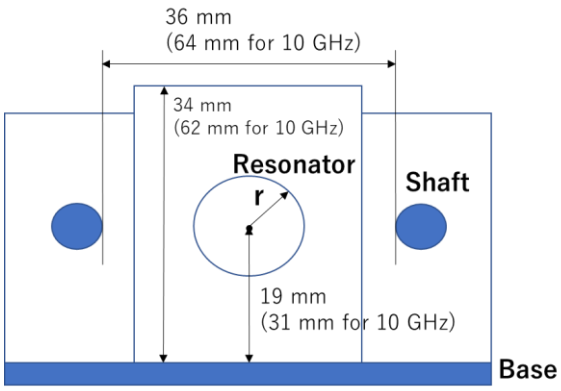
It is also necessary to cut the materials properly so that it fits well in the fixture. The following table provides the proper sample size for the resonators.

Resonator	Short side (mm)	Long side (mm)
10 GHz	58 – 63	70 - 80
20 - 80 GHz	30 – 35	40 – 50

About thickness measurement

When actually measuring permittivity, you need to input sample thickness according to the measurement software instruction. It is recommended to measure the sample thickness in advance. Since the error of the input value causes the error of the permittivity measurement, accurate measurement is necessary.

It is generally recommended to measure three or more points with a micrometer, and use the average value. In that case, it is important to measure the thickness of the part used for permittivity measurement. The figure and table below show the position of the part to be measured.



Model	Radius r (mm)
CR-710	20
CR-720	10
CR-724	8
CR-728	7.5
CR-735	6
CR-740	5
CR-750	4
CR-760	3.5
CR-780	2.5

Measurement procedure

Start the permittivity measurement software and follow the instructions on the screen to perform the measurement. Please refer to the software manual for detailed procedure. This section focuses on key points to know on the hardware operation for proper measurement.

Before starting measurement

Before starting the permittivity measurement software and starting the actual measurement, please make sure that the following preparation has been completed.

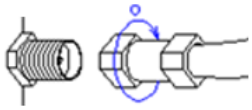
- The temperature of the resonator is stable. It is recommended to start measurement at least 30 minutes after setting the fixture in the actual measurement environment.
- The network analyzer has been warmed up. (Follow the recommended warm-up time of the network analyzer)
- The size of the samples has been measured and recorded.
- A torque wrench and spanner for connector connection must be prepared. Tweezers and gloves for handling samples are prepared, if necessary.

Instrument connection

Connect the split-cylinder resonator to the network analyzer to measure permittivity. Since the connector type varies depending on the frequency band, please use the appropriate cable respectively. The type of connector is described in the product specifications.

NOTE

It is important to use a torque wrench to apply proper torque when tightening the connector. Excessive torque can damage the connector. Torque shortage causes measurement errors and rotation of the center conductor, which can damage the connector. Also, be careful to rotate only the nut of the male connector. Rotating the center conductor leads to wear and damage of the connector.



For accurate measurement

The split cylinder resonator is designed and manufactured to measure permittivity with high accuracy. There are some key points in order to make full use of its performance.

About particles on sample surface

If particles adhere to the surface of the sample, the space between the resonators when the sample is sandwiched is widened accordingly. Since the distance between the resonators affects the resonance frequency, it causes an error in permittivity measurement.

This effect is particularly significant in thin film measurement. Wipe the surface with a nonwoven fabric before measuring the sample. If there is a possibility that particles attached to the sample may be transferred to the sample insertion space of the resonator, gently sandwich the nonwoven fabric with a small amount of alcohol and then pull it up for cleaning.

About cables

Minimize the cable movement during measurement. Also, minimize the movement of the resonator.

3. Maintenance and Repairs

This section explains daily maintenance and simple troubleshooting.

Health check with stable samples

It is recommended to periodically measure samples with stable characteristics and check the condition of the measurement system.

Daily cleaning

The split cylinder is basically maintenance free. If the surface of the sample insertion space becomes contaminated due to transfer from the sample etc., gently sandwich the nonwoven fabric with a small amount of alcohol then pull it up for cleaning.

> **NOTE**
>
> Do not disassemble the fixture for cleaning as it may cause malfunction. Especially, do not touch the inside of the resonator. Performance may deteriorate greatly.

Simple troubleshooting

This section explains what to do when an error occurs in the measured value. Please make sure that the cable is securely connected. Clean the surface of the sample insertion space according to Daily cleaning. If the problem remains, then the fixture needs to be repaired.

Repair

If repair is necessary, contact us directly from our website.

https://www.emlabs.jp