

OPERATION MANUAL

FP-MA permittivity measurement software

EM LABS INC.

March 11, 2024

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First edition: November 4, 2022 2nd edition: June 2, 2023 3rd edition: July 24, 2023 4th edition: March 11, 2024

1. Product Overview

FP-MA Permittivity Measurement Software is designed to efficiently perform complex relative permittivity measurement using FP series Fabry-Perot resonators. It controls a Keysight Technologies network analyzer to automatically acquire the necessary parameters and output the complex permittivity.

2. System Requirement

This section describes the operating environment required to use the software. OS

- Windows OS (Windows 10 /11)
- Keysight IO Libraries

Usable analyzers

Keysight PNA Series Network Analyzers

NOTE

PNA series with firmware A07.50.48 and later is supported.

3. Install and Uninstall

This section provides detailed instructions on how to install and uninstall this software.

How to Install

- 1. Please have the following items ready at hand.
 - FPMASetup.msi software installer
 - 16-digit product key provided at the purchase

2. Run FPMASetup.msi on a Windows PC and follow the on-screen instructions to proceed with the installation.

📮 EM labs FPMA Permittivit	/ Measurement Software Setup - 🗆 🗙
\odot	Welcome to the EM labs FPMA Permittivity Measurement Software Setup Wizard
	The Setup Witard will install EM labs FPMA Permittivity Measurement Software on your computer. Click Next to continue or Cancel to exit the Setup Wizard.
	Back Next Cancel

How to uninstall

Run FPMASetup.msi on your Windows PC and follow the on-screen instructions to proceed with the uninstallation.

EM labs FPMA Permittivity N	Measurement Software Setup	-		×
S	Welcome to the EM lab Measurement Software			vity
	The Setup Wizard will install EM la Measurement Software on your cor or Cancel to exit the Setup Wizard.	mputer. Click N		ntinue
	Back	Next	Cane	cel

NOTE

You can also uninstall the permittivity measurement software using the standard "Uninstall app" feature of Windows. In that case, follow the Windows instruction.

4. Preparation for measurement

Instruments connection and sample preparation

Before starting this software, prepare the hardware referring to FP series OPERATION MANUAL.

Start the Software

Start [EM Lab FPMA Permittivity Measurement Software] from Windows.

EM labs FPMA Permittivity Meas...

The start screen is followed by Select Resonator box.

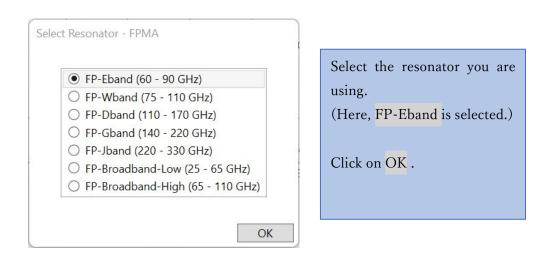
File Help Setup Samples Sample Name Thickness	Export Data	Empty Measurement	Position Adjustment V	Sample Measurement
	¹ ω 0.0	Select Resonator - FPMA FP-Eband (60 - 90 GHz) FP-Wband (75 - 110 GHz) FP-Dband (110 - 170 GHz) FP-Gband (140 - 220 GHz) FP-Jband (220 - 330 GHz) FP-Broadband-Low (25 - 65 GHz)	1 1 GHz] 1 1 GHz] Empty Q Sample Frequ	1 1 1 1 1 1 1 1 1 1 1 1
		C FP-Broadband-High (65 - 110 GHz)	Empty measurement t	

NOTE

If the window below opens, the network analyzer is not properly connected to the PC. Check the connection and click Scan.

File Help Setup Samples	Export Data	Empty Measurem	ent Position Adjustme	nt 💌 Si	ample Measurem	ent
Sample Name Thickness	1.0 ~					
(Select Instrument - FPMA		- 0	×		
	Address Model Numb Revision	Serial Numbe		Scan	1	
			Selected Interface GPIB LAN (TCPIP) USB Specified Resource Ex 2*INSTR Open	pression 2	1 y Sample Q	
	1	~	OK Exit Ap	plication		

Select the Resonator



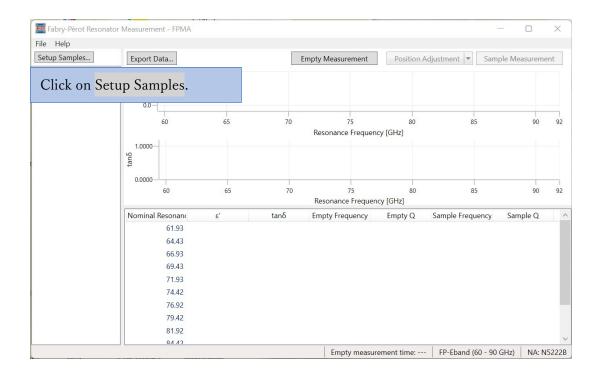
NOTE

To change the resonator selection after clicking OK in Select Resonator box, quit and re-start the software.

NOTE

For the broadband model, the user must operate the band selector to switch between Low and High. for details, see Chapter 7 Reference .

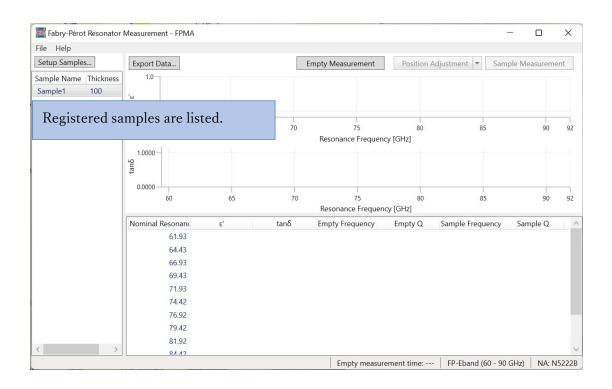
Setup Samples



Samples Setup - FPMA		
	Add	Click <mark>Add</mark> .
Sample Name	Thickness [um]	1
		\mathbf{A}
		×
Import Export		

Samples Setup - FPMA				×
			Add	
Sample Name	Thic	kness [um]	Ť
New Sample	0			Ť
New Sample 0 appears.				
Import Export				

🐹 Samples Setup - FPMA	- 0	×	
	Add		
Sample Name	Thickness [um]	Ť	Enter any value* for:
Sample1	100	\mathbf{v}	Name: (e.g. Sample1)
		×	Thickness: (e.g. 100)
			Click <mark>OK.</mark>
Import Export			*Unit of thickness is μ m.
	OK Cance		



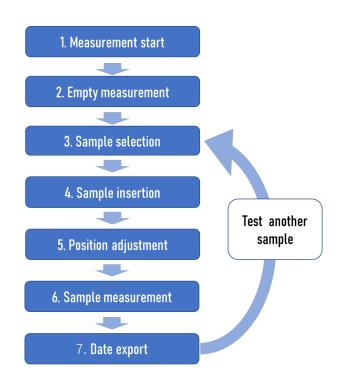
NOTE

Multiple samples can be registered. In addition, you can [Import] or [Export] the sample information. For details, please refer to Chapter 7.

5. Measurement Procedure

We will focus on basic measurement procedures here. Refer to Chapter 7 for more details on each function.

Overall flow

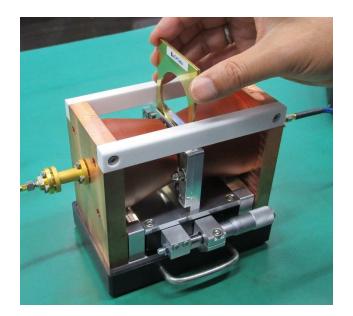


The measurement proceeds as shown in the figure above, according to the display. The following is an explanation of each step based on the screen display.

1. Measurement start

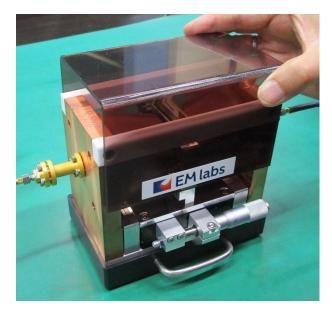
Completing the preparations described in the previous chapter, proceed the measurement steps.

2. Empty measurement

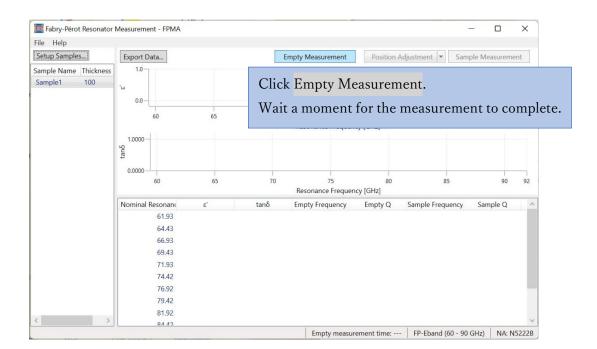


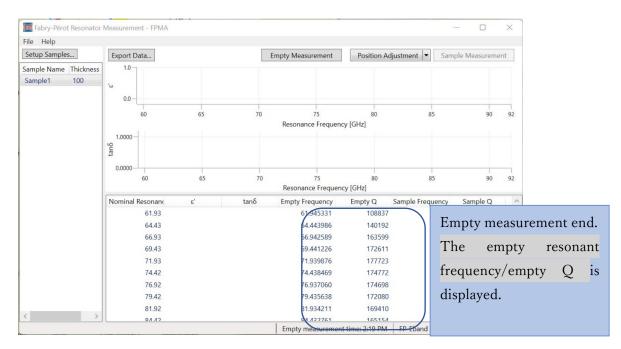
Perform 'Empty' (without a sample) measurement.

Insert the sample plates to the sample holder. Make sure **EM labs** mark on each sample plate comes outside.



Set the cover.





NOTE

When using FP-Broadband, the message 'Please push in the band selector' or 'Please pull out the band selector' will be displayed as required. Follow the message and operate the band selector on the resonator. For more information, refer to 7. Reference FP-Broadband: Operating the band selector.

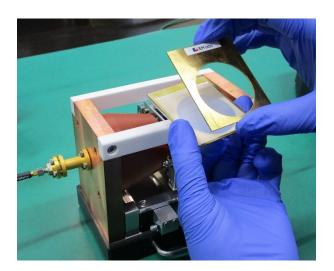
3. Sample selection

Eile <u>H</u> elp								
Setup Samples	Export Data			Empty Measurement	Position A	djustment 💌 Sa	mple Measurer	nent
ample Name Thickness Sample1 100	-ω							
	sample you n				80	85	90	92
(Sample1 10) <mark>0</mark> is selected l	here)						
	0.0000	65	70	75 Resonance Frequen	80 cy [GHz]	85	90	92
		65 ε'	70 tanδ	75 Resonance Frequen Empty Frequency		85 Sample Frequency		92
	60			Resonance Frequen	cy [GHz]	Sample Frequency		92
	60 Nominal Resonanc			Resonance Frequen Empty Frequency	cy [GHz] Empty Q	Sample Frequency		92
	60 Nominal Resonanc 61.93			Resonance Frequen Empty Frequency 61.945331	cy [GHz] Empty Q 108837	Sample Frequency		92
	60 Nominal Resonanc 61.93 64.43			Resonance Frequen Empty Frequency 61.945331 64.443986	cy [GHz] Empty Q 108837 140192	Sample Frequency		92
	60 Nominal Resonanc 61.93 64.43 66.93			Resonance Frequen Empty Frequency 61.945331 64.443986 66.942589	cy [GHz] Empty Q 108837 140192 163599	Sample Frequency		92
	60 Nominal Resonanc 61.93 64.43 66.93 69.43			Resonance Frequen Empty Frequency 61.945331 64.443986 66.942589 69.441226	cy [GHz] Empty Q 108837 140192 163599 172611	Sample Frequency		92
	60 Nominal Resonanc 61.93 64.43 66.93 69.43 71.93			Resonance Frequen Empty Frequency 61.945331 64.443986 66.942589 69.441226 71.939876	cy [GHz] Empty Q 108837 140192 163599 172611 177723	Sample Frequency		92
	60 Nominal Resonanc 61.93 64.43 66.93 69.43 71.93 74.42			Resonance Frequency 61.945331 64.443986 66.942589 69.441226 71.939876 74.438469	cy [GHz] Empty Q 108837 140192 163599 172611 177723 174772	Sample Frequency		92
	60 Nominal Resonanc 61.93 64.43 66.93 69.43 71.93 74.42 76.92			Resonance Frequency 61.945331 64.443986 66.942589 69.441226 71.939876 74.438469 76.937060	cy [GHz] Empty Q 108837 140192 163599 172611 177723 174772 174698	Sample Frequency		92

NOTE

You can register additional samples using Setup Samples. (Refer to the previous chapter.)

4. sample insertion

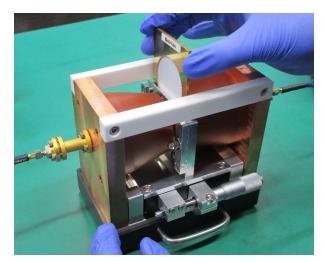


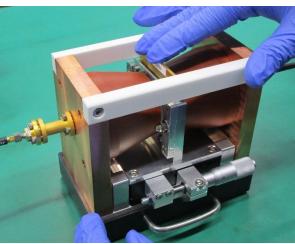
Place the sample between the sample plates. At this time, observe the following precautions.

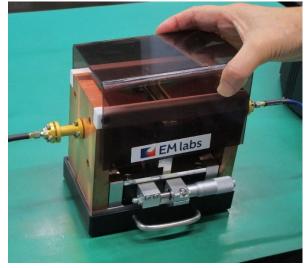
Align the sample plates so that
 EMlabs marks come on the outside.

2. The sample should completely cover the holes of the sample plates.

3. The sample should not protrude from the sample plate.





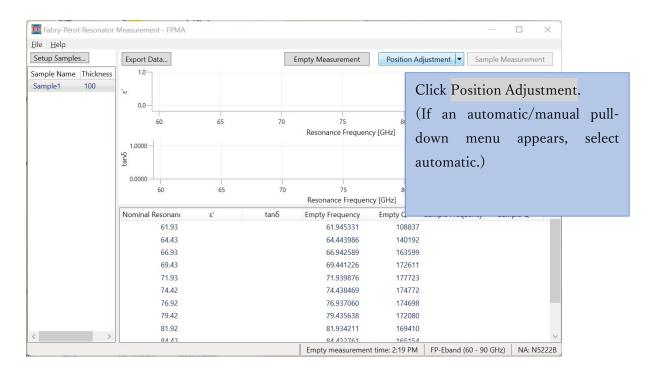


Insert the sample plates into the sample holder.

Push the sample plates firmly into the bottom of the sample holder.

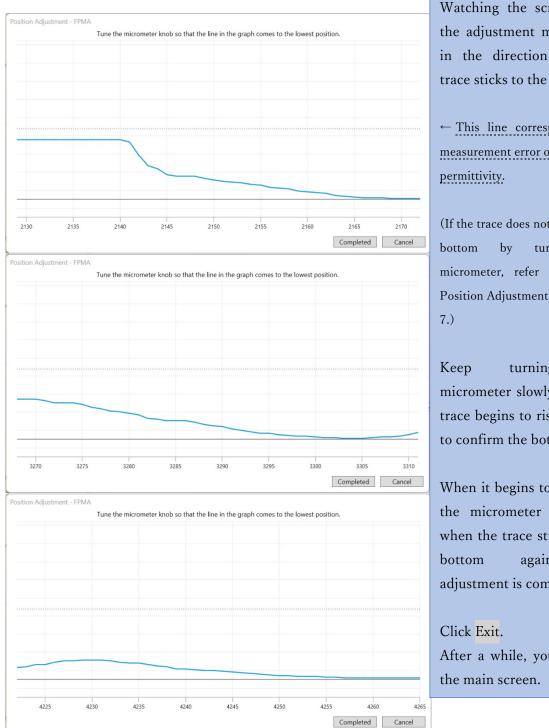
Set the cover.

5. Position adjustment



"Tune the micrometer knob so that the line in the graph comes to the lowest position." is displayed, then operate the adjustment micrometer as follows.

(If resonance is not detected, refer to "Sample Positioning" in Chapter 7 Reference.)



Watching the screen, turn the adjustment micrometer in the direction that the trace sticks to the bottom.

← This line corresponds to a measurement error of 1% for the

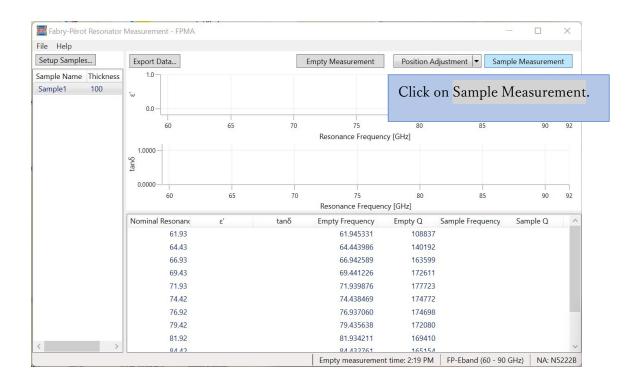
(If the trace does not stick to the turning the micrometer, refer to "Sample Position Adjustment" in Chapter

the turning micrometer slowly until the trace begins to rise in order to confirm the bottom.

When it begins to rise, turn the micrometer back and when the trace sticks to the again, the adjustment is complete.

After a while, you come to

6. Sample measurement



NOTE

When using FP-Broadband, the message 'Please push in the band selector' or 'Please pull out the band selector' will be displayed as required. Follow the message and operate the band selector on the resonator. For more information, refer to 7. Reference FP-Broadband: Operating the band selector.

File Help							
Setup Samples	Export Data		Empt	y Measurement	Position Ad	ljustment 🔻 Sample	e Measurement
Sample Name Thickness	2.3						
Sample1 100					8 2 8		
	2.0						
		1					
	60	65	70	75	80	85	90 9
	1.1		R	esonance Frequen	icy [GHz]		
	0.0004				10	0 00 0	
	tanδ	• •	• •	•		• • •	•
	0.0000						
	60	65	70	75	80	85	90 9
			F	esonance Frequer	ncy [GHz]		
	Nominal Resonance	ε'	tanδ Er	mpty Frequency	Empty Q	Sample Frequency	Sample Q
	61.93	2.06045	0.000221	61.945331	108837	61.891185	100655
	64.43	2.05910	0.000227	64.443986	140192	64.387718	126582
	66.93	2.05884	0.000229	66.942589	163599	66.884200	145240
	69.43	2.05881	0.000230	69.441226	172611	69.380676	152295
	71.93	2.05877	0.000229	71.939876	177723	71.877139	156285
	74.42	2.05837	0.000234	74.438469	174772	74.373611	153662
	76.92	2.05802	0.000247	76.937060	174698	76.870082	152626
	79.42	2.05783	0.000252	79.435638	172080	79.366537	150265
	81.92	2.05745	0.000252	81.934211	169410	81.862992	148228
>	R1 12	2.05700	0.000252	QA 132761	165154	84 350443	1//008

When all the measurement results are displayed, the measurement is complete.

7. Data export

Setup Samp	ples	Export Data		En	npty Measurement	Position Ad	ljustment ▼ Sam	ple Measuremen	nt
ample Nam	ne Thicknoor	2.3							
Sample1	Click	Export Da	<mark>ta</mark> to	export t	he • •	•	• • •	•	
	measu forma	urement resu	ılts (in	Excel bo	ok 75 ance Frequen	80 cy [GHz]	85	90	9
	1011118	tty.	• •	•		•	• • •	•	
		0.0000	65	70	75	80	85	90	9
					Resonance Frequen	cy [GHz]			
		Nominal Resonance	٤	tanδ	Empty Frequency	Empty Q	Sample Frequency	Sample Q	
		61.93	2.06045	0.000221	61.945331	108837	61.891185	100655	
		64.43	2.05910	0.000227	64.443986	140192	64.387718	126582	
		66.93	2.05884	0.000229	66.942589	163599	66.884200	145240	
		69.43	2.05881	0.000230	69.441226	172611	69.380676	152295	
		71.93	2.05877	0.000229	71.939876	177723	71.877139	156285	
		74.42	2.05837	0.000234	74.438469	174772	74.373611	153662	
		76.92	2.05802	0.000247	76.937060	174698	76.870082	152626	
		79.42	2.05783	0.000252	79.435638	172080	79.366537	150265	
		81.92	2.05745	0.000252	81.934211	169410	81.862992	148228	
	>	QA A2	2 05708	0.000252	QA A22761	16515/	QA 250AA2	1//000	
					Empty measuremen	t time: 2:19 PM	FP-Eband (60 - 90	GHz) NA: N5	22

Save Measurement F	Result			×	
$\leftarrow \rightarrow ~ \cdot ~ \uparrow$	This PC	~ C	✓ Search This PC	2	
Organize 🔻				8: • ?	
🗸 📮 This PC		Y Folders (6)			
> 🔚 Desktop		Desktop			
> 📑 Documents		Documents	5		
 > Downloads > Music > Pictures 	Enter a file nar and click <mark>Open</mark>	ne (default is Sa	mpleName_S	ampleThick	ness_Date)
> 🚺 Videos					
File name: Save as type: E	ample1 100 2209261445 xcel Book			~ ~	
∧ Hide Folders			Open	Cancel	

6. If you think something is wrong...

When problems such as installation failure and software freeze occur, please contact us directly from our website for support..

https://www.emlabs.jp

For effective support, please provide the following information:

- This software version
- PC OS version
- Keysight IO Libraries version
- Network Analyzer model number and its firmware version

7. Reference

Supplementary explanation of each function

We provide further explanations of the functions shown in the figure below.

	Setup	Sar	nples					Position	Adjustr	nen
Fabry-Péro	tResonator	Measureme	ent - FPMA						_	×
Setup Sample	es	Export D)ata			Empty Measurement	Position Ac	justment 👻 Sam	ple Measurem	ent
Sample Name		1.0				Linpty measurement		Justinent]		
Sample Name	100									
Sample2	20	ω								
test	35	0.0 —								
re-test	30		60	65	70	75	80	85	90	92
re-test	30					Resonance Frequence				
		- 0000.1 tayo - 0000.0	60	65	70	75 Resonance Frequenc	80 cy [GHz]	85	90	92
		Nominal	Resonand	ε'	tanδ	Empty Frequency	Empty Q	Sample Frequency	Sample Q	^
			61.93			61.945313	109072			
			64.43			64.443983	140335			
			66.93			66.942628	163650			
			69.43			69.441289	172588			
			71.93			71.939851	177612			
			74.42			74.438466	174762			
			76.92			76.937070	174536			
		79.42			79.435649	171956				
			81.92			81.934226	169435			
<	>		QA AD			QA A22775	165152			~
						Empty measuremen	t time: 2:56 PM	FP-Eband (60 - 90	GHz) NA: N	15222B

Sample Setup

Sample Name	Thickness [um]	1
Sample1	100	J
Sample2	20	
test	35	×
re-test	30	

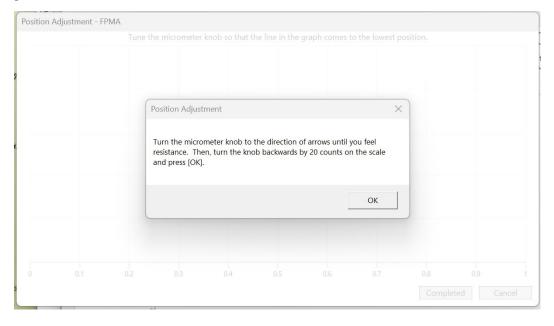
Click Export to export the sample information in Excel book format. Click Import to import a previously prepared sample information file in Excel book format. The sample information file will be created in the following format.

	A	B	<u> </u>		D	
1	Sample Name	Thickness	[um]	•	— Ent	er any string
2	Sample1	100				
3	Sample2	20				
4	test	35	-			
5	re-test	30			T	hickness unit is μ m
6						

Position Adjustment

Click on Position Adjustment and the network analyzer will detect the resonance peak. If the position adjustment fails, please refer to the following items.

1. if no peak is detected, or if the following message appears, the sample holder may be positioned too far from the center.



As instructed, turn the micrometer knob in the arrow direction until you feel it tight (the sample holder has moved to the left limiter), and back off for 20 counts.

Click OK to re-search for peaks.



NOTE

The sample holder is moved left or right by turning the micrometer. To prevent excessive movement, there are limiters on the left and right sides of the sample holder. If the sample holder hits the left limiter, the micrometer cannot be turned any further. Do not turn it by force, or it may be damaged. If the sample holder hit the right limiter, you can continue to turn the micrometer, but the sample holder will not move any further. 2. If the sample holder hits the right or left limiter before the trace in the screen reaches the bottom and cannot be adjusted any further, the following causes may be considered.

- The sample is warped or undulated.
- The sample is not firmly seated between the sample plates.
- The sample plates are not firmly seated in the sample holder.

Place the sample between the sample plates so that the warp or waviness of the sample is as small as possible, and then place the sample plate firmly in the sample holder. Swapping the left and right sides of the sample plates may work. If this does not work, the sample may need to be processed flatter.

FP-Broadband: Operating the band selector

Pull the handle on the top of the band selector on the back of the resonator to operate it. Below, on the left is the pulled-out state, and on the right is the pushed-in state.



FP-Broadband : Switching Low/High

Set the band selector on the back of the FP-BB resonator properly: on Low, pull the band selector out completely by holding the top handle; on High, push it in completely.



In the case of High band, Φ 45 mm sample plates with a small aperture can be used. This is useful when measuring warped samples or samples smaller than Φ 65 mm.

NOTE

When measuring in Low band, always use $\Phi 65$ mm sample plates; using $\Phi 45$ mm sample plates in Low band will result in a large measurement error.