Agilent E4980A Precision LCR Meter

Dielectric Constant Measurement Program Operation Manual

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Sample Program

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1. General information

Overview of the program

The E4980A Dielectric Constant Measurement Program assists dielectric constants measurement using the Agilent E4980A Precision LCR Meter and the 16451B Dielectric Test Fixture. This program (a VBA macro for Microsoft Excel®) provides step-by-step instruction for the measurement. It calculates dielectric constants from capacitance and dissipation factor measured by the E4980A and the 16451B. Following parameters can be calculated and listed on the spreadsheet of Microsoft Excel®.

Program Description

Program title	Dielectric Constant Measurement Program
File Name	E4980A_Permittivity_0102.xls
Revision	Rev.01.02

Supported models and firmware

Models	**Firmware**
E4980A Precision LCR Meter	Rev.1.00 or later

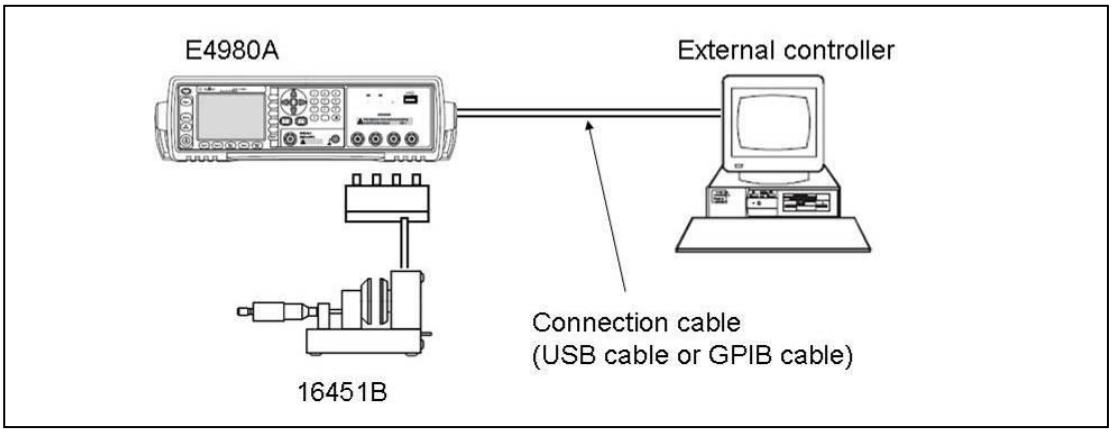
Required equipments

- 16451B Dielectric Test Fixture
- External controller (external computer such as PC)
  * Agilent I/O Libraries Suite 14 or higher needs to be installed.
- Connection cable (USB cable furnished with the E4980A or GPIB cable)

2. Boot/Exit the program

2.1. Connecting the instruments and controller

Connect the E4980A, 16451B, and the controller as shown below.



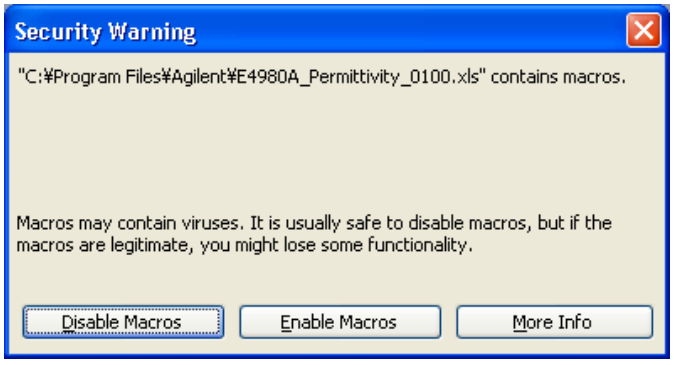
Note: The Agilent I/O Libraries Suite needs to be installed in the external controller in advance. Use Agilent I/O Libraries Suite 14 or higher.

For further information on I/O Libraries Suite, see the Agilent I/O Libraries Suite manual.

Agilent I/O Libraries Suite may not be available for certain external controllers or OS versions. For further details, refer to the help guidance for Agilent I/O Libraries Suite.

2.2. Boot the program

Open E4980A_Permittivity_xxxx.xls file. Since this file contains macros, a message box shown below appears when opening the file. Click “Enable Macros” to boot the program.



2.3. Exit the program

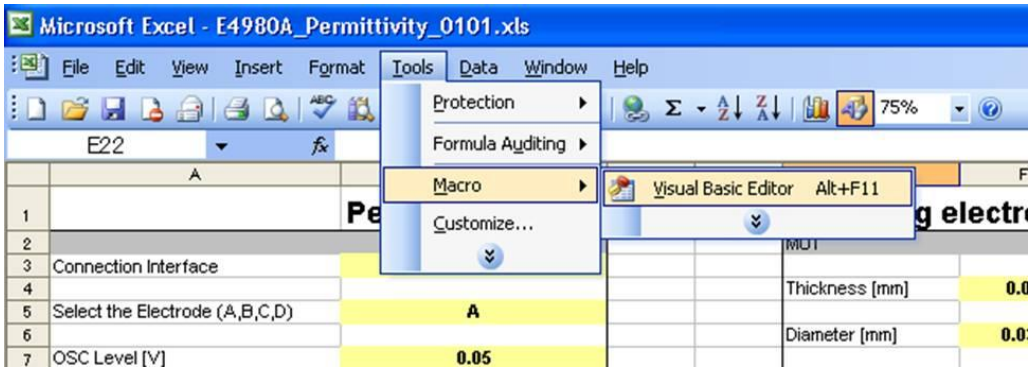
Close E4980A_Permittivity_xxxx.xls file.

3. Setting the GPIB address or USB ID

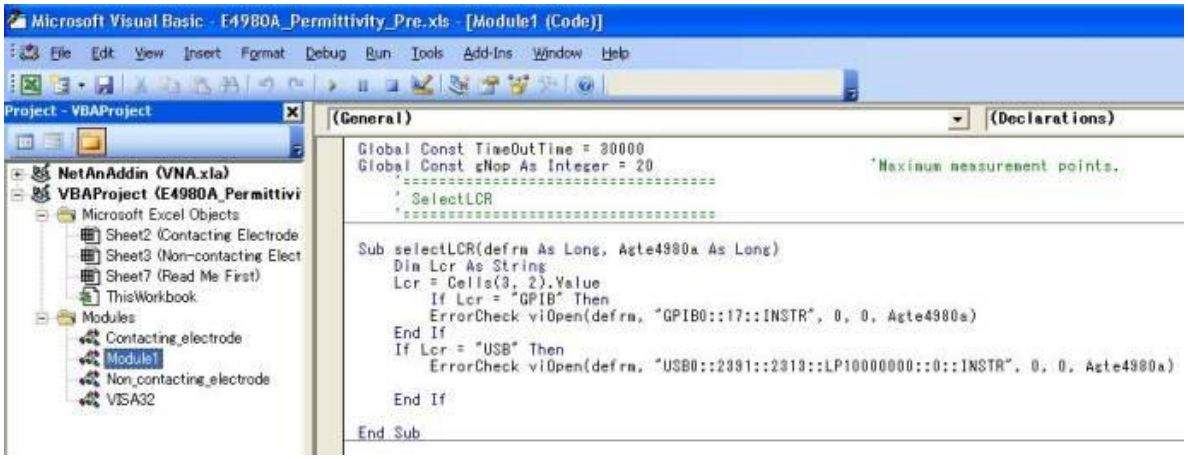
In order to control the E4980A from the external controller by using the program, GPIB address or USB ID must be set in the macro. The procedures are described below.

3.1. Open Visual Basic Editor.

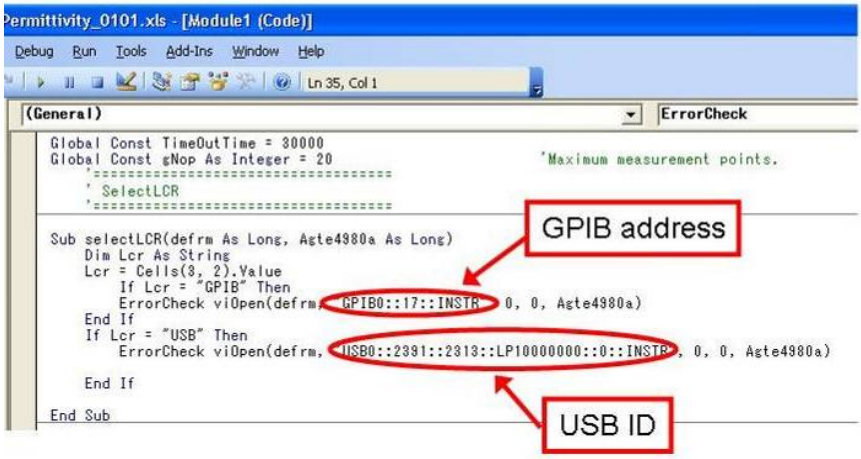
"Tools" – "Macro" – "Visual Basic Editor"



Open the module named "Module1" which is stored in "Modules" folder. Then, the display will be as follows.



3.2. Modifying the GPIB address or USB ID



3.2.1. When using GPIB cable for connecting the controller and the E4980A:

Modify the code "GPIB0::17::INSTR". In other words, change the number "17", which indicates the GPIB address of the E4980A employed, to the appropriate number for your E4980A. Factory-shipped setting of the E4980A's GPIB address is 17. For the details about GPIB address of the E4980A, refer to Chapter 5 "System Configurations" of the E4980A User's Guide.

3.2.2. When using USB cable for connecting the controller and the E4980A:

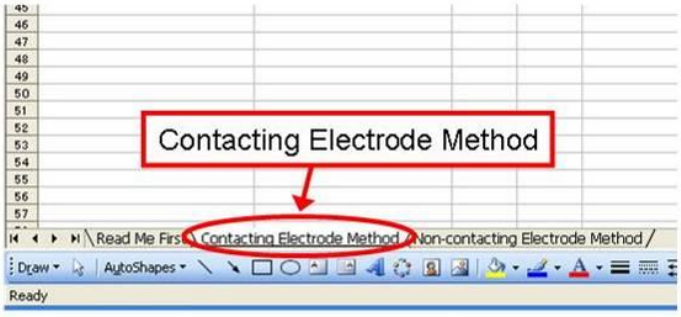
Modify the code "USB0::2391::2313::LP10000000::0::INSTR". In other words, change "LP10000000" to the serial number of your E4980A.
Serial number can be checked on "SYSTEM INFO" page of the E4980A (see Chapter 5 "System Configurations" of the E4980A User's Guide) or on the rear panel of the E4980A.

4. Measurement procedure

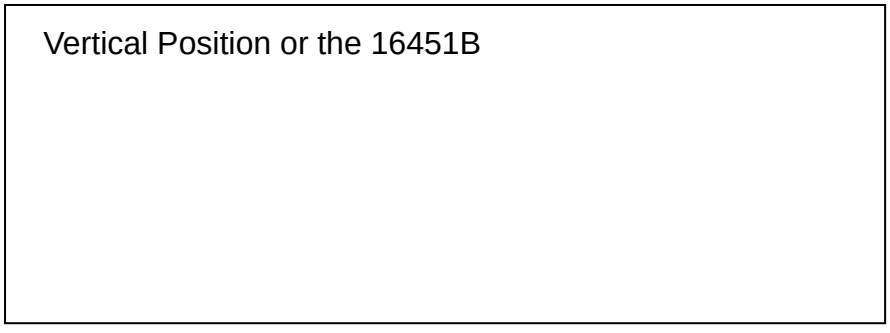
This section describes how to use the program. For the detail of each measurement method available with the 16451B, please refer to Chapter 3 “Operation” of the 16451B Operation and Service Manual.

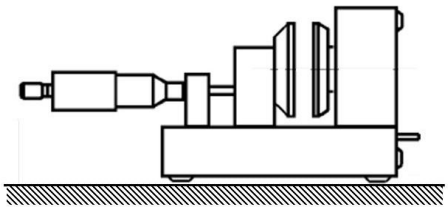
4.1. Contacting Electrode Method

1. Boot the program and modify GPIB address or USB ID as shown in section 2 and 3.
2. Change the sheet to “Contacting Electrode Method”.



3. Change the Guarded/Guard Electrode to the appropriate one (Electrode-A, B, C or D). The details about how to change the electrode are described in the paragraph “Changing the Guarded/Guard Electrode” in Chapter 3 of the 16451B Operation and Service Manual.
4. Place the 16451B in vertical position as shown below. Then, perform a “rough adjustment”. For the details, refer to the paragraph “Rough Adjustment to Make Electrodes Parallel” in Chapter 3 of the 16451B Operation and Service Manual.



5. Fill the entry fields in  l by yellow cells.
   A. Connection Inter
   Choose “GPIB”

B. Select the Electrode

Choose appropriate one among A, B, C, or D.

C. OSC Level

Set the oscillator voltage level of the E4980A. Available voltage level is 0 Vrms to 2 Vrms (Standard model) or 0 Vrms to 20 Vrms (Option 001)

D. OPEN/SHORT Correction

Choose the correction method. Following two methods are available.

Correction based on all frequency points

Correction based on specified frequency points

For the details of these methods, please refer to "CORRECTION page" in Chapter 4 of the E4980A User's Guide.

Note: When you choose "Correction based on specified frequency points," the correction is performed at frequency points input in "Frequency" field.

E. Thickness

Input the thickness of the MUT (Material Under Test).

F. Diameter

(Fill this field only when the Electrode-C or -D is used.)

Input the diameter of the guarded thin film electrode.

G. Parameter

Choose measurement parameters. Following parameters are available.

ε_r' - tan δ, $|\varepsilon_r|$ - tan δ, ε_r' - ε_r"

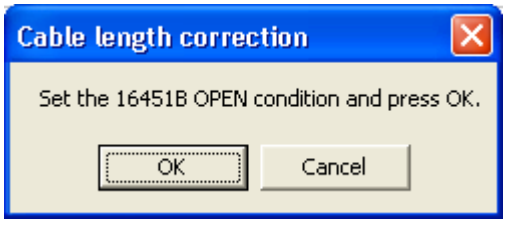
H. Frequency

Set the frequency at which the dielectric constants are measured.

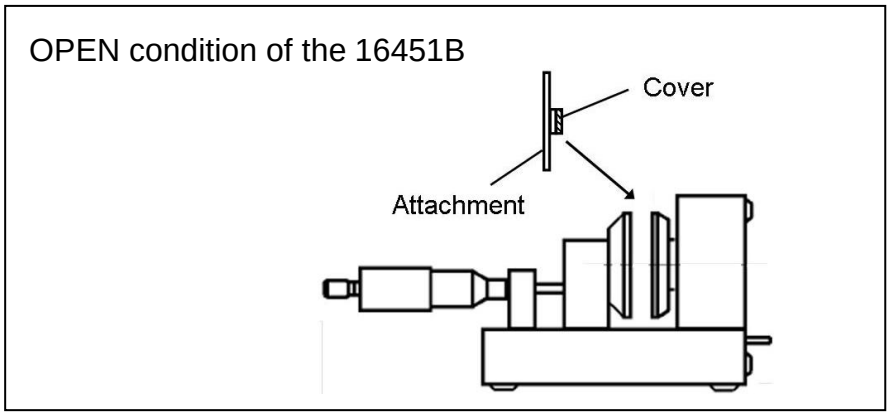
6. Click "Cable length correction" button. The subsequent step is different depending on the electrode used in the measurement.

6-1. When the Electrode-A or -B is used

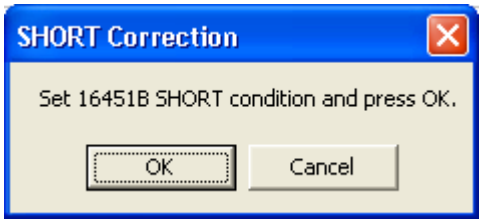
When the "Cable length correction" button is clicked, the cable length correction and measurement settings are performed after presetting the E4980A.When they are completed, the following message box appears.



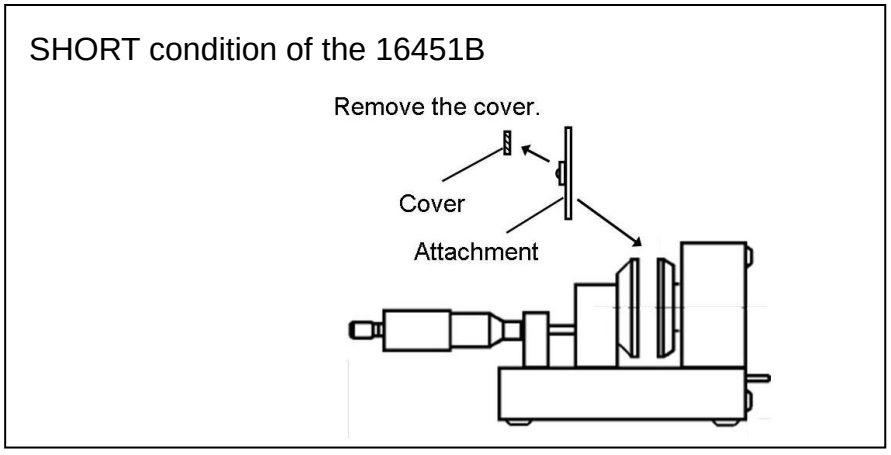
After setting the 16451B OPEN condition as shown in the figure below, press "OK". This step performs the OPEN correction for electrode adjustment.



When the OPEN correction is completed, the following message box appears.



After setting the 16451B SHORT condition as shown below, press "OK" to perform the SHORT correction for electrode adjustment. A message "Done" is shown in the blue area below the "Cable length correction" button when this step is completed.

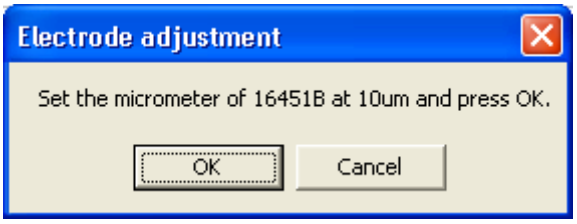


6-2. When the Electrode-C or -D is used

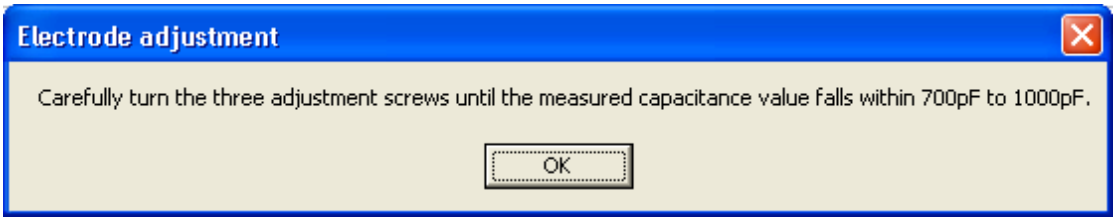
When the “Cable length correction” button is clicked, the cable length correction and measurement settings are performed after presetting the E4980A. A message “Done” is shown in the blue area below the “Cable length correction” button when this step is completed.

7. Click “Electrode adjustment” button. The following message box appears.

Note: This step is necessary only when the Electrode-A or -B is used. When using the Electrode-C or D, skip the step 7 and go to the step 8.

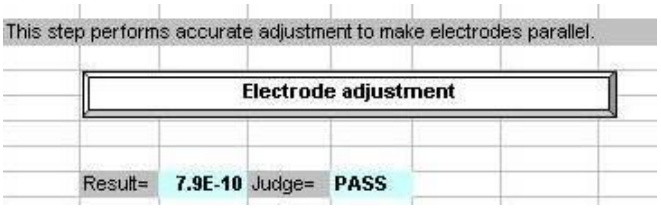


Click “OK” in this message box. Then, the following message box appears (this is an example when the Electrode-A is used).

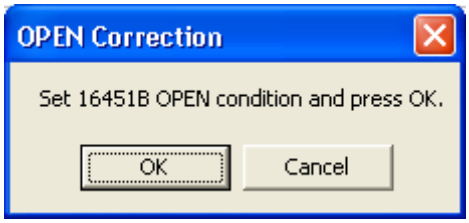


Adjust the Unguarded electrode by turning the three adjustment screws until the measured Cp value falls within the limit. The details about the adjustment are described in the paragraph “Accurate Adjustment to Make Electrodes Parallel” in Chapter 3 of the 16451B Operation and Service Manual.

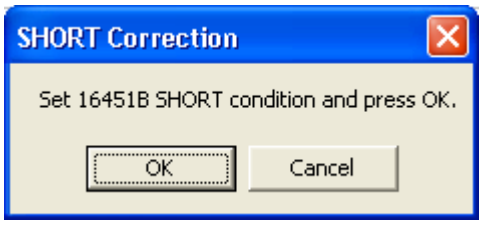
When the Cp value falls within the limit, click “OK” in the dialog box. The measured Cp value and the Pass/Fail result are displayed on the spreadsheet as follows.



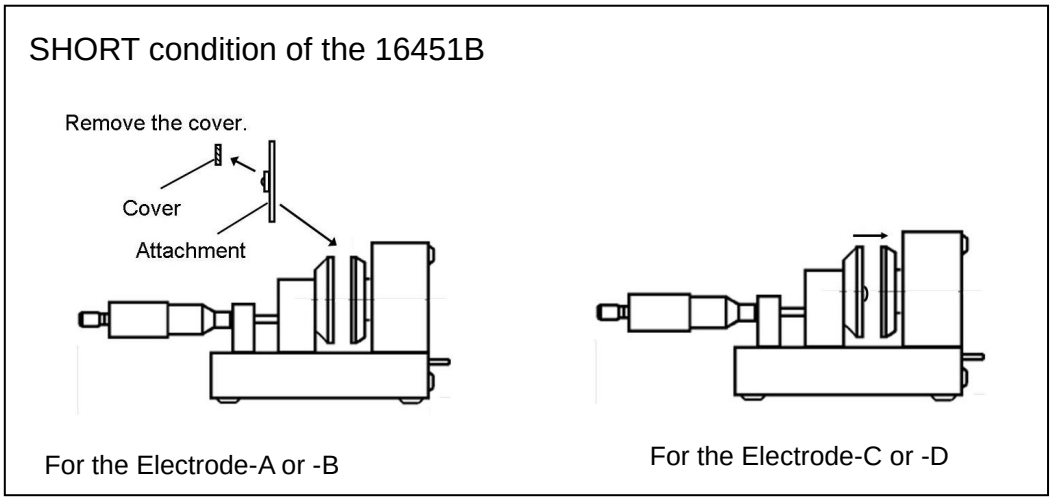
8. Click “OPEN/SHORT correction” button. The following message box appears.



After setting the 16451B OPEN condition as shown in the step 6, press “OK” to perform the OPEN correction. When the OPEN correction is completed, the following message box appears.

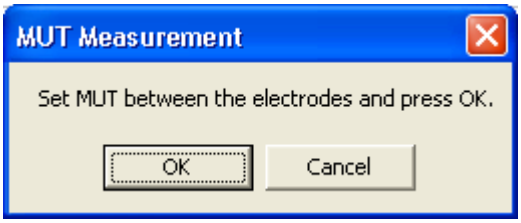


After setting the 16451B SHORT condition as shown below, press “OK” to perform the SHORT correction.



When the SHORT correction is completed, “Done” message is displayed in the blue area below the “OPEN/SHORT correction” button.

9. Click “Measure and calculate” button. The following message box appears.

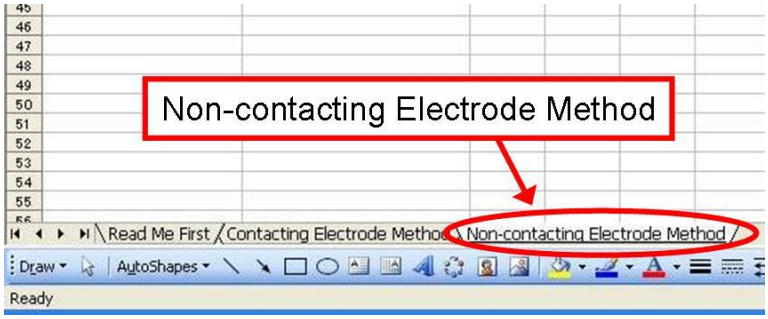


By clicking “OK”, the measurement is performed and the results are displayed in the spreadsheet.

4.2. Non-contacting Electrode Method

1. Boot the program and modify GPIB address or USB ID as shown in section 2 and 3.

2. Change the sheet to “Non-contacting Electrode Method”.



3. Change the Guarded/Guard Electrode to the appropriate one (Electrode-A or B). The details about how to change the electrode are described in the paragraph “Changing the Guarded/Guard Electrode” in Chapter 3 of the 16451B Operation and Service Manual.

4. Place the 16451B in vertical position as shown in the step 4 of the paragraph “4.1 Contacting Electrode Method”. Then, perform a “rough adjustment”. For the details, refer to the paragraph “Rough Adjustment to Make Electrodes Parallel” in Chapter 3 of the 16451B Operation and Service Manual.

5. Fill the entry fields in the spreadsheet, which are indicated by yellow cells.
   A. Connection Interface
      Choose “GPIB” or “USB” based on the interface used.
   B. Select the Electrode
      Choose appropriate one from A or B.
   C. OSC Level
      Set the oscillator voltage level of the E4980A.
      Available voltage level is 0 Vrms to 2 Vrms (Standard model) or 0 Vrms to 20 Vrms (Option 001)
   D. OPEN/SHORT Correction
      Choose the correction method. Following two methods are available.
         Correction based on all frequency points
         Correction based on specified frequency points

For the details of these methods, please refer to “CORRECTION page” in Chapter 4 of the E4980A User’s Guide.

Note: When you choose “Correction based on specified frequency points,” the correction is performed at frequency points input in “Frequency” field.

E. Thickness

Input the thickness of the MUT (Material Under Test).

F. Distance of Electrode Gap

Input the distance between the Guarded/Guard Electrode and the Unguarded Electrode. The unit should be millimeter.

G. Parameter

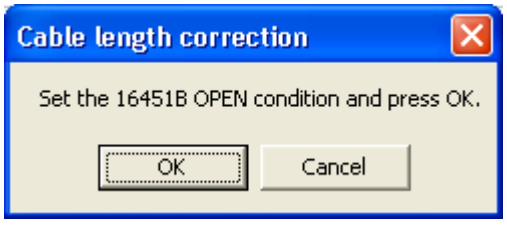
Choose measurement parameters. Following parameters are available.

ε_r’ - tan δ, $|\varepsilon_r|$ - tan δ, ε_r’ - ε_r”

H. Frequency

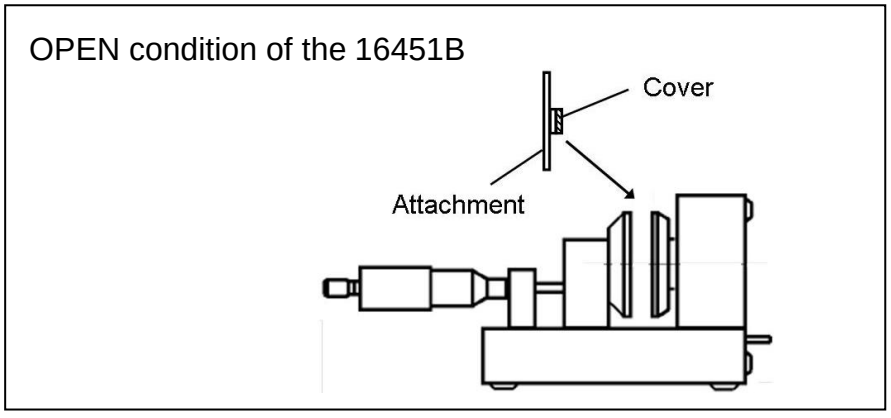
Set the frequency at which the dielectric constants are measured.

6. Click “Cable length correction” button. Then, the cable length correction and measurement settings are performed after presetting the E4980A.When they are completed, the following message box appears.

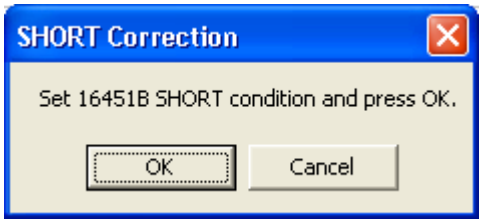


After setting the 16451B OPEN condition as shown in the figure below, press “OK”. This step performs the OPEN correction for electrode adjustment

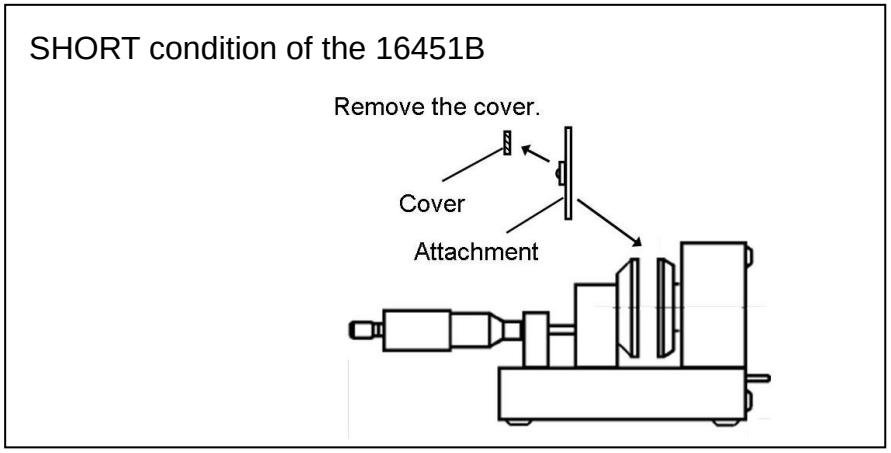
.



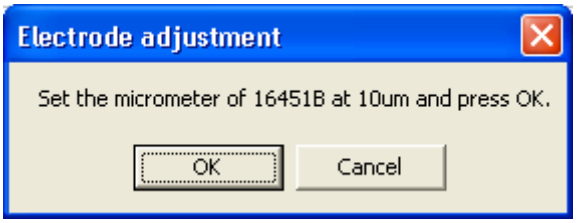
When the above operation is completed, the following message box appears.



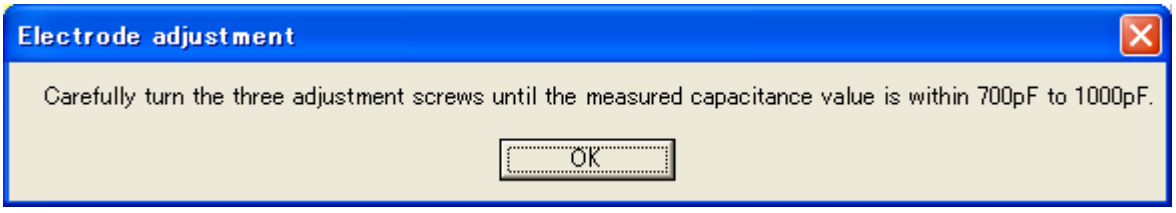
After setting the 16451B SHORT condition as shown below, press "OK" to perform the SHORT correction for electrode adjustment. A message "Done" is shown in the blue area below the "Cable length correction" button when this step is completed.



7. Click "Electrode adjustment" button. The following message box appears.



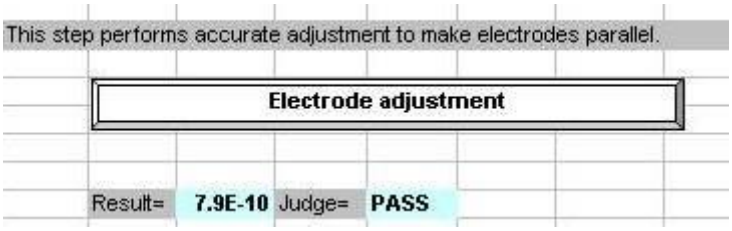
Click "OK" in this message box. Then, the following message box appears (this is an example when the Electrode-A is used).



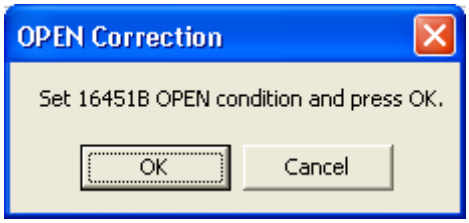
Adjust the Unguarded electrode by turning the three adjustment screws until the measured Cs value falls within the limit. The details about the adjustment are

described in the paragraph “Accurate Adjustment to Make Electrodes Parallel” in Chapter 3 of the 16451B Operation and Service Manual.

When the Cs value still falls within the limit at “horizontal position”, click “OK” in the dialog box. The measured Cs value and the Pass/Fail result are displayed on the spreadsheet as follows.



8. Click “OPEN/SHORT correction” button. The following message box appears.

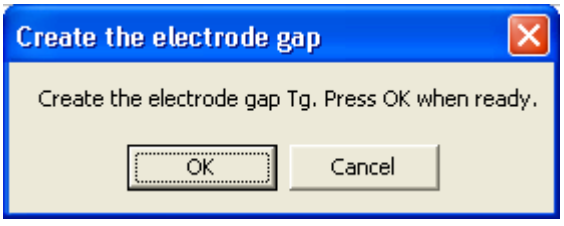


After setting the 16451B OPEN condition as shown in the step 6, press “OK”. The OPEN correction is performed. When the OPEN correction is completed, the following message box appears.

After setting the 16451B SHORT condition as shown in the step 6, press “OK”. The SHORT correction is then performed.

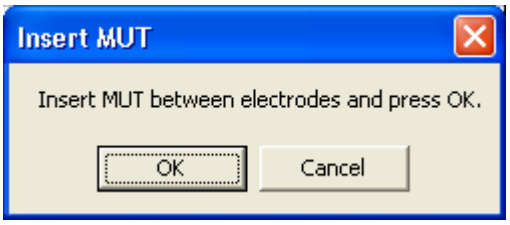
When the SHORT correction is completed, “Done” message is displayed below the “OPEN/SHORT correction” button.

9. Click “Measure and calculate” button. The following message box appears.



Adjust the distance of the electrodes by turning the knob of the micrometer. The

distance should be the same value as that entered in the “Distance of Electrode Gap (Tg) [mm]” field. When ready, click “OK” button. The following message box appears.



Insert the MUT between the electrodes and click “OK” button. This step performs capacitance and dissipation factor measurement with the MUT inserted. When this step is finished, the following message box appears.

Remove the MUT and click “OK” button. The capacitance and dissipation factor measurements without the MUT inserted are performed. After the measurement, the calculated dielectric constants are automatically displayed in the sheet.

Revision Control

Revision	Date	Description of change
01.00	2008/08/06	Initial revision
01.01	2011/12/20	Fixed bug on tanδ calculation
01.02	2012/03/09	Changed timeout value