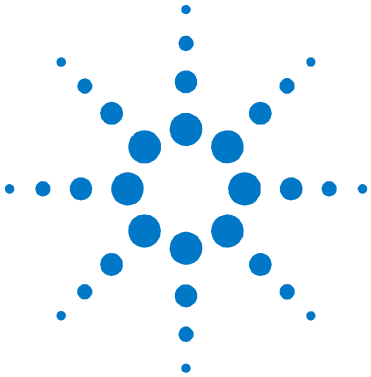

Agilent
85070E Dielectric Probe Kit

Printed Version of 85070E Help File

July 16, 2013

Agilent Technologies

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Certification

Agilent Technologies, Inc. certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies, Inc. further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Contacting Agilent

Assistance with test and measurements needs and information on finding a local Agilent office are available on the Web at: http://www.agilent.com/find/assist
If you do not have access to the Internet, please contact your Agilent field engineer.
In any correspondence or telephone conversation, refer to the Agilent product by its model number and full serial number. With this information, the Agilent representative can determine whether your product is still within its warranty period.

TABLE OF CONTENTS

85070E Help File - Home

This manual is a complete guide to using the 85070 Dielectric Probe Kit and software to make dielectric measurements.

See **Critical Note** regarding the Slim Probe Connector Saver.

- General Information explains the functions of the analyzer, computer, software, and probe in making measurements.
- Getting Started provides procedures for installing and configuring the software and analyzer.
- Software Reference Each menu choice is explained.
- Measurement Tutorials provides a step-by-step, guided example of a calibration and measurement with the probe kit.
- Programming provides the available commands and a Visual Basic example.
- Common Problems and Solutions presents common measurement hang-ups and what to do about them.
- Glossary defines important words and concepts used in this manual.
- Technical Support provides links and other support information

The Fine Print Section contains the software license agreement and warranty information.

Help File Revision: July 16, 2013

What's New in 85070E Rev. E.07.02

- Import *.sNp Files (option 400)
- S-parameter Display (option 400)
- Format choices for S-parameters
- Date Field added to .csv File Save
- Probe Cal Normalization in ALL supported VNAs
- IFBW and Power Settings
- *.prb File Extension
- Copy Chart to another chart
- Windows 7 Requires NO Administrative privileges

What's New in 85070E Rev. E.07.01

- Multiple Charts that contain Multiple Traces
- Multiport Measurements (85070E Opt 400)
- Name files for User-defined standards
- Show User-defined standards as traces
- Edit and Table menus removed.
- Additions to Chart menu
- Trace Statistics and Markers
- Changes to Preferences settings
- Save Data to *.csv files

General Information

The dielectric probe kit allows measurements of the complex permittivity for a wide range of semi-solid, pliable-solid, and liquid materials. It performs all of the necessary network analyzer control, calculation, and data presentation functions. The software controls the network analyzer to measure the complex reflection coefficient of the material under test (MUT). Then it converts the reflection coefficient into the complex permittivity of the MUT.

Finally it displays the measurement results in a variety of graphical and tabular formats. The software also facilitates printing or plotting the results, saving the results to disk, and saving test setups to disk.

The dielectric probe provides a convenient, repeatable method for measuring various dielectric materials. The convenience is a result of needing only to press the probe against (or immerse it in) the MUT to make a measurement. The probe is used with a vector network analyzer to take advantage of the analyzer's measurement flexibility, speed, and accuracy. Use of the vector network analyzer allows the software to calibrate out (as detailed later) a variety of measurement errors and thus enhances accuracy.

See **Critical Note** regarding the Slim Probe Connector Saver.

Topics in this section

Kit Contents

The 85070E Dielectric Probe Kit can be configured to meet your needs. Below is a list of the various options and their contents.

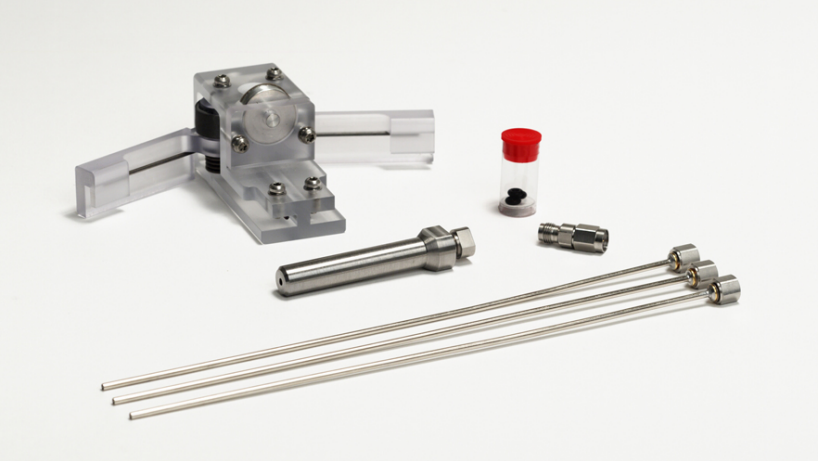
Standard Kit, 85070E-STD

- Dielectric Probe Software application on CD
- Software Entitlement Certificate
- 1 mounting bracket to connect probe to Option 001 Probe Stand or similar stand
- 1 10mm diameter holder to connect performance probe or slim form probe to mounting bracket
- 1 ECal holder to connect ECal module to mounting bracket, 85070-60008
- 1 typeN female to 3.5mm male adapter, 1250-1743
- 1 3.5mm female to 2.4mm female adapter, 11901D
- 1 foam lined walnut box

Probe Options

High-temperature Probe, option 020

- 1 High-temperature Probe, 8710-2036
- 1 High-temperature Probe Calibration Short, 85070-60003
- 1 Conductive Elastomer Disc (not shown), 85070-20036



Slim Form Probe, option 030

- 3 Slim Form Probes, 85070-60009
- 1 Slim Form Probe Calibration short, 85070-60004
- 1 10mm diameter sealed probe holder, 86070-60007
- 6 o-rings for probe holder (included in 85070-60007)
- 1 connector saver, 1250-3449

Slim Form probe replenish Kit, Option 033

- 3 Slim Form Probes, 85070-60009

Performance Probe, option 050

- 1 Performance Probe, 85070-60010
- 1 Performance Probe Calibration short, 85070-60012

Cable Options

- High Temperature Cable, option 002
- 20GHz Flexible Cable, option 022
- 50GHz Flexible Cable, option 032

Accessory Options - Highly recommended

- Probe Stand, option 001

Security Key Options- Must choose one

- Parallel Hardware Key, option UL7
- USB Hardware Key, option UL8

Parts that can also be ordered separately

- 8710-2036, High temperature dielectric probe
- 85070-60003, High temperature probe calibration short
- 85070-60009, Set of three Slim Form Probes
- 85070-60004, Short for Slim Form Probes
- 85070-60007, Slim Form Probe holder
- 85070-60008, Ecal Holder
- 85070-60010, Performance Probe
- 85070-60012, Performance Probe Calibration Short
- 85070-60011, 10mm Holder for Slim Form and Performance Probes
- 8120-6286, High Temperature Cable
- 8120-6192, 20GHz Flexible Cable
- 8121-1290, 50GHz Flexible Cable
- 9301-1298, Probe Stand
- 1250-3449, Connector Saver for Slim Form Probe

Probe Characteristics

Characteristics for the 85070E probe options are described below.

Specifications describe the warranted performance over the temperature range 0 °: C to 55 ° C.

Supplemental characteristics are intended to provide information useful in applying the instrument, by giving typical but non-warranted performance parameters. These are denoted as typical, nominal, or approximate.

All Probe Options, 020, 030 and 050

- Typical Accuracy (see Overall Measurement Accuracy)

  Dielectric constant, ε $_r$': ± 5% of | ε$_r$* |

  Loss factor, ε$_r$'': ± 5% of | ε$_r$* |

  Repeatability and resolution: Two to four times better than accuracy

- Expected Value Requirements

  Maximum recommended ε$_r$ ':<100

  Minimum recommended tan δ : >0.05

- Temperature Slew Rate: 10

High-temperature Probe, Option 020

Note: The original version of this probe is also known as the **85070A Probe**. This probe is almost identical to the High Temperature probe. The way to distinguish these two probes is that the glass seal on the 85070A probe looks clear and the glass seal on the High Temperature probe is a translucent milky white.

- Frequency Range : 200 MHz to 20 GHz with network analyzer, or 10MHz to 3GHz with impedance analyzer (normal) . Maximum limited by MUT properties, where fmax = $\leq \frac{110}{|\sqrt{\varepsilon_r}|}$ GHz
- Temperature Range: -40 ° C to +200 ° C
- Sample Requirements:

  Material is ‘infinite’ in size, non-magnetic μ $_r$* = 1), isotropic (uniform orientation and homogeneous

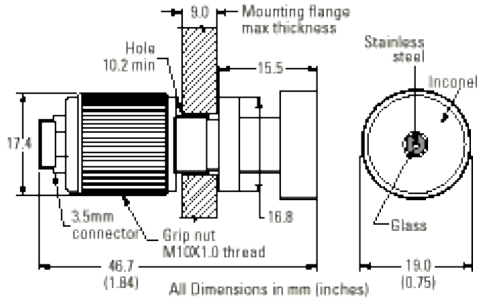
(uniform composition). Solids have a single, smooth, flat surface with gap-free contact at the probe face.

Diameter: >20 mm

Thickness: $\geq \frac{20}{|\sqrt{\varepsilon}|}\ mm$

Granule size: < 0.3 mm

- Probe Dimensions



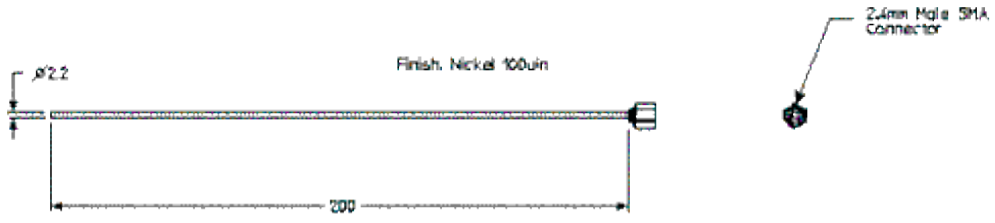
Slim Form Probe, Option 030

- Frequency range: 500 MHz to 50 GHz (normal). Maximum frequency limited by MUT properties: $\left|\frac{(265 - j125)}{\sqrt{\varepsilon}}\right|$ GHz
- Temperature Range: 0 to +125 degrees C
- Sample Requirements:

  Material is 'infinite' in size, non-magnetic μ $_r$* = 1), isotropic (uniform orientation and homogeneous (uniform composition). Liquids or soft semi-solids that can conform to the probe tip.

  Minimum insertion of 5 mm with 5 mm around the tip of the probe.

- Probe Dimensions



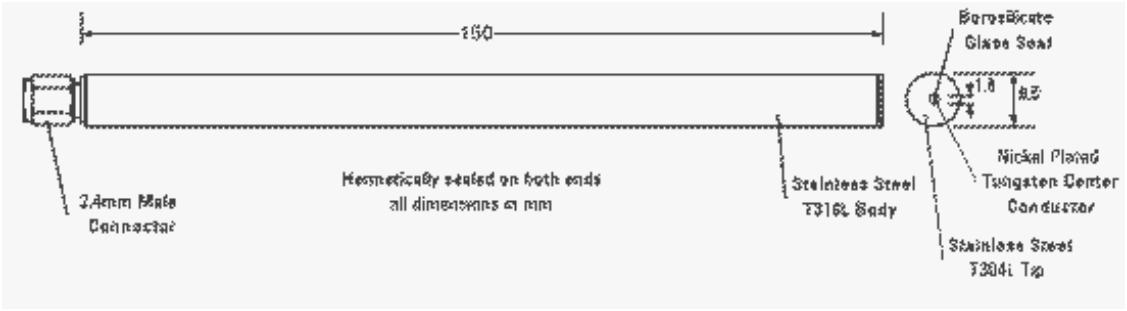
Performance Probe, Option 050

- Frequency range: 500 MHz to 50 GHz (normal). Maximum frequency limited by MUT properties: $\left|\frac{(265 - j125)}{\sqrt{\varepsilon}}\right|$ GHz
- Temperature Range: -40 ° C to +200 ° C
- Sample Requirements:

  Material is 'infinite' in size, non-magnetic μ ᵣ* = 1), isotropic (uniform orientation and homogeneous (uniform composition). Solids have a single, smooth, flat surface with gap-free contact at the probe face.

  Minimum insertion of 5 mm with 5 mm around the tip of the probe.

- Probe Dimensions



Additional Equipment Needed

To complete your measurement system, you will need these additional items.

Agilent Network or Impedance Analyzer

The latest list of supported Agilent analyzers can be found on the Agilent 8507x Technical Support Website.

Adapters may be needed to connect probe kit to analyzer.

See Adapter Selection Guide

USB or Network CD Drive, or Internet Connection needed to install software

Personal Computer (PC)

Optional for PNA Series and ENA-C network analyzers

- Operating System: Windows XP or Windows 7
- Interface card with a compatible driver:
    - GPIB, Agilent SICL or National Instruments 488.2M
    - LAN

Adapter Selection Guide

Some configurations may need extra adapters. The Agilent adapter part numbers are charted below.

Critical Note: Before using a Slim Form Probe, connect the 2.4 mm male to 2.4 mm female connector saver to the probe. Otherwise, damage may occur to the probe. The connector saver part number is 1250-3449 and is included in the 85070E-030

Network Analyzer port to Cable

Network Analyzer port connector	High Temperature 20GHz Cable	20GHz Flexible Cable	50GHz Flexible Cable
TypeN female	1250-1743*	1250-1743*	11903A
3.5mm male	None needed	None needed	11901C
2.4mm male	11901D*	11901D*	None needed

*quantity of one included in standard kit

Probe to Cable

Probe	High Temperature 20GHz Cable	20GHz Flexible Cable	50GHz Flexible Cable
High Temperature Probe	None needed	None needed	11901C
Slim Form Probe	11901D*	11901D*	None needed
Performance Probe	11901D*	11901D*	None needed

*quantity of one included in standard kit

The following adapters are needed when using Automated Electronic Calibration Refresh

Ecal Module to Cable

ECal Module connector	High Temperature 20GHz Cable	20GHz Flexible Cable	50GHz FlexibleCable
typeN male	1250-1750	1250-1750	11903C
typeN female	1250-1743*	1250-1743*	11903A
3.5mm male	None needed	None needed	11901C
3.5mm female	83059A	83059A	11901A
2.4mm male	11901D*	11901D*	None needed
2.4mm female	11901C	11901C	11900A

*quantity of one included in standard kit

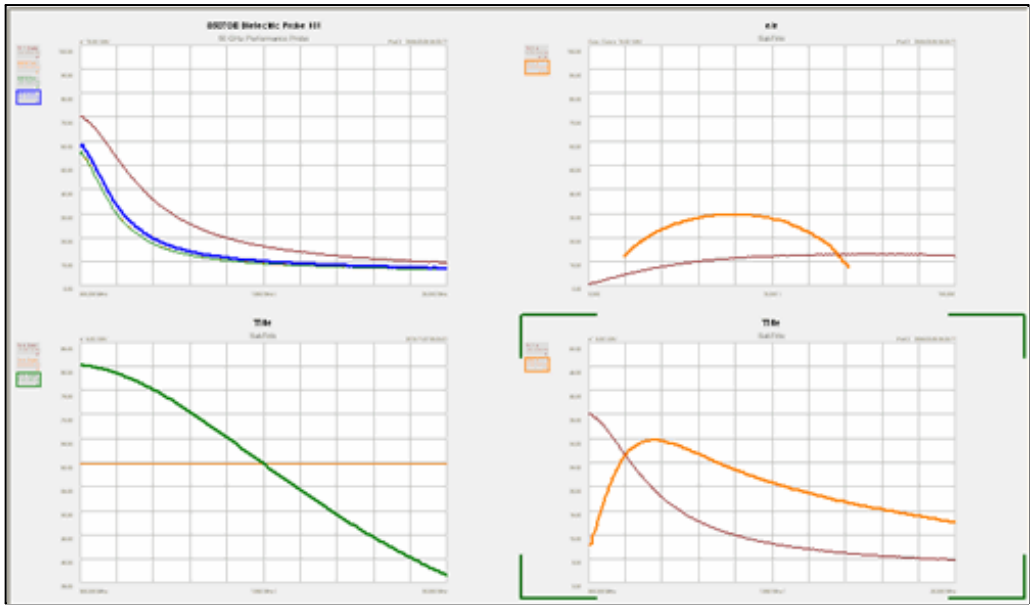
Ecal Module to Probe

ECal Module connector	High Temperature Probe	Slim Form Probe	Performance Probe
typeN male	1250-1745	11903B	11903B
typeN female	1259-1744	11903D	11903D
3.5mm male	83059B	11901B	11901B
3.5mm female	None needed	11901D*	11901D*
2.4mm male	11901B	11900B	11900B
2.4mm female	11901C	None needed	None needed

*quantity of one included in standard kit

Working with Charts and Traces

An unlimited number of charts can be displayed at the same time on the 8507xE screen. There is always at least ONE chart present on the screen.



Four charts, each with multiple traces

Charts

- The chart with the green **[**Brackets**]** is the Active (selected) chart.
- **To view a single chart** in full-screen, double-click the chart.
- **To return to viewing all charts**, again double-click on the single chart.
- Right-click anywhere on a chart (NOT on a trace name) to make the following settings:
    - **New Trace** - Click, the select a new trace to display.
    - **Autoscale All** - Sets the scale so that one or all traces fit most of the chart depending on the Scale Coupling setting.
    - **Reset Scale All** - Return the scale of all traces to the original setting.
    - **Scale Coupling** - See Scale dialog help.
    - **Scale** - See Scale dialog help.
    - **Marker** - See Marker dialog help
    - **Trace Math** - See Trace Math dialog help.
    - **Chart**

- **New Chart** - Creates a new chart window.
- **Delete Chart** - Removes the chart (if it is not the only chart).
- **Copy** - Copies the current chart and traces to the clipboard. The image can then be copied to an external program such as Microsoft Paint.

Traces

Only ONE measured data set can be resident in the 8507x software for each port. Option 400 allows more than one port to be measured.

A trace is the display of the measured data points connected by a line. An unlimited number of traces can be displayed in a single chart to represent that data set.

To compare measured data sets from the same port, save one of the traces to memory. Learn how.

- Each trace in a chart can be the result of a unique or duplicate measurement or equation.
- Each trace can have unique Scale and Markers.
- The date and time the measurement was made appears in the top right corner of the chart.

Trace Names

	Trace names appear to the left of the chart. The trace with the box around the **Tr** name is the Active (selected) trace.

Right-click on a trace name to make the following Trace settings:

- **Format** - Change the measurement for the active trace.
- **Format All** - Change the measurement for ALL traces in the chart.
- **Autoscale** - Change the scale of the trace to fit in the chart. See Scale Coupling to determine which traces are scaled.
- **Reset Scale** - Change to the original scale for the chart.
- **Scale** - Start the Scale dialog.
- **Marker** - Start the Marker dialog.
- **Rename** - change the trace name.
- **Delete** - Remove the trace.

Last modified:

20-Nov-2012	New topic

Getting Started

This section details everything you need to get your software and hardware installed correctly.

Topics in this section

- Redeem Software License
- Install and Configure the Software
- Set Up Probe Hardware
- Calibration and Measurement Tutorial

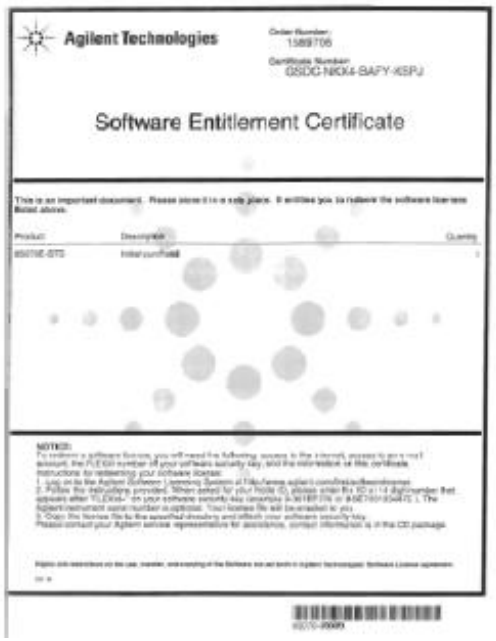
Redeem License

The 8507x series software uses node locked software security, which requires both a license file and a USB software security key (dongle) for the software to run. Here's how to redeem your license file

1. **Verify You Have Everything**

   Before you begin, verify you have received these items

   - Software CD (alternatively, you can download software from software download website. See http://www.agilent.com/find/Materials
   - Software Entitlement Certificate


Agilent Technologies

Software Entitlement Certificate

   - USB Key (dongle)

   You will also need an Internet Connection and an Email Account

   Please contact Agilent if you are missing anything.

2. **Redeem the License File**

   - Log on to the Agilent Software Licensing System and follow instructions to redeem your license file.

The URL for the website can be found on your Software Entitlement Certificate.

- When asked for Order and Certificate numbers, enter these numbers from your Software Entitlement Certificate
- When asked for your Dongle Serial Number, enter the number printed on your key. USB key serial numbers always start with "9-".
- You do not have to enter an Instrument serial number.
- When you complete the redemption process, your license (8507x.lic) file will be emailed to you.
- Save the .lic file to the following folder location:
    - For Windows XP or Windows 7 (32bit):
      C:\Program Files\Agilent\85070 (or 85071)\Data and Setup
    - For Windows 7 (64bit):
      C:\Program Files(x86)\Agilent\85070 (or 85071)\Data and Setup
- Do NOT delete the 8507xE-Demo.lic file. This will cause the software to run the 8507x.exe file.
- Do not open and re-save the file, as this could corrupt the encrypted keyword.

Install and Configure the 8507x Software

There are many ways to install and run the 8507x software depending on the analyzer model.

- Install 8507x Software on the Analyzer - This configuration affords maximum speed and efficiency.
    - **Install 8507x Software on the PNA**
    - **Install 8507x Software on the ENA C**
- **Installing 8507x Software on a PC**- The PC controls the analyzer. When installed on a PC, the connection to the analyzer must be configured. The following configuration methods are available:
    - **Configure PC to Analyzer over LAN** **PNA**, **ENA**, **FieldFox**- Both the PC and analyzer are connected to the internet
    - **Configure PC to Analyzer using Crossover LAN**- **PNA**, **ENA**, **FieldFox** - A direct connection. Neither PC nor analyzer are connected to the internet.
    - **Configure PC to Analyzer over GPIB** - **PNA**, **ENA**, **E4991 -** A GPIB interface card is required in the PC.
    - **Configure_PC_to_Analyzer_over_USB** - **PNA**, **ENA -** A direct connection which is very fast, and internet connections can still be maintained.

See Also

8507x Software - Scan Hardware

Install 8507x Software on the PNA

This procedure shows how to install the software on a PNA

- Because this topic pertains to both the 85070 and 85071 software products, the term "8507x" is used to refer to both software products.
- Agilent IO Libraries is already installed on the PNA and ENA.
- See other configuration methods

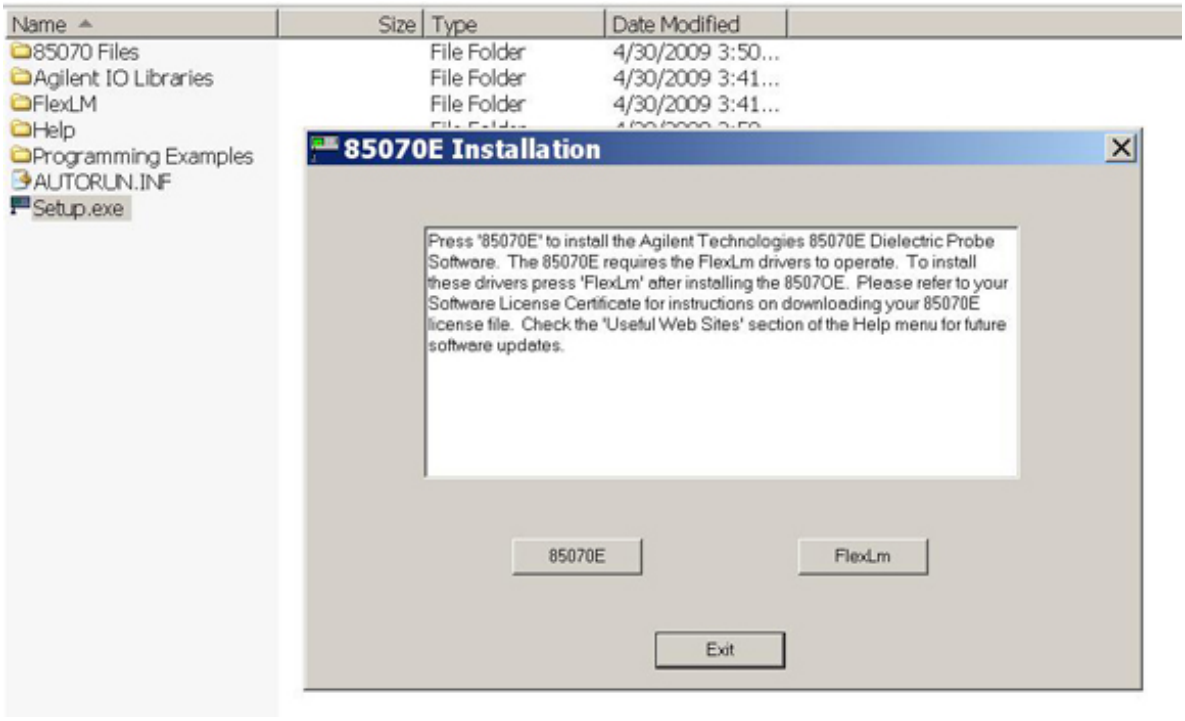
Procedure

Install 8507x software on the Analyzer

1. Log onto the analyzer as an administrator.
2. PNA ONLY - click **File**, then **Exit** to close the PNA application
3. You can install from the software CD that came with your kit, or download and install the latest version from the Agilent 8507x Series Software Download Page.
    - From CD
        - Connect the analyzer to a CD drive. This can be a USB drive or a mapped PC drive.
        - The CD has an autorun function and the installation program should start by itself. If this function is disabled on your PNA, open your CD drive folder and click on setup.exe
    - From Agilent 8507x Series Software Download Page.
        - Connect analyzer to the internet
        - Click on file down load and save it to temporary folder on the analyzer.

    You can also copy the folders from the CD or Agilent Software Download Page to a USB memory device to transfer them to the PNA. 100 MBytes is needed for the entire CD image. The folders Agilent IO Libraries and Programming Examples are not needed to run the software on the analyzer. Not copying them reduces the download size to 20 MBytes

    Note: Do Not install Agilent IO Libraries on the PNA



From the 8507x Installation Screen

- Install 8507xE software by clicking on the 8507xE button and follow the on-screen instructions.
- Install Software Security Key (dongle) driver by clicking on the FLEXLm button and follow the on-screen instructions.
- Run the analyzer application.

Install License File and Connect Security Key

- Copy the license file emailed to you during the License Redemption Process to C:\Program Files\Agilent\8507x\Data and Setup. Note: If you haven't received a license yet, you can still use the software for two weeks with the automatically installed Free Two Week Demo License.
- Connect Software Security Key (dongle) to known good USB port on the PNA. A light on the USB key should illuminate.

Run 8507xE Software

- Click the 8507x Icon on the analyzer desktop to run software.

Install 8507x Software on the ENA C

Follow these steps to install and run the software on an ENA-C (E5071C).

Note: Software can also be installed on a PC. Learn how.

The following instructions are performed in the ENA-C application

- [ ] indicates hard key
- { } indicates soft key
- > indicates a progression of keystrokes

1. Turn on SICL-LAN Server in ENA-C

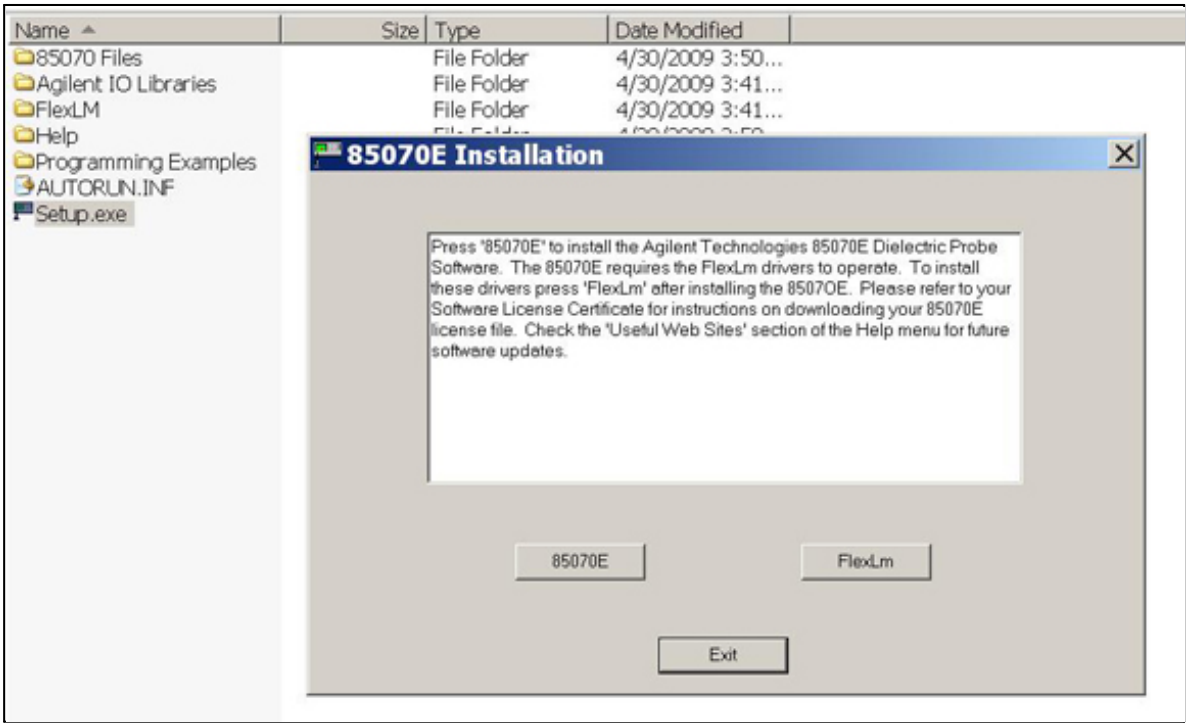
- {System} > {Misc. set up} > {Network Setup} > {SICL-LAN server}
- Restart firmware
- Two Windows Security Alert (Agilent Remote I/O Port Manager and Agilent Remote I/O Server) will appear. Unblock both.

2. Install 8507x software on ENA-C

- Log onto the ENA-C as an administrator
- You can install from the software CD that came with your kit, or download and install the latest version from the Agilent 8507x Series Software Download Page.
- You can also copy the folders from the CD or Agilent Software Download Page to a USB memory device to transfer them to the ENA-C. 100 MBytes is needed for the entire CD image. The folders Agilent IO Libraries and Programming Examples are not needed to run the software on the ENA-C. Not transferring them to the ENA-C will reduce the size to 20 Mbytes.
    - **From CD**:
        - Connect the ENA-C to a CD drive. This can be a USB drive or a mapped PC drive.
        - The CD has an autorun function and the installation program should start by itself. If this function is disabled on your ENA-C, open your CD drive folder and click on setup.exe
    - **From Agilent 8507x Series Software Download Page**
      http://na.tm.agilent.com/materials/downloads.html
        - Connect ENA-C to internet
        - Click on file download and save it to temporary folder on ENA-C.

      Note: Do Not install Agilent IO Libraries on the ENA-C

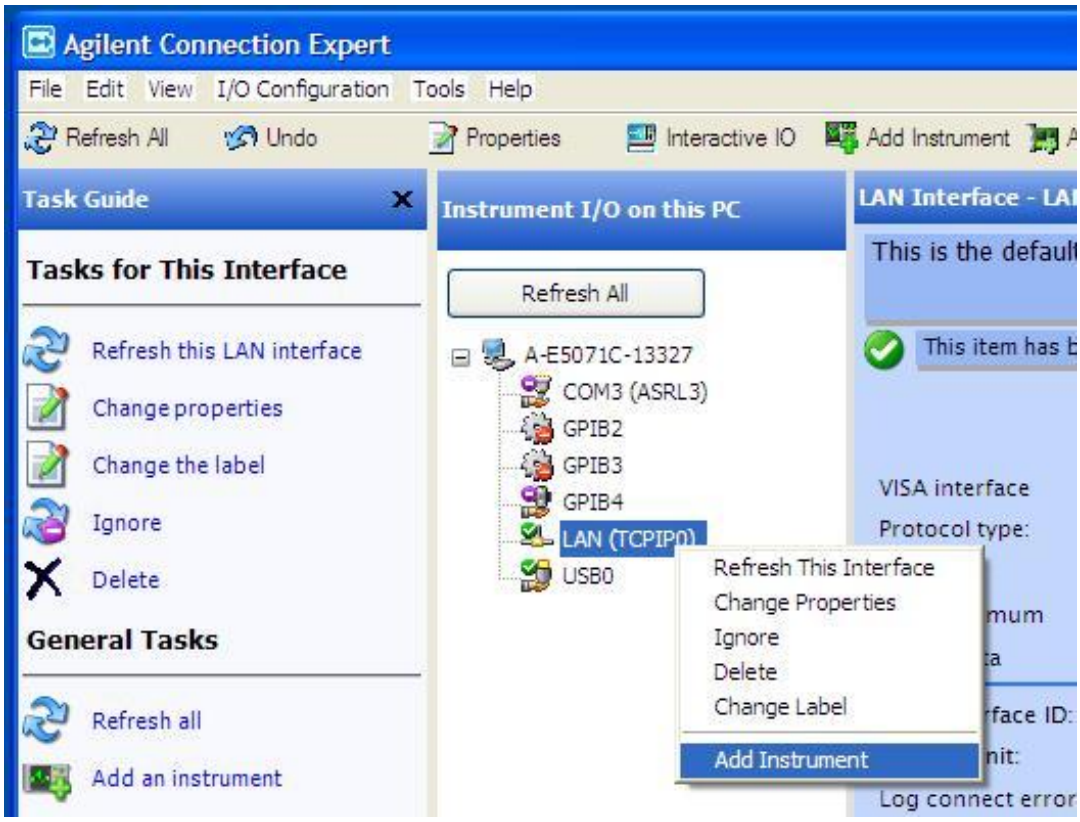
- From the 8507x Installation Screen



  - Click the **8507xE** button and follow the on-screen instructions.
  - Install Software Security Key (dongle) driver by clicking on the FLEXLm button and follow the on-screen instructions.

3. Create a VISA address of ENA-C with Agilent Connection Expert

- Launch Agilent Connection Expert on ENA-C.
  - In the ENA-C application {System} > {Misc. set up} > {GPIB Setup} > {System Controller Configuration...}
  - Do not close the ENA-C application.
- In Agilent Connection Expert, right-click on “LAN (TCPIP)” and left-click “Add Instrument”. Then “Add LAN Instrument” dialog box will appear.



- In “Add LAN Instrument” dialog box
  - Select **Add Address**
  - Select **Use IP Address** and enter **127.0.0.1** (local loop-back address) in the IP address text box.
  - Click **Test Connection**, and then click **OK**.
  - You can create the VISA address of ENA-C as “TCPIP0::127.0.0.1::inst0::INSTR”.

4. Install License File and Connect Security Key

- Copy the license file emailed to you during the License Redemption Process to “C:\Program Files\Agilent\85070\Data and Setup” or “C:\Program Files\Agilent\85071\Data and Setup”.

  Note: If you haven't received a license yet, you can still use the software for two weeks with the automatically installed Free Two Week Demo License.

- Connect Software Security Key (USB dongle) to known good USB port on the ENA-C. A light on the USB key should illuminate

5. Run 8507xE Software

- Click on the 8507x Icon on the PC desktop to run software.
- The “Select Instrument” dialog box appears. Select **E5071C** and click **OK**.

Install 8507x Software on a PC

This procedure shows how to install the 8507x software on a PC.

- Because this topic pertains to both the 85070 and 85071 software products, the term "8507x" is used to refer to both software products.
- In addition, Agilent IO Libraries must be installed on the PC. If they are not already installed on PC, install them now. A complimentary copy is located on your software CD and from the Agilent 8507x Series Software Download Page.
- See other configuration methods

Procedure

1. **Install from the software** CD that came with your kit, or download and install the latest version from the Agilent 8507x Series Software Download Page.

- **From CD -** The CD has an autorun function and the installation program should start by itself. If this function is disabled on your PC, open your CD drive folder and click on setup.exe.
- **From Agilent 8507x Series Software Download Page:**

    1. Click on file download and save it to temporary folder on PC.
    2. Click on the file to start the setup program.
    3. On the 8507xE Installation dialog, click the 8507xE button and follow the on-screen instructions.

2. **Install Dongle Key Driver**

    Click the FLEXLm button and follow the on-screen instructions.

3. **Install License File and Connect Security Key**

    - Copy the license file emailed to you during the License Redemption Process to C:\Program Files\Agilent\8507x\Data and Setup. Note: If you haven't redeemed your license yet, you can still use the software for two weeks with the automatically installed Free Two Week Demo License. See Redeem License procedure.
    - Connect Software Security Key (dongle) to known good USB or parallel port on the PC running the 8507x software. A light on the USB key should illuminate.

4. **Configure the PC to Analyzer connection**

Choose from the following methods:

Configure PC to Analyzer over LAN

Configure PC to Analyzer using Crossover LAN

Configure PC to Analyzer over GPIB

Configure PC to Analyzer over USB

Configure PC to Analyzer over USB

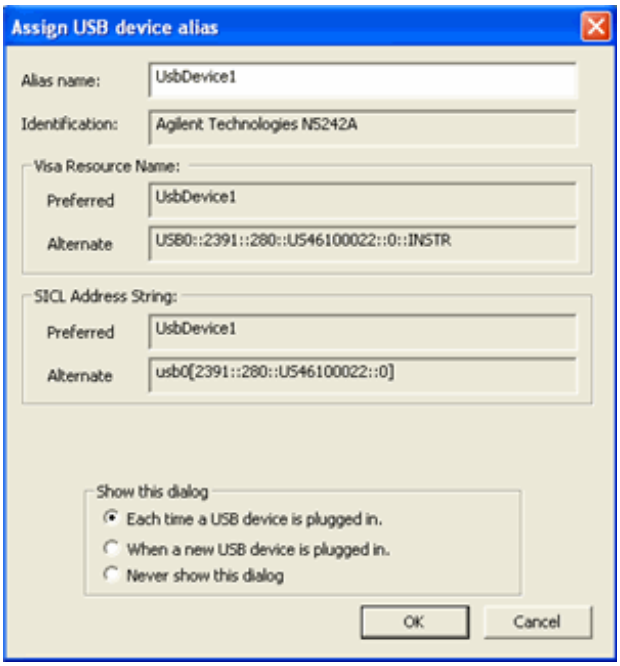
Beginning with 8507X Rev. E06.01.xx, you can connect to the PNA or ENA from the remote computer using a USB cable. The PNA must have Firmware A.09.00 or higher. This is possible only with the PNA-X, N522x, N523x, or PNA 'C' models.

This is done through the Agilent I/O Libraries which must be installed on your remote computer.

Measurement data transfers MUCH faster using USB as compared to GPIB.

To communicate with the PNA or ENA as a USB device:

1. Connect the analyzer to the remote computer using the rear-panel device-side USB connector.
2. The 'Found New Hardware' wizard is launched. Follow the prompts to install the PNA driver software.
3. The Agilent I/O Libraries will recognize the PNA as a Test and Measurement device. To set an alias name, start Agilent I/O libraries and find the USB connection. Depending on the Agilent I/O Libraries version, you will see a dialog like the following.



Note: The PNA is not a USB Mass Storage Device. Therefore, Windows Explorer does NOT recognize it as a USB device. You can NOT use Windows Explorer to transfer files to and from the PNA. For file transfer, use the SCPI command MMEM:TRANsfer.

Alias name Change this to a name that is easy to recognize. Once configured, use the Alias name to communicate with the USB device using applications such as VISA and SICL:

```
VISA: viOpen (...,"UsbDevice1",...)
```

```
SICL: iopen ("UsbDevice1")
```

For more information, see the Connectivity Guide in the Agilent I/O libraries.

Configure PC to Analyzer over LAN

This procedure shows how to configure a PC to a **PNA, ENA, or FieldFox** over LAN. Both the PC and analyzer must be connected to the internet.

- **Note:** Because this topic pertains to both the 85070 and 85071 software products, the term "8507x" is used to refer to both software products.
- This procedure assumes that the 8507x software is installed on your PC. Learn how.
- In addition, Agilent IO Libraries must be installed on the PC. If they are not already installed on PC, install them now. A complimentary copy is located on your software CD and from the Agilent 8507x Series Software Download Page.
- See other configuration methods

Overview

The following is an overview of the detailed steps in this topic:

1. Connect LAN cable between the analyzer and site LAN hub or router.
2. Obtain the Hostname or IP address of the analyzer:
    1. PNA - (Also enable VISA/SICL)
    2. ENA
    3. FieldFox
3. Setup LAN on PC using ACE
4. For PNAs with older firmware, install PNAProxy.exe

---

2. Obtain Hostname or IP address

You can connect to all of the analyzers using either the Hostname (also known as computer name) or the IP address. The following instructions show how to learn the hostname of each analyzer. Make a note of the hostname as it will be needed later in the process.

...On the PNA

1. Click **File**, then **Minimize Application**
2. On the PNA desktop, right-click **My Computer** Icon, then click **Properties**
3. Click the **Computer Name** tab at the top of the dialog box
4. Note the **Full computer name**.

5. Click **OK**.

Enable VISA or SICL communication over LAN:

1. On the PNA, click **System,** point to **Configure,** then click **SICL/GPIB**.
2. Check **SICL Enabled.** To automatically enable SICL when the PNA is booted, check **Automatically enable on Startup**.
3. Click **OK.**

...On the ENA

1. Press **System**, then **Misc Setup**, then **Network Setup**, then **Network Identification**.
2. Click the **Computer Name** tab, then under **Computer Description.**
3. Note the **computer name**.
4. Click **OK**.

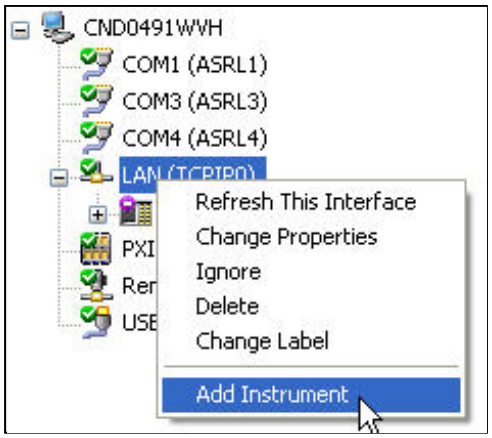
...On the FieldFox

1. Press **System**, then **System Configuration**, then **LAN**.
2. Line "Obtain IP" should be "DHCP" If not:
    a. Scroll cursor down to "Obtain IP" line
    b. Press **Edit**
    c. Press **Obtain IP** to toggle from "Static" to "DHCP"
    d. Press **Done Edit**
3. Note the **Hostname** on the FieldFox display on the line above.
4. Select **Done**

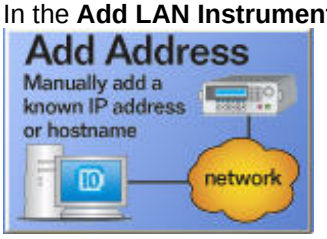
3. Setup LAN on the PC using Agilent Connection Expert

These instructions show screen shots from Agilent IO Libraries version 16.1. Other versions may be slightly different.

1. Right click on Agilent IO Libraries icon  in lower right hand corner of PC display and select Agilent Connection Expert.
2. In the **Instrument I/O on this PC** window, right click **LAN (TCPIPO)** and select **Add Instrument** as shown in this image:



3. In the **Add LAN Instrument** dialog, click **Add Address**



4. Check **Use Hostname** and enter the Hostname that you wrote down earlier from analyzer. You can also enter the IP address.

5. Click **Test Connection** or **Identify Instrument** to verify the connection is made. If verification is returned, click **OK**. Otherwise, check the connection or Hostname / IP address and try again.

6. Optionally, right click on the analyzer that you just connected to and select **Add VISA Alias**. Type a name for the analyzer (such as "FieldFox") in VISA alias text box. Click **OK**.

7. Start the 8507x software, click **Preferences**, then **Instrument**, then **Re-scan** to find the new connection. Select it, then click **OK** to complete the connection. Learn more about Hardware Scan.

4. For the following PNA models with older firmware

- All PNA 836xA/B/C models and N5230A/C models with firmware versions below A.09.42.18.
- All PNA-X, N522x, N523x models with firmware versions below A.09.50.12.

The following steps show how to locate and install the program **"pnaproxy.exe"** on your PC. The file is located on the PNA at C:\Program Files\Agilent\ Network Analyzer \Automation

1. Either map a drive from the PC to the PNA or copy the file to the PC using a flash drive or other media. Learn how to map a drive at: http://na.tm.agilent.com/pna/help/latest/S5_Output/Drive_Mapping.htm

Note: If mapping a drive to the PNA, to avoid potential security permission complications, it is easiest to add

yourself as an administrator on the PNA using the same name and password as that used on your PC. Firewall or Anti-virus software running on the PC can sometimes interfere. Disable them if possible.

2. On the PC, double-click **pnaproxy.exe** and follow the prompts to Install PNA Proxy.

   - If the installation offers a choice of Modify, Repair, or Remove, then select **Remove**. Then double-click on **pnaproxy.exe** again.
   - If prompted for the Computer name of the PNA, click **Next>**.

Configure PC to Analyzer using Crossover LAN

This procedure shows how to directly connect the PC to a **PNA, ENA, or FieldFox** using an RJ-45 LAN **crossover** cable.

- Because this topic pertains to both the 85070 and 85071 software products, the term "8507x" is used to refer to both software products.
- This procedure assumes that the 8507x software is installed on your PC. Learn how.
- In addition, Agilent IO Libraries must be installed on the PC. If they are not already installed on PC, install them now. A complimentary copy is located on your software CD and from the Agilent 8507x Series Software Download Page.
- See other configuration methods

Overview

The following is an overview of the detailed steps in this topic:

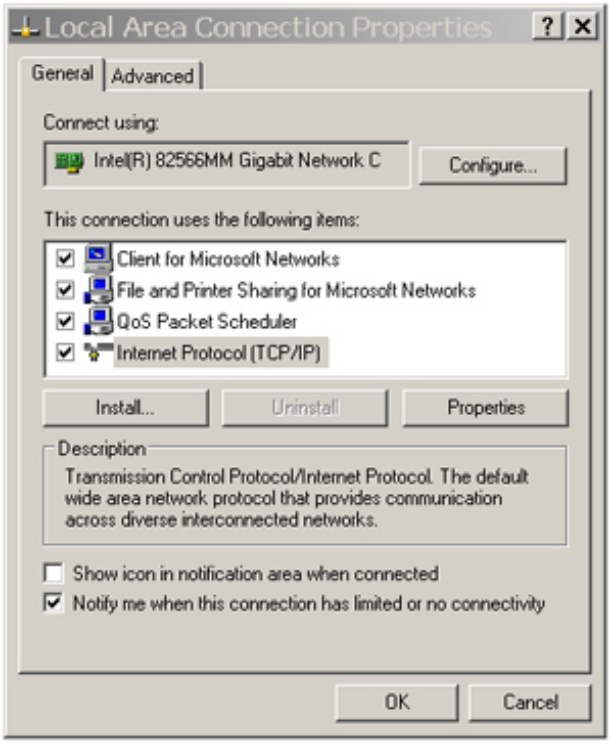
1. Setup LAN on PC
2. Setup LAN on the Analyzer
    1. PNA
    2. ENA
    3. FieldFox
3. Setup LAN on PC using ACE
4. Start the 8507x Software

---

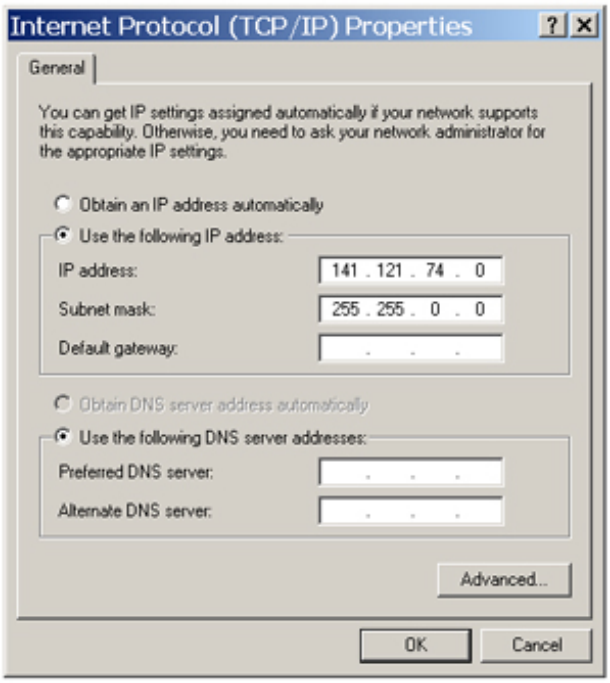
1. Setup LAN on PC

Note: Do not connect the LAN cable until instructed.

- On the PC, click **Start**, then **Control Panel**, then **Network Connections**
- Click **Local Area Connection**
- In the dialog box,, click on **Properties**
- Select **Internet Protocol(TCP/IP)** then click **Properties**



- Select **Use the following IP address**
- Enter an IP address and Subnet mask. For example:
    - IP address: 141.121.74.0
    - Subnet mask: 255.255.0.0



- Click **OK**
- Click **Close**
- Click **Close**

2. Setup LAN on the Analyzer

...On a FieldFox

- Press **System**, then **System Configuration**, then **More**, then **LAN**
- Line "Obtain IP" should be "Static" If not:
    - Scroll cursor down to "Obtain IP" line
    - Press **Edit**
    - Press **Obtain IP** to toggle from "DHCP" to "Static"
    - Press **Done Edit**
    - Edit Static IP address so that is one more or less than the IP address you set on the PC and the Subnet mask is the same . For example:
        - IP address: 141.121.74.1
        - Subnet mask: 255.255.0.0

- Connect LAN cable between PC and analyzer. This can be a regular LAN or crossover LAN cable.
- Scroll down to **Apply Settings** and select **Now**

...On a PNA

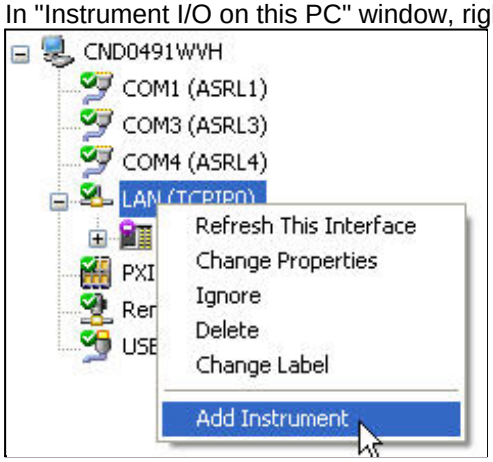
- click file, then Minimize Application
- On the PNA desktop, click **Start**, then **Control Panel**, then **Network Connections**
- Click **Local Area Connection**
- In the dialog box,, click on **Properties**
- Select **Internet Protocol(TCP/IP)** then click **Properties**
- Select **Use the following IP address**
- Edit the Static IP address so that is one more or less than the IP address you set on the PC and the Subnet mask is the same . For example:
  - IP address: 141.121.74.1
  - Subnet mask: 255.255.0.0
- Connect a crossover LAN cable between PC and analyzer.
- Close the Network Configuration windows.

...On an ENA

- Press **System**, then **Misc Setup**, then **Network Setup**, then **Network Configuration**.
- Double-click the Local Area Connection icon in the Network Connections window. The Local Area Connection Status screen appears.
- Click **Properties**. The Local Area Connection Properties screen appears.
- Select **Internet Protocol (TCP/IP)**, then click **Properties**.
- The Internet Protocol (TCP/IP) Properties appears. Click **Use the following IP address.**
- Edit the Static IP address so that is one more or less than the IP address you set on the PC and the Subnet mask is the same . For example:
  - IP address: 141.121.74.1
  - Subnet mask: 255.255.0.0
- Connect a crossover LAN cable between PC and analyzer.
- Close the Network Configuration windows.

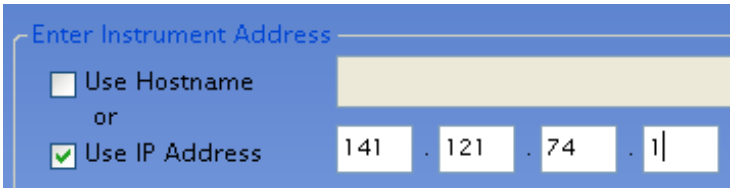
3. Setup LAN on PC using Agilent Connection Expert

- These instructions show Agilent IO Libraries 16.1. Other versions may be slightly different
- Right click on Agilent IO Libraries icon in lower right hand corner of PC display and select Agilent Connection Expert.
- In "Instrument I/O on this PC" window, right click on LAN(TCPIPO) and select Add Instrument.



- In the **Add LAN Instrument** dialog, click **Add Address**

- Click on IP address radio button and enter IP address of the analyzer.



- Click **Test Connections** or **Identify Instrument** to verify the connection is made. If verification is returned, click **OK**. Otherwise, check the connection or IP address and try again.
- Optionally, right click on the analyzer that you just connected to and select **Add VISA Alias**. Type a name for the analyzer (such as "FieldFox") in VISA alias text box. Click **OK**.

Start the 8507x Software

- In the 8507x, click **Preferences**, then **Instrument**, then **Re-scan** to find the new connection.
- Select it, then click **OK** to complete the connection. Learn more about Hardware Scan.

Configure PC to Analyzer over GPIB

This procedure shows how to connect the PC to a **PNA or ENA** using a GPIB cable.

Important Note

This connection method can NOT be used for the following **PNA** models/firmware versions:

- All PNA C models with firmware versions below A.09.42.18
- All PNA/PNA-X models with firmware versions below A.09.50.12
- All other older PNA models.

Use Configure PC to Analyzer over LAN method with the additional Step 4.

- The PC must have a GPIB Interface card installed.
- In addition, Agilent IO Libraries must be installed on the PC. If they are not already installed on PC, install them now. A complimentary copy is located on your software CD and from the Agilent 8507x Series Software Download Page.
- Because this topic pertains to both the 85070 and 85071 software products, the term "8507x" is used to refer to both software products.
- This procedure assumes that the 8507x software is installed on your PC. Learn how.
- See other configuration methods

Procedure

1. Connect GPIB interface cable between the PC and the analyzer.
2. Run 8507x Software. Click **Preferences**, then **Instrument**, then **Re-Scan**. The software will automatically try to connect to the GPIB instrument.
3. If the connection dialog does NOT show the GPIB instrument, use Agilent IO Libraries to verify that the instrument was properly configured.

Scan Hardware

It would be very time-consuming to look for hardware at every interface and address each time the 8507x software is started. This is especially true considering that most people use the same hardware every time. The following process is used by the 8507x software to establish a connection with your analyzer.

When the 8507x software is started, it looks for the same instrument at the same address that was last used when the software was run.

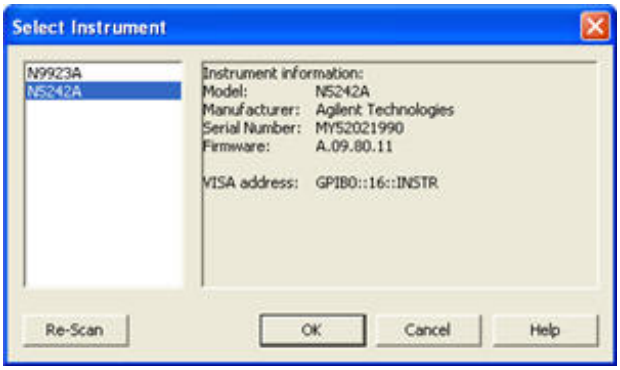
- If that instrument IS found, the 8507x software is launched and the connection to that instrument is made. To change instruments, perform a Re-Scan.
- If that instrument is NOT found, or when 8507x is first run, then 8507x automatically performs a Hardware Scan.

Re-Scan for New Hardware

In addition to the automatic scan when the 8507x software begins, you can initiate a Re-Scan at any time. You would do this to connect to a new instrument or the same instrument at a new address.

In the 8507x software, click **Preferences**, then **Instrument,** then **Re-Scan** to list all the instruments that are configured in Agilent IO Libraries. Instruments that are connected using GPIB are automatically configured in Agilent IO Libraries. Learn how to configure analyzers in Agilent IO Libraries.

For 85071 Resonant Cavity Option 300, click the **Instrument** button on the main window, then **Re-Scan**.



Select the Instrument / Interface you want to use, then click **OK**.

Set Up Probe Hardware

This section explains how to connect the probe kit hardware to the analyzer.

Topics in this section

Setup without ECal

The following instructions are for setting up with a network analyzer.

- High Temperature Probe Setup
- Slim Form Probe Setup
- Performance Probe Setup

See Also

Setup with ECal.

Set Up with E4991A for instructions to set up with E4991A.

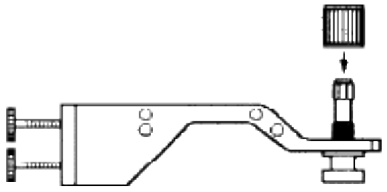
High Temperature Probe Setup

Equipment Used

- Probe Stand, 85070E-001
- Mounting Bracket (silver colored with two large thumb screws), included in 85070E
- Dielectric Probe, 85070E-020
- Cable, Recommended 85070E-002 or 85070E-022
- Adapters may be needed to make connections depending on your configuration. See Adapter Selection Guide

Connections

- Connect Mounting Bracket to Probe Stand by slipping the opening over the Probe Stand rod, and tightening the two large thumb screws in the back
- Connect Probe to Mounting Bracket



  - Remove large knurled nut from connector end of Probe
  - Guide probe connector up through hole in Mounting Bracket and reconnect large knurled nut to

hold it in place.

- Connect Cable to Probe.
- Connect other end of Cable to analyzer

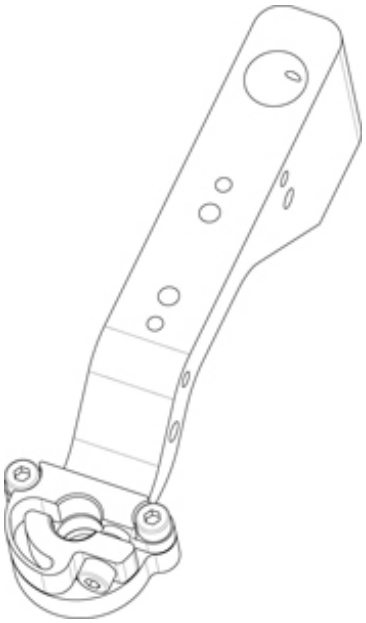
Slim Form Probe Setup

Equipment Used

- Probe Stand, 85070E-001
- Mounting Bracket (silver colored with two large thumb screws), included in 85070E
- 10mm Dia Holder (silver colored with 3 hex screws), included in 85070E
- Blue handled Hex Key, included in 85070E
- 10mm Sealed Holder (silver colored long), included in 85070E-030
- O-ring (included in 85070E-030)
- Connector Saver (included in 85070E-030)
- Slim Form Probe, 85070E-030
- Cable, Recommended 85070E-032
- Adapters may be needed to make connections depending on your configuration. See Adapter Selection Guide

Connections

- Connect Mounting Bracket to Probe Stand by slipping the opening over the Probe Stand rod, and tightening the two large thumb screws in the back
- Connect 10mm Holder to Mounting Bracket



- Loosen top two screws on 10mm Holder with Hex Key
- Slide 10mm Holder on to Mounting Bracket so that 10mm holes align
- Tighten top two screws on 10mm Holder with Hex Key

- Connect Probe to 10mm Dia Sealed Holder

- Disassemble 10mm Dia Sealed Holder by holding outer jacket steady turning inner jacket counter clockwise with a 5/16" open ended wrench.
- Slip inner jacket of 10mm Dia Sealed Holder on to the probe, large opening first, so that the end with the wrench flats is closer to the probe connector end.
- Slip an o-ring over the probe tip and slide it up until the top of the inner jacket almost all the way up the length of the probe.
- Slip the outer jacket of the 10mm Dia Sealed Holder on to the probe, large opening first, over the o-ring, and over the inner jacket so that the two wrench flat ends come together.
- Hold the outer jacket and turn the inner jacket clockwise with the open ended wrench to tighten

- Connect Probe in 10mm Sealed Holder to Mounting Bracket with 10mm Holder

- Carefully guide the probe tip through the 10mm holes in the 10mm Holder and Mounting Bracket.
- Loosen the single horizontal screw in front of the 10mm Holder with the Hex Key so that the Probe/10mm Sealed Holder can fit inside. You may also have to loosen the top two screws if the holes were not aligned well enough earlier.

        - Tighten all screws to hold everything firmly in place
    - Connect Connector Saver to Probe.
    - Connect Cable to Connector Saver
    - Connect other end of Cable to analyzer

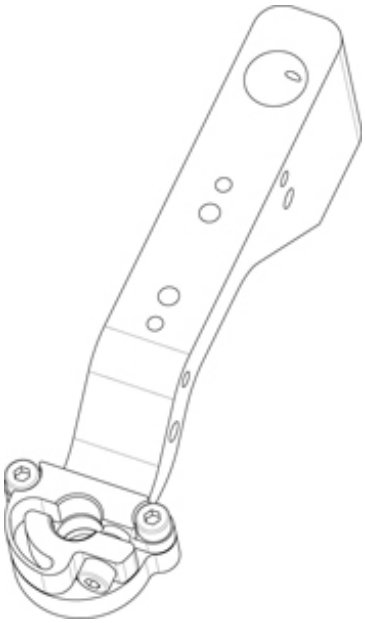
Performance Probe Setup

Equipment Used

- Probe Stand, 85070E-001
- Mounting Bracket (silver colored with two large thumb screws), included in 85070E
- 10mm Dia Holder (silver colored with 3 hex screws), included in 85070E
- Performance Probe, 85070E-030
- Cable, Recommended 85070E-032
- Adapters may be needed to make connections depending on your configuration. See Adapter Selection Guide

Connections

- Connect Mounting Bracket to Probe Stand by slipping the opening over the Probe Stand rod, and tightening the two large thumb screws in the back
- Connect 10mm Holder to Mounting Bracket



- Loosen top two screws on 10mm Holder with Hex Key
- Slide 10mm Holder on to Mounting Bracket so that 10mm holes align
- Tighten top two screws on 10mm Holder with Hex Key

- Connect Performance Probe to Mounting Bracket with 10mm Holder
  - Carefully guide the probe tip through the 10mm holes in the 10mm Holder and Mounting Bracket.
  - Loosen the single horizontal screw in front of the 10mm Holder with the Hex Key so that the Performance Probe can fit inside. You may also have to loosen the top two screws if the holes were not aligned well enough earlier.
  - Tighten all screws to hold everything firmly in place
- Connect Cable to Probe.
- Connect other end of Cable to analyzer

Setup with ECal

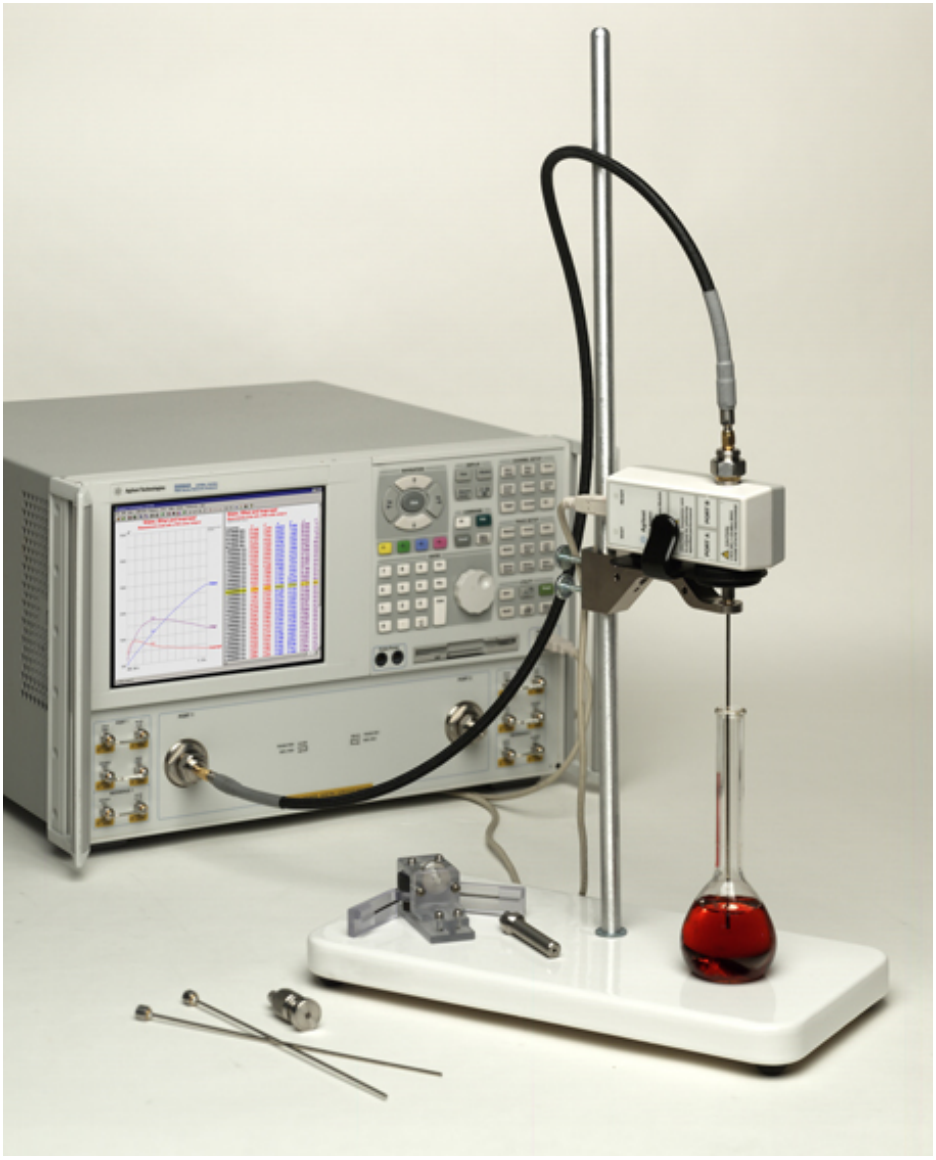
The following instructions are for setting up an ECal module with a network analyzer.

See Set Up with E4991A for instructions to set up with E4991A

How Electronic Calibration Refresh with ECal works

The electronic calibration refresh feature utilizes Agilent's ECal user characterization to recalibrate the system automatically, in seconds, each time a measurement is made. This virtually eliminates cable instability and system drift errors. This is useful for process monitoring over time or if the cable must be moved.

An Agilent ECal is connected in line between the probe and the cable that connects to the network analyzer. The probe should always be connected directly to the ECal module. The ECal module's USB cable is connected to the PC, PNA Series or ENA-C running the 85070E software. Behind the scenes during the normal three standard calibration, (usually open, short, water) performed at the tip of the probe, the software characterizes the calibration states within the ECal module. With the ECal module still in line, a complete ECal calibration is then automatically performed before each measurement.

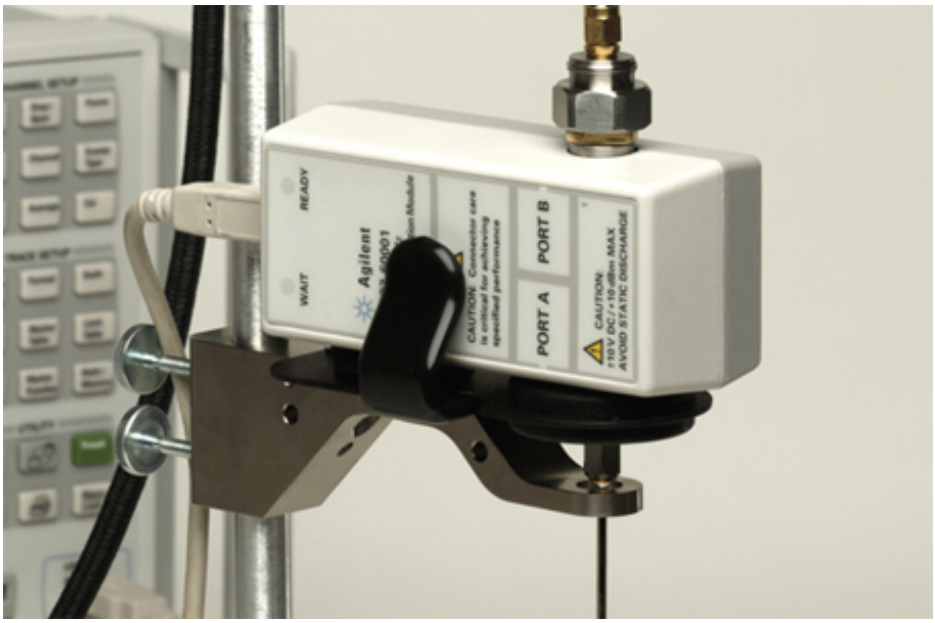


Equipment Used

- Probe Stand, 85070E-001
- Mounting Bracket (silver colored with two large thumb screws), included in 85070E
- ECal Holder (black colored), included in 85070E
- Blue handled Hex Key, included in 85070E
- Dielectric Probe, 85070E-020, 85070E-030, or 85070E-050
- ECal Module with USB cable
- Cable, Recommend 85070E-022 or 85070E-032

- Adapters may be needed to make connections depending on your configuration. See Adapter Selection Guide

Connections



1. Connect mounting bracket to Probe Stand by slipping the opening over the Probe Stand rod, and tightening the two large thumb screws in the back
2. Connect ECal Holder to mounting bracket using screws from mounting bracket and tightening with Hex Key.
   Note: The fit is tight to make sure ECal is secure.

For Slim Form Probe

1. Connect Probe to Connect Connector Saver
2. Connect Connector Saver to ECal.
3. Carefully guide probe down through hole in Mounting Bracket and fit ECal module into ECal Holder, being careful not to scratch the probe tip.

For Performance Probe

1. Connect Probe to ECal.
2. Carefully guide probe down through hole in Mounting Bracket and fit ECal module into ECal Holder, being careful not to scratch the probe tip.

For High Temperature Probe

1. Fit ECal module into ECal Holder.
2. Remove large knurled nut from connector end of Probe and put it away in the foam lined box

3. Guide connector end of probe up through hole in Mounting Bracket and connect to ECal

3. Connect Cable to ECal module.
4. Connect other end of Cable to analyzer.
5. Connect ECal USB cable to USB port on PC, PNA Series or ENA-C running the 85070E software

E4991A Setup

The E4991A Setup is different than that of Network Analyzers. Follow these steps to set up the Dielectric Probe Kit with E4991A.

Equipment Used

- E4991A option 010 Test Port Extender
- APC 7 to 3.5mm or 2.4mm female adapter or equivalent combination to connect probe to E4991A-010
- Probe Stand, 85070E-001
- Mounting Bracket (silver colored with two large thumb screws), included in 85070E or other lab stand bracket.
- Dielectric Probe, 85070E-020
- Adapters may be needed to make connections depending on your configuration. See Adapter Selection Guide

Connections

1. Connect Mounting Bracket to Probe Stand by slipping the opening over the Probe Stand rod, and tightening the two large thumb screws in the back
2. Connect E4991A-010 cables to analyzer
3. Connect E4991A-010 test port extender to Mounting Bracket using tie wraps or other secure method so that APC7 port connector is facing downward. The probe will be connected to this port later. Make sure there is sufficient space surrounding the probe to be able to calibrate and make measurements.

Calibrate E4991A-010

The E4991A-010 extended test port requires calibration using the APC7 standards that came with E4991A before connecting the probe. Follow the procedure in the E4991A firmware.

Connect the probe and adapters as needed to E4991A-010 extended test port.

Typical Probe Accuracy

Dielectric constant, ε_r':

$\pm .05 \left|\varepsilon_r^*\right|$

Loss factor, ε_r'':

$\pm .05 \left|\varepsilon_r^*\right|$

Loss tangent, tan δ, $\varepsilon_r'' / \varepsilon_r'$:

$$\frac{(\varepsilon_r'' - \Delta\varepsilon)}{(\varepsilon_r' + \Delta\varepsilon)} < \tan\delta < \frac{(\varepsilon_r'' + \Delta\varepsilon)}{(\varepsilon_r' - \Delta\varepsilon)}$$

$\Delta\varepsilon = .05 \left|\varepsilon_r^*\right|$

See Also

Probe Characteristics

Calibration and Measurement Tutorial

After completing this tutorial, you should be familiar with the main operating techniques and features of the 85070 dielectric probe software.

Note: This tutorial uses a 91% isopropyl alcohol and 9% water mixture as the MUT.

1. **Set the frequency range and type of sweep.** Click Calibration then enter a Start frequency of 500 MHz and a Stop frequency of 2.9 GHz. The default 51 points will cause the calibration and measurement to be done for 51 points linearly spaced between these two frequencies. Click OK. The main window will now show the new start and stop frequencies.

2. **Calibrate the system**. The calibration consists of measuring three known standards and using the results to characterize the three major sources of measurement error. The default calibration standards are air, a short circuit, and water. See Calibration for other choices. To ensure measurement accuracy, do not move the probe cable between calibration and measurements. If you have not already done so, stabilize the cable by locking the probe in the mounting bracket of the probe stand as shown in the Set Up Probe Hardware section. Always move the sample to the probe, never move the probe to the sample.

   Click **Calibration**, then **Perform Cal**. The following prompts appear to instruct you to connect standards.

   a. **Leave the probe open in air.** This is the open standard. Select **OK** in the dialog box and a measurement will be made.

   b. **Connect the shorting block**. The procedure for connecting the short varies with each probe. When the short is connected, click **OK**.

   a. High Temperature Probe Short

   b. Slim Form Probe Short

   c. Performance Probe Short

c. **Remove the short circuit and place the probe in 25 °C water**.

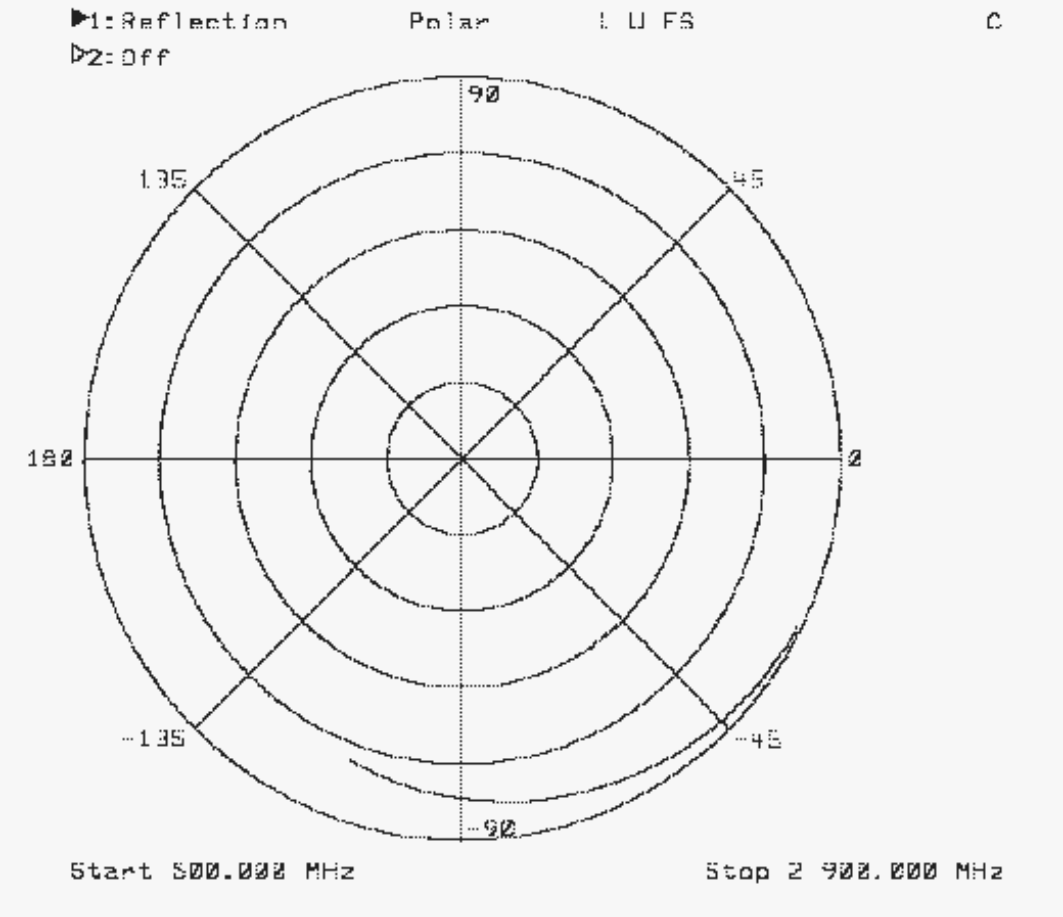
   a. Measure the temperature of a vial of deionized water with a thermometer. It should be 25 ° C. See the Software Reference to learn how to change the temperature setting.

   b. Immerse the probe in the water by moving the water to the probe. Make sure no air bubbles are clinging to the probe tip.

   c. Click OK. When the calibration is complete, remove the probe from the water and dry it. You may want to save the calibration by selecting Save Setup under the File menu. You are now ready to make measurements. A measurement can be made by selecting Trigger Measurement under the Measure menu.

4. **Measure the MUT**.

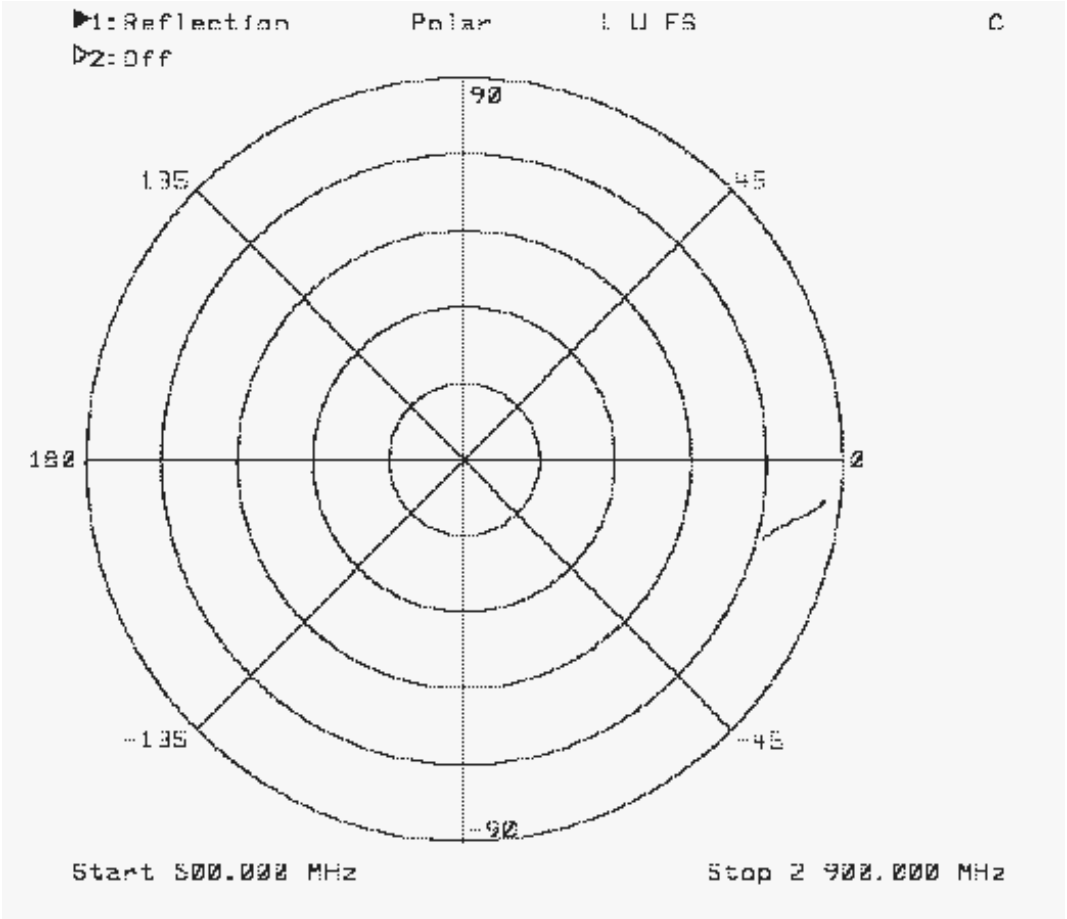
   1. Reinsert the probe into the water you used to calibrate the system, then click OK. The analyzer's display should look like the display below.



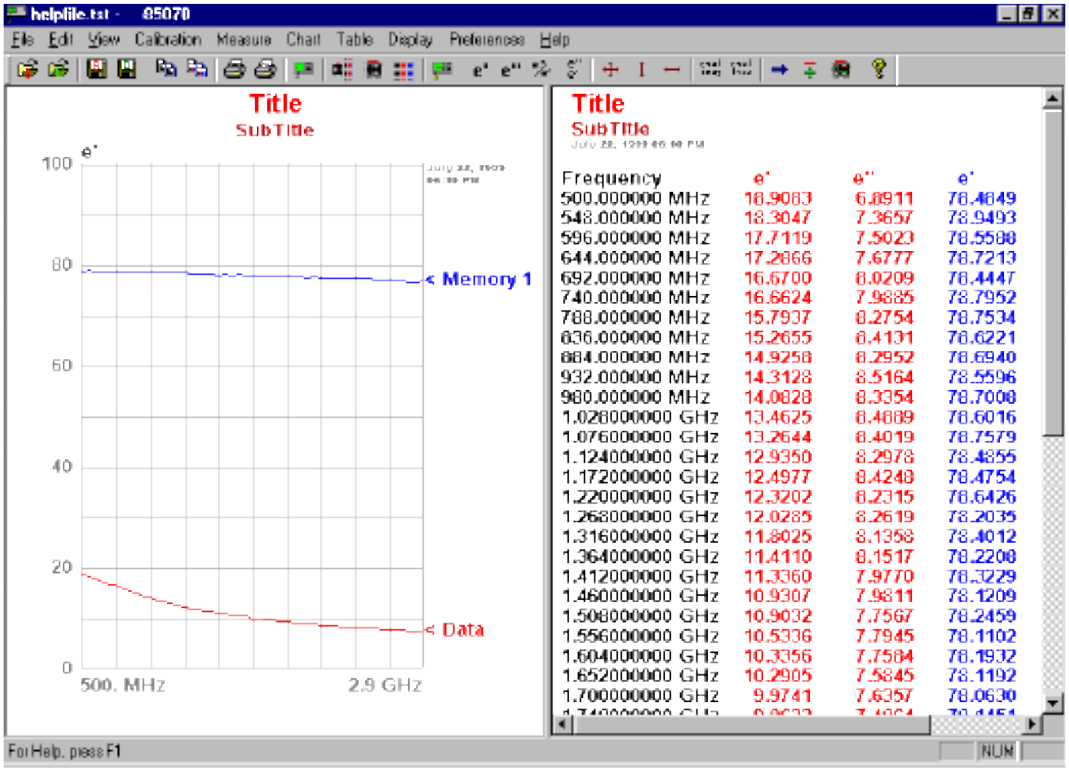
2. Insert the probe into the sample (MUT), then click OK. A measurement will be triggered. The measurement should appear on the display of the computer as shown below. This data can be saved to a file by selecting Save Data under the File menu.

3. Click **Display**, then **Data to Memory**, then **Memory 1**. A copy of the measured water is made to this memory trace. The Chart and Table will be updated to reflect this change.

4. Remove the water and dry the probe. Insert the probe into the alcohol and trigger a measurement as before. The display on the instrument will look similar to the one shown below.



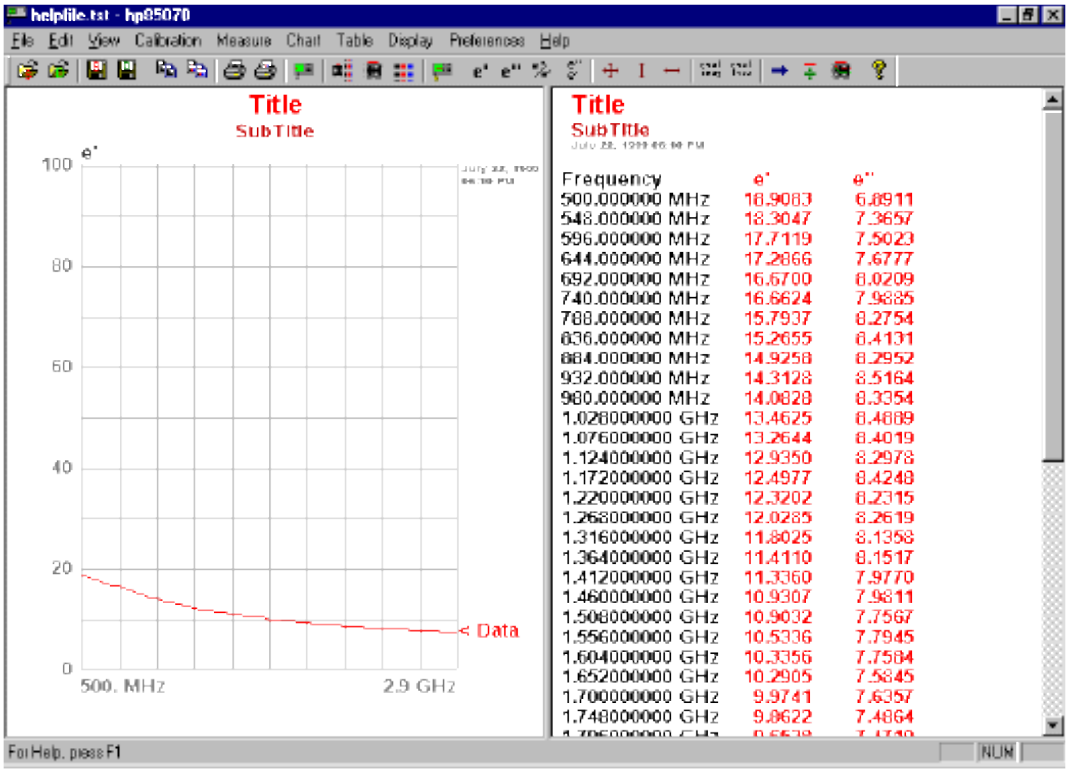
When the measurement is complete, the display on the PC should look the one below.



Note that only the Data trace is changed. The water measurement, stored in Memory 1, remains unchanged.

Click Display, then **Traces Displayed** to select which of the four valid traces are shown in the Chart and Table.

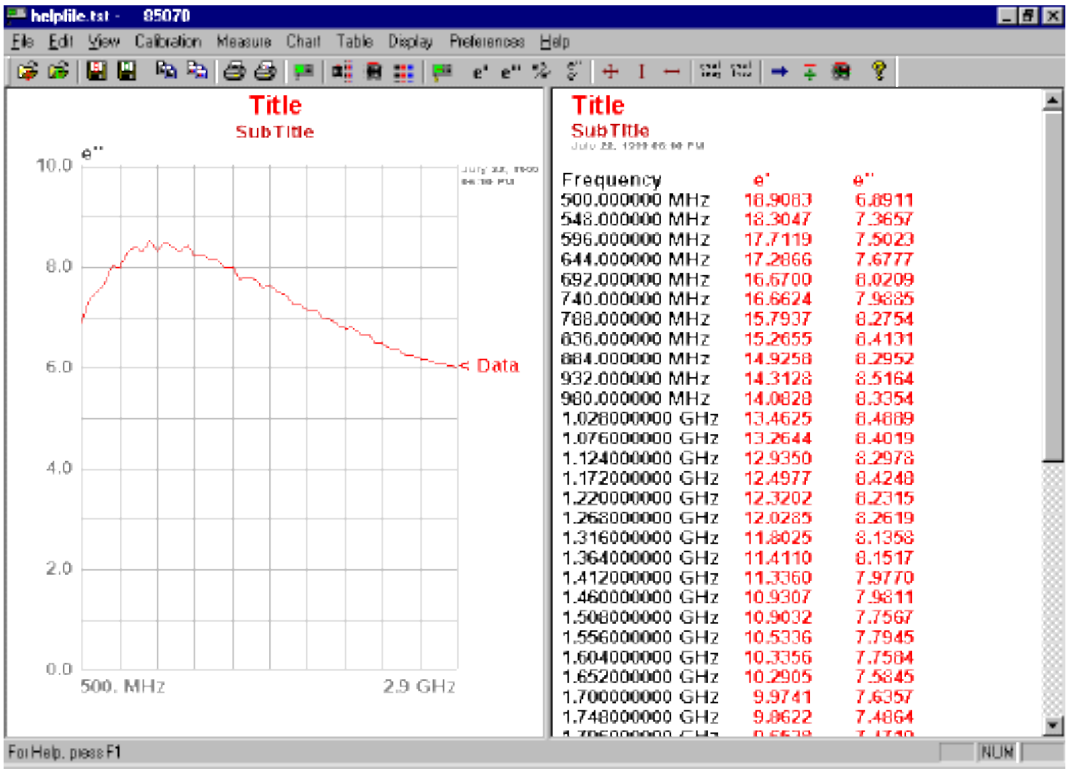
If you select **Data** then **OK**, the displayed window will look like the one below.



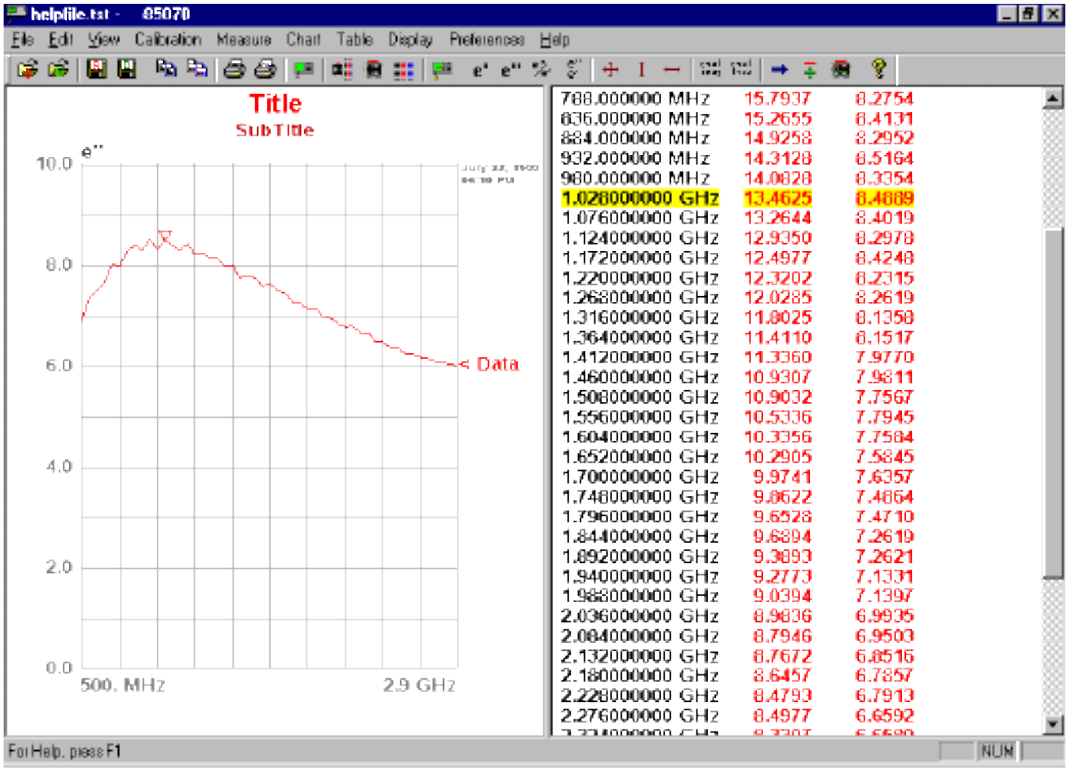
The Chart menu allows you to select which parameter you want to plot. Selecting ε'' from the Chart menu plots the measured loss factor.

Autoscale automatically selects the scale for the displayed measurements. When this is selected, the chart changes as shown below.

Alternatively, you can set the scale as desired using the Scale selection.



Clicking on a point of interest turns on a marker. Notice that the corresponding point in the Table is highlighted.



The marker can be moved by clicking at another location on the chart or a listed value in the table. The up and down arrows on the PC keyboard also move the marker. The marker can be turned off by clicking on the Marker item of the Display menu.

85070E Software Reference

This chapter details the operations of each menu, command, and entry parameter in the 8507xE software. The following are menu choices:

File - Save or recall measurement setups or previous measurement results. Print copies of the measurement results in a tabular or graphical format.

View - Select the section you want to view. Selection includes the toolbar, status bar, table of the measurement data and chart of the measurement data.

Calibration - Select the frequency range, number of points, linear or log sweep. Guided calibration sequence; choice of calibration materials or user-specified; refresh calibration for single standard, recalibration versus temperature.

Measure - Configure and Trigger a measurement.

Chart - Select the format to be displayed on the chart. Set the scale factors either manually or automatically. Select from linear, semi-log or log-log representation.

Display - Display current measurement data; save/display up to 3 memory traces; compare data to reference trace with trace math. Turn the marker on or off.

Preferences - Select your preferences of fonts, colors and annotations used to plot and list the measurement data.

Help - This help file and several menu choices.

ToolBar - Provides single click access to the most important menu items.

File Menu

Click **File** to make the following settings:

- Open Setup File
- Save Setup File
- Save Setup File As
- Open Data File
- Save Data File
- Include Sensitivity Data (85070E Only)
- Save S-parameter Data (85071E Only)
- Print Chart
- Print Chart Preview
- Printer Setup

Beginning with software release E.07.02:

- The **85070E** software uses a ***.prb** file extension for setup files.
- The **85071E** software continues to use ***.tst** file extension.

Open Setup File

Allows the user to open a previously saved setup file. This file contains all the all the information pertaining to the measurement setup including the calibration, previous measurements and other preferences chosen at the time the file was saved.

Only one file can be open at any time. When you open another file, the previous setup is replaced.

Save Setup File

Allows the user to save the current setup. The file created contains all the information pertaining to the measurement including the calibration, previous measurements. If the current setup has not previously been saved, this choice is treated as ‘Save Setup File As’ described below.

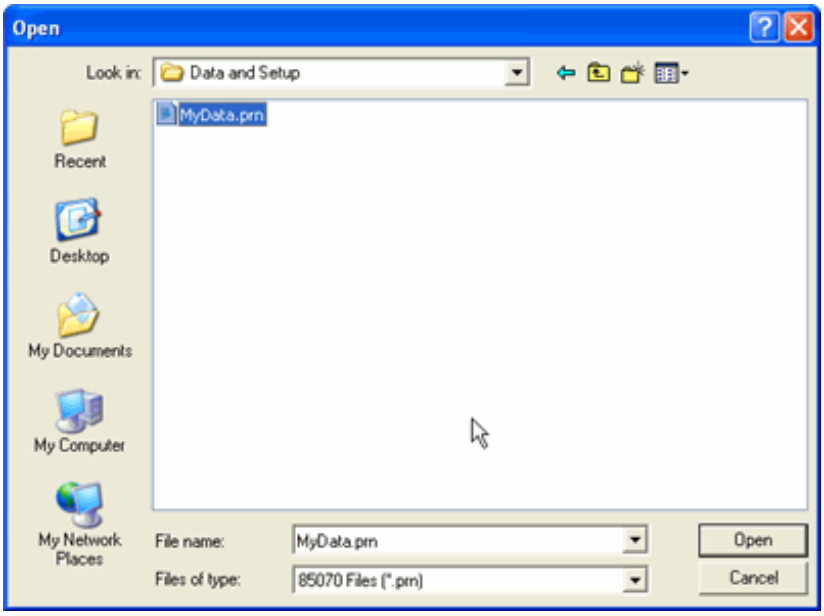
Save Setup File As

Allows the user to save the current setup. The file created contains all the information pertaining to the measurement including the calibration and previous measurements.

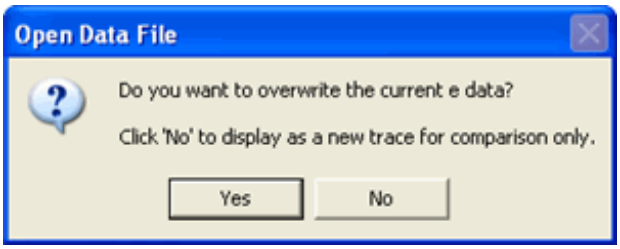
Enter a file name and click **OK**.

Open Data File

Open a previously saved *.prn or *.csv data file.



If a data set is already resident in the 8507x software, the following message appears:



Yes - Overwrite/replace the current data set.

No - Store the current data set in memory for comparison to the new data set.

Save Data File

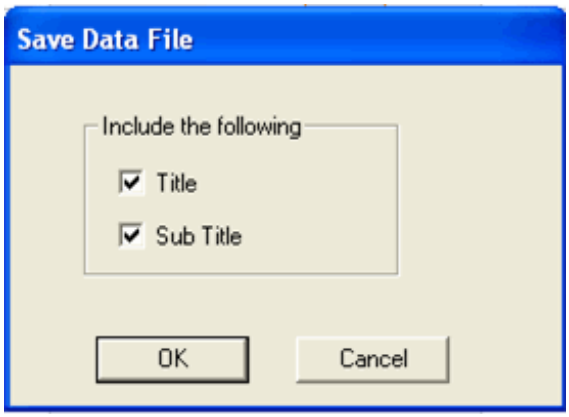
Saves measurement data.

In the Save As dialog

- Enter a File name (without suffix)
- Click **Save as type:** then choose from:

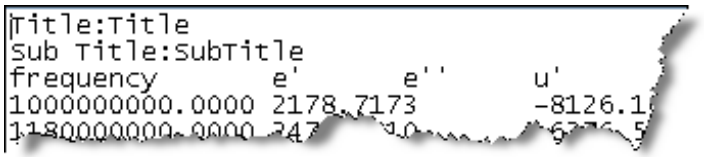
  85070 Files (*.prn) - Tab-separated data.

  Click **Save** and the following dialog appears:



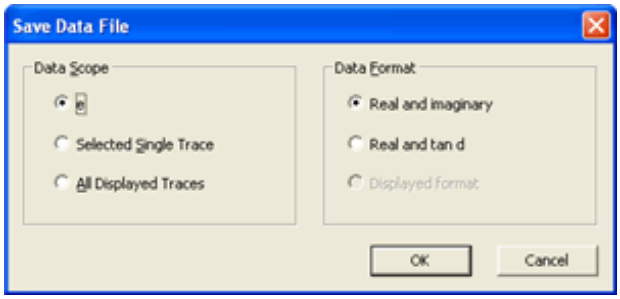
The selected fields appear in the saved *.prn file.

The following shows the header for a *.prn file



CSV files (*.csv) - Comma-separated values. Open easily with a compatible spreadsheet program.

Click **Save** and the following dialog appears:



Data Scope

Choose from:

- **e** - Save frequency, e, and e' data
- **Selected Single Trace** - Save frequency and data for the active trace.
- **All Displayed Traces** - Save frequency and data for ALL traces in ALL displayed charts.

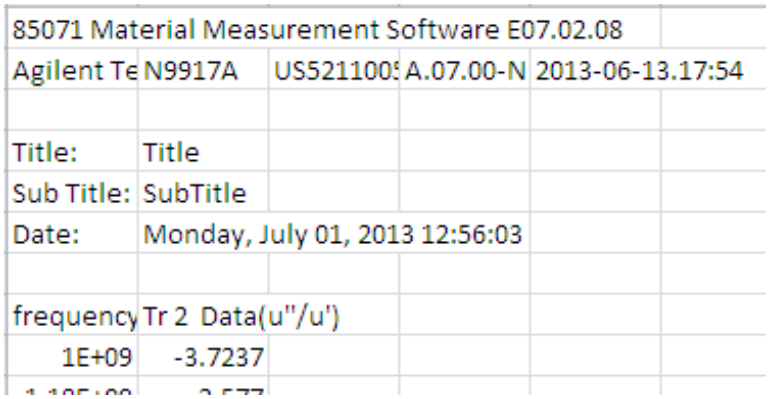
Data Format

Choose from:

- **Real and imaginary** - saves both real and imaginary values.
- **Real and tan d** - saves both real and tan d values.

- **Displayed format** - Save data in its native or selected format.

  The following image shows the header information for a *.csv file



85071 Material Measurement Software E07.02.08					
Agilent Te	N9917A	US521100	A.07.00-N	2013-06-13.17:54	
Title:	Title				
Sub Title:	SubTitle				
Date:	Monday, July 01, 2013 12:56:03				
frequency	Tr 2 Data(u''/u')				
1E+09	-3.7237				

  When "Selected Single Trace" is select, the measurement date for this trace is used as the date. Otherwise, the date for the last valid active measurement is used.

Include Sensitivity Data (85070E Only)

When selected, the sensitivity data will be included. See **Measurement Uncertainty** for information on the use of sensitivity data.

S-Parameter Data (85071E Only)

When selected, the S-parameter data, in <Real,Imag> pairs is saved to a *.txt file.

Print Chart

Prints the Chart (graph)

Print Chart Preview

Shows what the printed chart will look like. Use Printer setup to change the orientation of the printed chart.

Printer Setup

Allows the printer to be setup. Exact behavior depends on the selected printer.

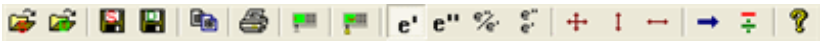
Last modified:

1-Jul-2013	Added date field to .csv file saves Added *.prb file ext.
20-Nov-2012	Major edits

View Menu

Click **View** to make the following settings:

Toolbar – Toggles the toolbar ON and OFF. When checked, the toolbar is visible. Learn more about these icons.



Status Bar – Toggles the Status Bar ON and OFF. When checked, the Status Bar is visible in the bottom of the software screen.

Show User-defined standards. (85070E Only) When clicked, traces appear on the current plot representing the three User-defined standards.

Calibration Menu

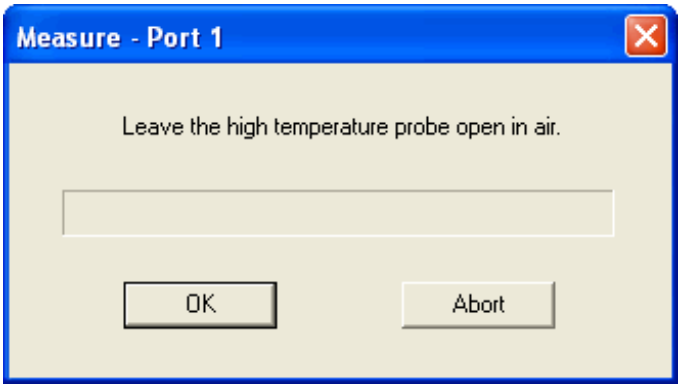
Click **Calibration** to make the following settings:

- Perform Cal
- Set Frequency (separate topic)
- Configure Cal
- Refresh Cal
- Auto Refresh ON
- Select Probe (requires 85070E Opt. 400)
- Copy Probe (requires 85070E Opt. 400)

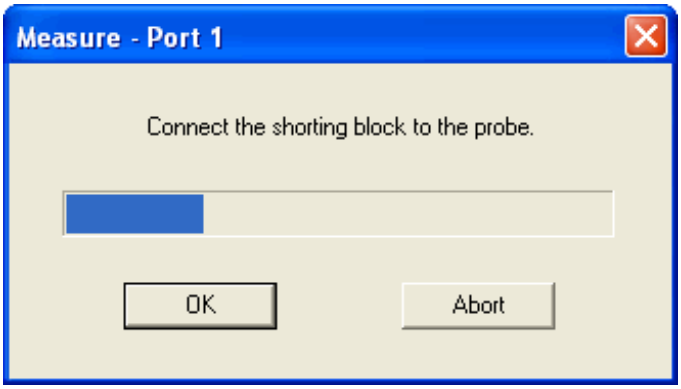
Perform Cal

This selection guides you through a calibration, which involves measuring three standards.

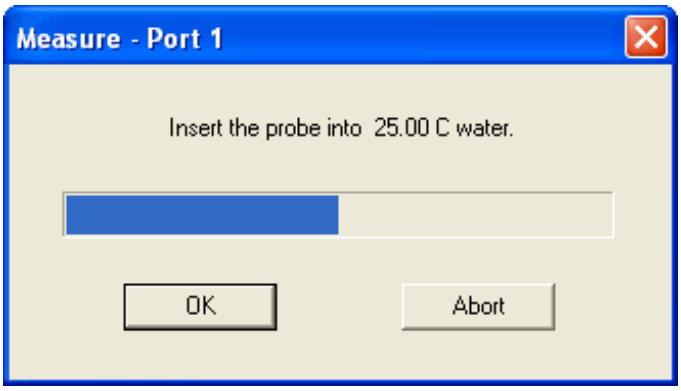
See Measurement Tutorial for additional information.



With the probe in open air, click OK. This measurement is stored into the analyzer memory. Then the Data / Memory trace is shown for the following Short measurement.



While watching the analyzer display, when the Shorting block is connected, you should see the phase of -180 degrees. Click **OK** to measure the Short.



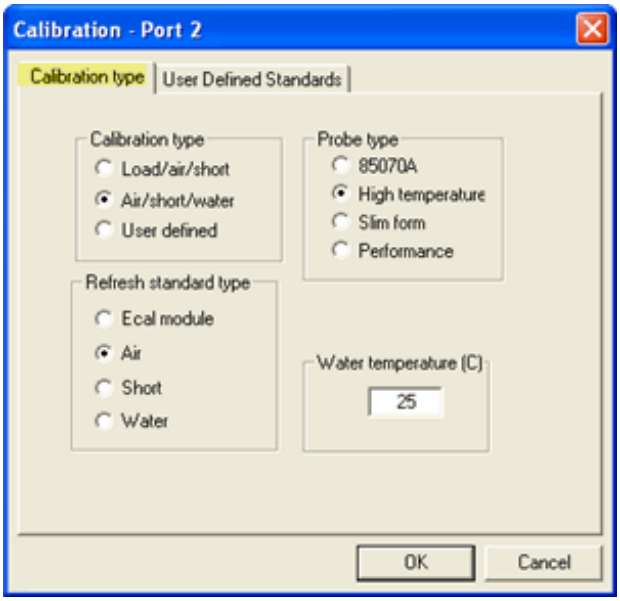
Insert the probe tip into water, then click OK.

Note: When using an 4991 impedance analyzer, you must first perform a calibration from the front panel of the analyzer. It is recommended that the probe be connected directly to the 7mm connector of the analyzer using an appropriate adapter. Using a cable is NOT recommended.

Configure Cal

This selection allows you to configure the calibration.

Calibration Type tab



Calibration Type - Choose from the following:

- **Load /air/short** Requires a measurement of a 50-ohm load connected to the end of the cable, measurement of the probe in air and measurement of the probe with the shorting block attached.
- **Air/short/water** Requires the measurement of the probe in air, with the shorting block attached to the probe, and with the probe immersed in water.
- **User defined** Allows you to define calibration standards. This type of calibration requires the measurement of the probe immersed in three liquids. Three choices are available for the refresh standard.

Probe Type

Click each link see the characteristics of each probe.

Choose from:

- 85070A
- High Temperature
- Slim Form
- Performance

Refresh standard type

After the calibration has been performed, the calibration can be refreshed by remeasuring one standard. This is useful when measuring at a temperature other than the one at which the calibration was performed.

Choose from: Air, Water, Short, or ECal Module.

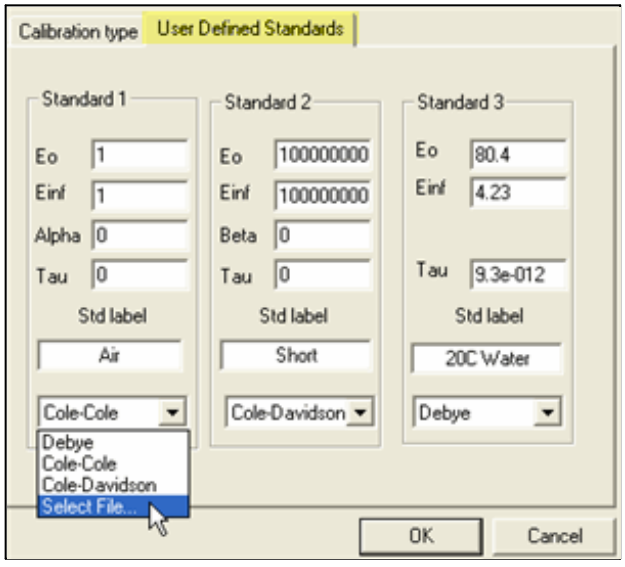
When an ECal module is being used as the refresh standard there will not be a prompt. Learn how to Setup with an ECal module.

Water Temperature - Set the temperature of the water that is to be used.

Auto Refresh On

When checked a refresh will be done before each measurement using an ECal module.

User-Defined Standards



This dialog allows you to define the liquids used in the user-defined calibration in terms of their model coefficients. These models are used to calculate the standards permittivity as a function of frequency.

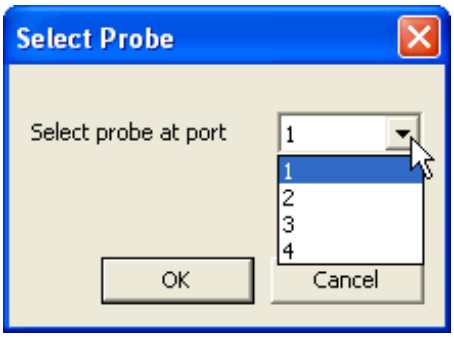
Choose from: Debye, Cole-Cole, or Cole-Davison model.

Or click **Select File**, then navigate to a *.prn file that contains this relationship. The format for these files are the

same as the files saved under the file menu. The std labels are the names that are used when prompted to immerse the probe into the standard.

Select Probe

This dialog, available with Opt. 400, allows you to setup several probes for simultaneous measurements.



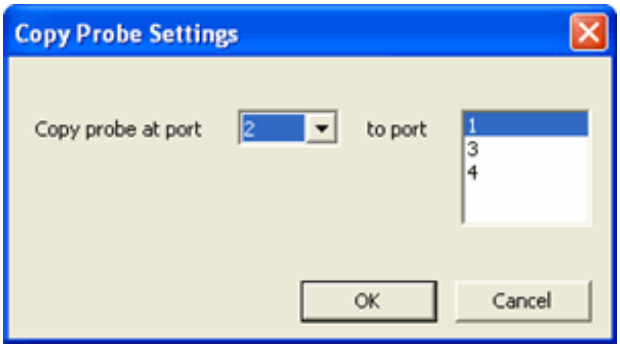
Select a port number for probe measurement. This port is appended to the calibration dialogs.

Copy Probe

Once a probe port has been configured, copy the settings from that port to other ports using this dialog.

The following settings are copied: frequency range, number of points, power, IFBW, calibration settings and data.

Although the calibration data can be copied to a new port, for highest accuracy perform a new cal for each new port.



Copy probe at port - Select the port for which settings are to be copied.

to port - Select the port to copy settings to.

Each port must be copied separately.

Last modified:

May 24, 2013	Added 85070 to Option 400
20-Nov-2012	Added opt 400

Measure Menu

Click **Measure** to show the following choices:

Trigger Measurement

Triggers a measurement ONLY if a Calibration has already been performed.

Import (Opt 400 only)

Loads an s1p, s2p, or *.ts (touchstone 2.0) file that contains measurement data. When a 2-port file is imported, the 85070E software uses ONLY the S11 data in the file, regardless of the currently-selected port.

Arm External Trigger

When selected, the Remote Switch is used to trigger a measurement. The Remote switch is connected to the external trigger connector on the back of the network analyzer.

Show prompt

When checked, a prompt will be displayed before the measurement is made. Otherwise the measurement will be triggered when 'Trigger Measurement' is selected or the 'Measure' Toolbar icon is clicked.

Measure Prompt

Chart Menu

Click **Chart** to make the following settings:

- Format (Opt 400 Only) (separate topic)
- Change Measurements
- New Trace
    - Measurements
- Autoscale
- Scale Coupling
- Set Scale (Manually)
- Default
- New Chart
- Delete Chart
- Copy Chart (85071E Only)

See Also: Working with Charts and Traces

Change Measurements

Also available by right-clicking on the chart.

- ε' – The real part of the complex permittivity (the dielectric constant) is plotted.
- ε'' – The imaginary part of the complex permittivity (the loss factor) is plotted.
- **Loss tangent e** – The ratio of the imaginary part (the loss factor) to the real part (the dielectric constant) of the complex permittivity (loss tangent) is plotted.
- **Cole-Cole e**– Loss factor vs. the dielectric constant is plotted.

New Trace

Also available by right-clicking on the chart.

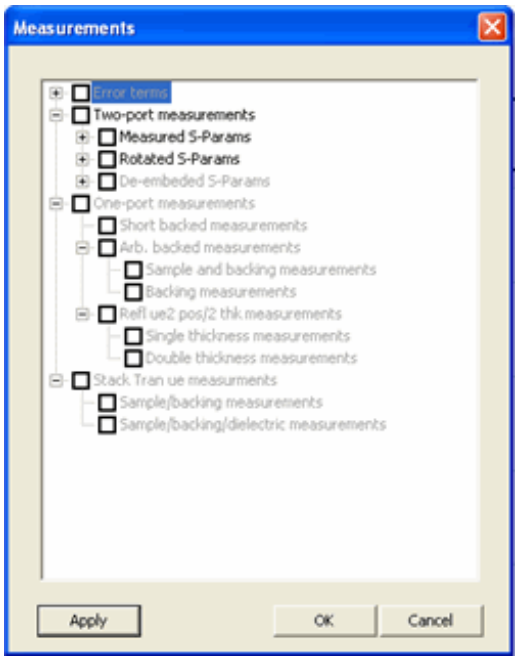
Select one of the above measurements. The trace will appear in the current (active) chart.

Measurements (Option 400 only)

Click **Chart**, then **New Trace**, then **Measurements** to see one of the following dialogs.

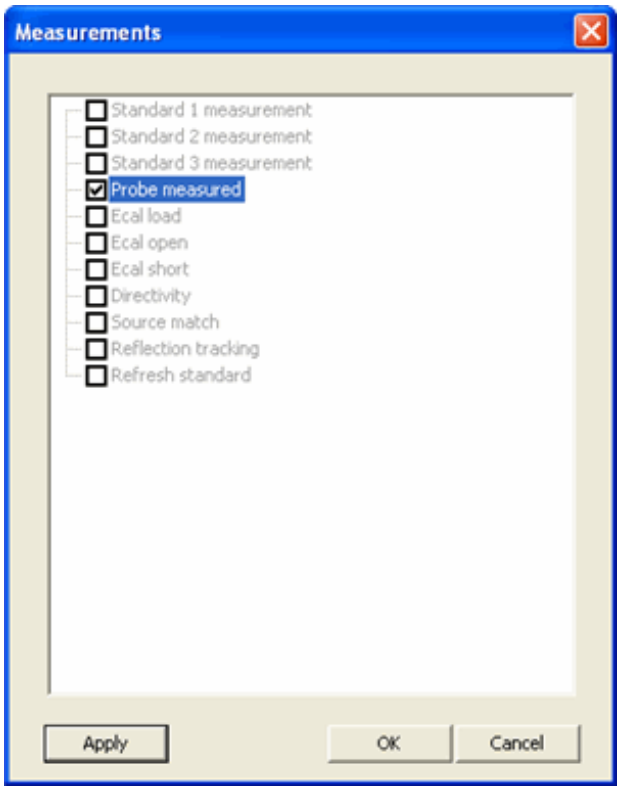
- Click **+** next to headings to show available measurements.
- Check boxes to create new traces in the active chart.
- Only those measurements with the same number of ports as those in the chart are available.

85071E Measurements available:



- Error terms - view the results from calibration std measurements
- Two-port measurements (85071E Only)
    - Measured S-Parameters - standard Network analyzer measurements. Select a format.
    - Rotated S-Parameters
    - De-embedded S-Parameters

85070E Measurements available:



- Error terms - view the results from calibration std measurements
- Probe measured - this is the only 85070E S-parameter available. This is a 1-port measurement.

Autoscale

Automatically selects the scale based on the traces displayed.

Autoscale ALL, available by right-clicking on the chart, performs this operation on all displayed traces in the chart.

Scale Coupling

Also available by right-clicking on the chart.

- **Off** - Scale is set individually for each trace.
- **Chart** - Scale is set for all traces in the chart.
- **All** - Scale is set for all charts.

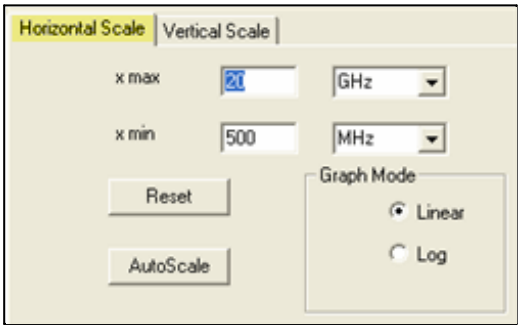
Set Scale (Manually)

Also available by right-clicking on the chart.

Starts the following dialog which allows the horizontal and vertical scales to be set for the active trace, chart, or all charts, depending on the **Scale Coupling** setting.

Note: To quickly zoom on an area of a trace, click and drag the mouse around the specific area.

Horizontal Scale



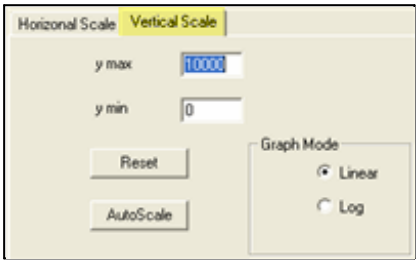
X max and X min - Enter the minimum and maximum X-axis value and unit. These settings default to the current X-axis range of the calibration and measurement. Reduce these values to zoom in on a measurement.

Reset - Click to reset to the default X-axis settings.

Autoscale - Click to autoscale the chart X-axis and Y-axis.

Graph Mode - Select **Linear** or **Log**arithm.

Vertical Scale



Y max and Y min - Enter the minimum and maximum Y-axis value. Reduce these values to zoom in on a measurement.

Reset - Click to reset to the default Y-axis settings.

Autoscale - Click to autoscale the chart X-axis and Y-axis.

Graph Mode - Select **Linear** or **Log**arithm.

Default

Resets the scale to the default values.

New Chart

Also available by right-clicking on the chart, then pointing to **Chart.**

A new chart appears with no measurement. Right-click in the chart, then select one of the above measurements.

Delete Chart

Also available by right-clicking on the chart, then pointing to **Chart.**

The chart can also be deleted by pressing **Delete** on your keyboard.

Copy Chart

Available ONLY by right-clicking on the chart, then pointing to **Chart.**

A duplicate chart is created identical to the one just right-clicked.

Last modified:

1-Jul-2013	Added copy chart
20-Nov-2012	Major edits

Display Menu

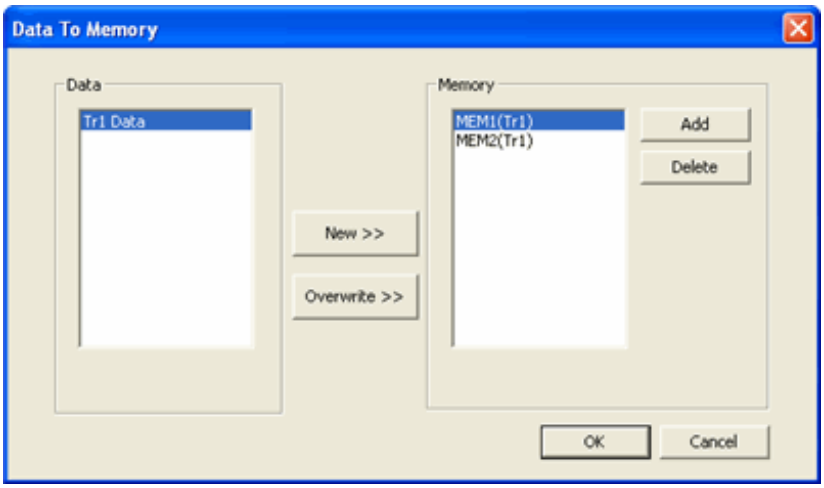
Click **Display** to make the following settings:

- Data > Memory
- Trace Math - Statistics (NOT available on 85071E Opts 200)
- Marker

Data >Memory

This dialog copies a displayed trace into memory. You can then display the Memory trace. This allows the original trace to be compared to the stored trace. An unlimited number of traces can be stored into memory.

Click **Display**, then **Data >Memory**



Data - Lists the traces that are displayed.

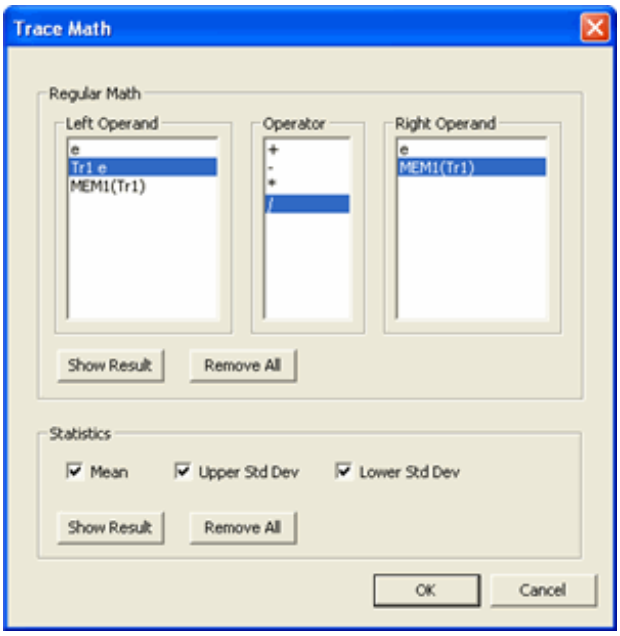
Memory - For each displayed Data trace, lists the traces that are stored into memory.

1. From the **Data** column, select a trace to store into memory.
2. Click **New >>** to copy that trace into memory.
3. Click **Add** to display the selected Memory trace.
4. To replace a memory trace with updated or different data, select a Data trace to store, select the memory trace to replace, then click **Overwrite >>**. Again, click Add.
5. To remove a trace from memory, select the Memory trace, then click **Delete.**

Trace Math

Trace math is performed between two or more traces in the current chart.

Click **Display**, then **Trace Math**



1. Select a chart that contains the traces on which Trace Math is to be performed.
2. Select a Left Operand, Operator, and Right Operand.
3. Click Show Result to create an Equation trace in the current chart.

For example, to perform Data / Memory (as shown in this dialog).

1. Store a trace into Memory using the Data > Memory dialog.
2. Select the following:
    a. Left Operand = Tr1
    b. Operator = '/' (divide)
    c. Right Operand = MEM1 (Tr1)
3. Click **Show Result** to create a new '**Tr2 Eq**' trace. The equation that created the trace is shown in the upper right corner of the chart 

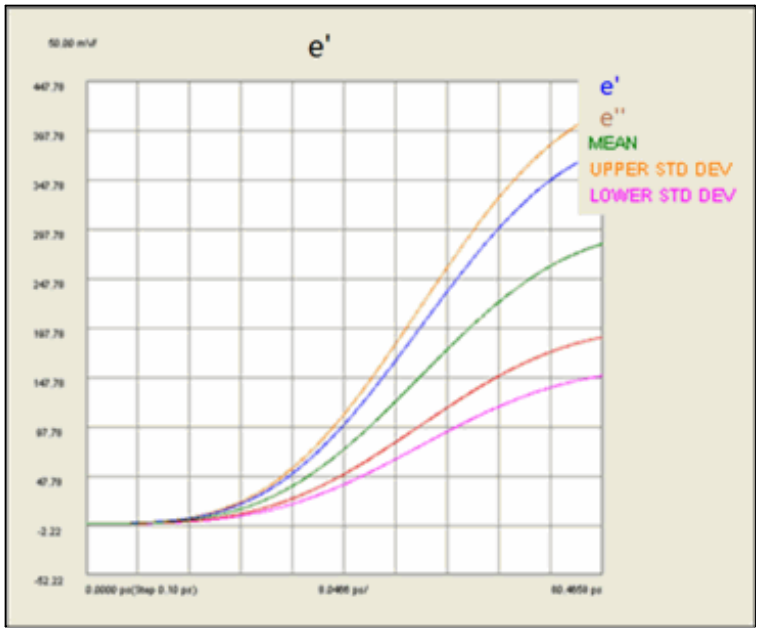
Statistics

This feature creates additional traces in a chart that represents the Mean, Upper, and Lower Standard Deviation of the existing traces in the chart.

Click **Display**, then **Trace Math**

1. Check one or more statistics to add.

2. Click **Add**
3. A new trace is added to the chart for each 'checked' statistic.



This chart contains e' and e'' traces. The three additional Statistics traces were added using this feature.

Notes:

- Statistics are calculated for each data point of all traces in the active chart.
- Calculations and plotting of the statistical traces occurs real time. Additional measurement traces can be added or removed and the statistical traces are updated automatically.
- The UPPER and LOWER Standard Deviation values are determined as follows:
    - MEAN = Average of traces
    - UPPER = Mean + (Std Dev / 2)
    - LOWER = Mean - (Std Dev / 2)
- Calculations are performed on any number of existing traces up to the maximum. The statistical traces are counted towards the maximum number of traces per chart.

Markers

There can be up to 9 markers for each data trace, plus one Reference marker.

Click **Display**, then **Marker**

1. Select one of the 9 regular markers.
2. **Set At**: Select an initial X-axis location for the marker.
3. Check **On** to create the marker.

To move a marker

- Click on the marker pointer and drag to any location on the X-axis.
- Markers on Cole-Cole traces can be moved ONLY by scrolling with the mouse wheel.

Choose from the following dialog settings:

Coupled Markers Check (default setting) to cause markers in different charts, on different traces, to all move across the X-axis simultaneously.

Delta Marker Check to make the active marker display data that is relative to the reference (R) marker. There is only one reference marker per trace. All nine other markers can be regular markers or delta markers. When a delta marker is created, if not already displayed, the reference marker is displayed automatically. A delta marker is shown in the

Discrete Marker Clear (default setting) to display values that are interpolated from the data points. The interpolated marker will report Y-axis data from ANY frequency value between the start and stop frequency.

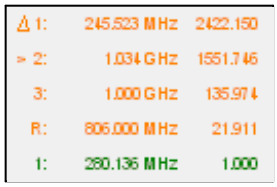
Check to display values at only the discrete points where data is measured.

All Markers Off Click to turn OFF all markers on the trace.

Note: Move a marker by clicking on, then dragging the marker along the X-axis. Or use the right-click feature. See below.

Marker Readout

The **Marker Readout** area is in the upper-right corner of each chart.



 A Delta marker is shown with a delta sign to the left of the marker number.

 The 'Active' marker is shown with > to the left of the marker number.

Right-click features

Click the relevant trace to activate, then:

- **Create a regular marker**: Right-click, then **Marker**, then **Insert**.
- Move a marker to a precise X-axis location: Activate the marker, right-click, then **Marker**, then **Set At**, then enter the X-axis location.
- Delete a marker: Activate the marker, right-click, then **Marker**, then **Delete**.

Last modified:

20-Nov-2012	Major edits

Preferences Menu

Click **Preferences** to make the following settings.

- Title
- Subtitle
- Trace (Settings)
- Always on Top
- Instrument
- Save as default
- Reset default

Title

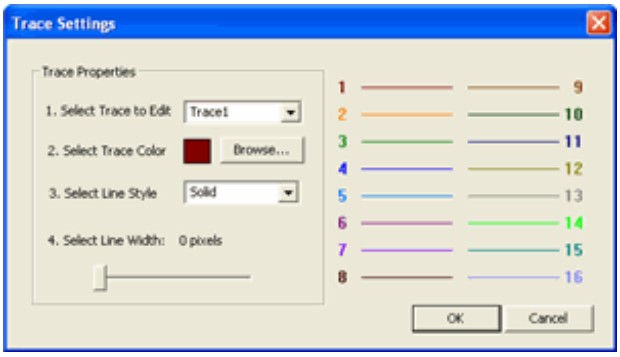
Enter a title for your measurement. 'Title' is shown by default.

Subtitle

Enter a subtitle for your measurement. 'SubTitle' is shown by default.

Trace

Configure trace properties.



Always on Top

When checked, the 85070E screen is always on top of other windows.

Instrument

When this selection is made, a scan begins immediately for an instrument that is configured in Agilent IO libraries.

Learn all about Scan and Rescan.

Learn how to Configure an Instrument

Save as default

The 'Default' 8507x.dft file is like the instrument and data settings for an instrument or software preset.

A new default file is written when any of the following occurs:

- The first time the software is run.
- When the default file is deleted.
- When **Save as default** is selected. This overwrites the default file with the current setup, instrument, and data. Do this when you change instruments or when the 8507x.dft file creates errors when loading.

If it becomes necessary to delete the 8507x.dft file, it is stored at the following locations:

- For Windows 7 (32bit), Windows XP and previous versions:
  C:\Documents and Settings\All Users\Documents\8507x\Data and Setup
- For Windows 7 (64bit)
  C:\Users\Public\Public Documents\8507x\Data and Setup

Reset default

This selection reloads 8507<x>.dft which is like an instrument Preset.

Last modified:

2-Jul-2013	Added Win7 file locations
20-Nov-2012	Major edits

Help Menu

Click **Help** to see the following choices:

Help topics

Run this help file.

ECal Module Check

Allows the functionality of the ECal module to be checked (if used).

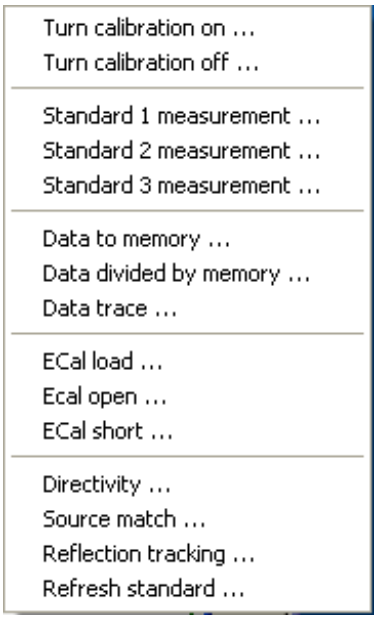
- **Check for module** - Checks for the presence of a ECal module.
- **Set to thru state** - Sets the ECal Module to the thru state and checks the ECal internal switch repeatability.
- **Set to load state** - Sets the ECal module to the load state and checks the ECal internal switch repeatability. This is not a perfect load but the measurement but a reflection coefficient measurement should look different from the short and open.
- **Set to open state** - Sets the ECal module to the open state and checks the ECal internal switch repeatability. This is not a perfect open but a reflection coefficient measurement should look different from the short and load states.
- **Set to short state** - Sets the ECal module to the short state and checks the ECal internal switch repeatability. This is not a perfect short but a reflection coefficient measurement should look different from the open and load.

Check Calibration Short

Runs a utility that checks the repeatability of the Calibration Short

Upload to Analyzer

While connected to an analyzer, click any of the following measurements to upload and view the trace on the analyzer.



About 85070...

Provides revision information for the 85070 software.

Last modified:

1-Jul-2013	Added upload information.

ToolBar

 - Open Setup

 - Open Data

 - Save Setup

 - Save Data

 - Copy the Chart

 - Print Chart

 - Print Table

 - Perform Cal (85070E ONLY)

 - Trigger Measurement

 - e'

 - e"

 - Loss tangent e

 - Cole - Cole

 - Autoscale

 - Set scale..

 - Set scale..

 - Data->Memory...

 - Trace Math...

 - Traces Displayed...

 - Help

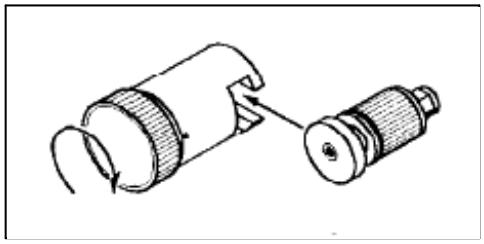
See Format Icons

Measurement Tutorial

This section provides a step-by-step, guided example of a calibration and measurement sequence with the 85070 software.

Topics in this section

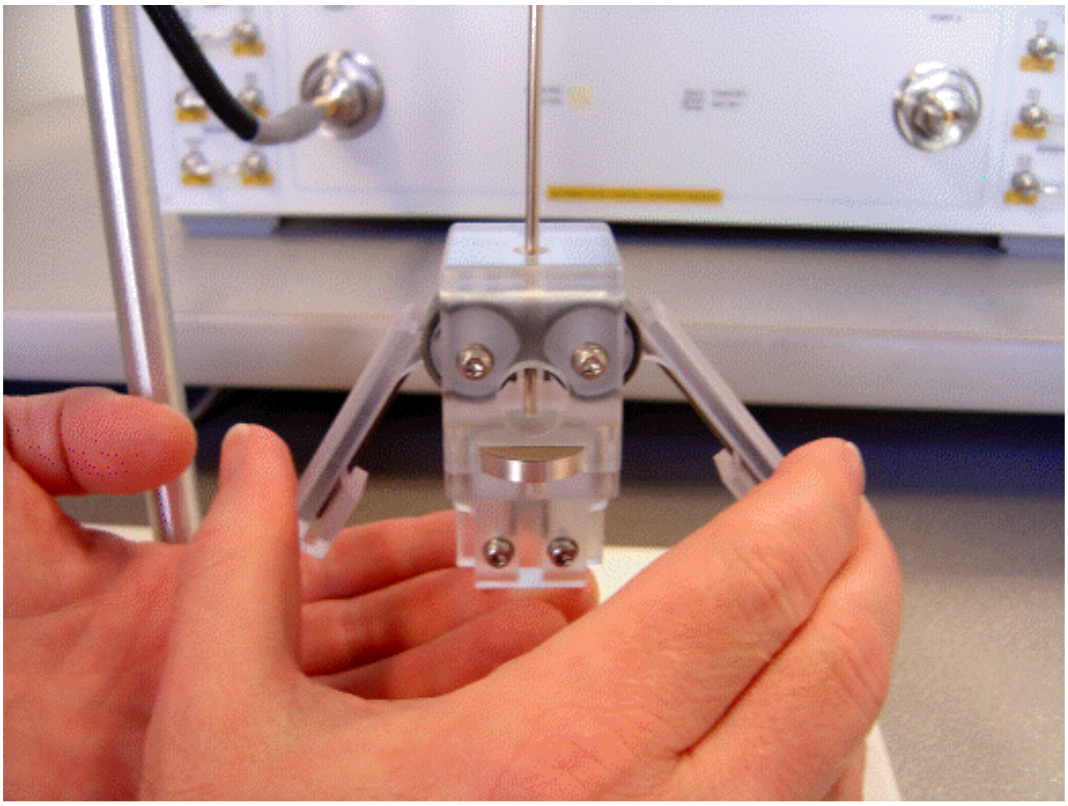
Connecting the High Temperature Short



1. Slide the short (circuit) onto the measurement end of the probe.
2. Tighten the knurled screw until the short makes good contact with the probe.

Five Easy Steps to Connecting the Slim Form Short

1. Grasp the short arms and press towards the short body.



2. With short arms fully pressed in, carefully slide probe tip through hole on top of short and straight down past the internal cams. Be careful not to bend the probe.

3. Make sure that the probe tip is inserted into the internal hole, touching conductive elastomer disc below.

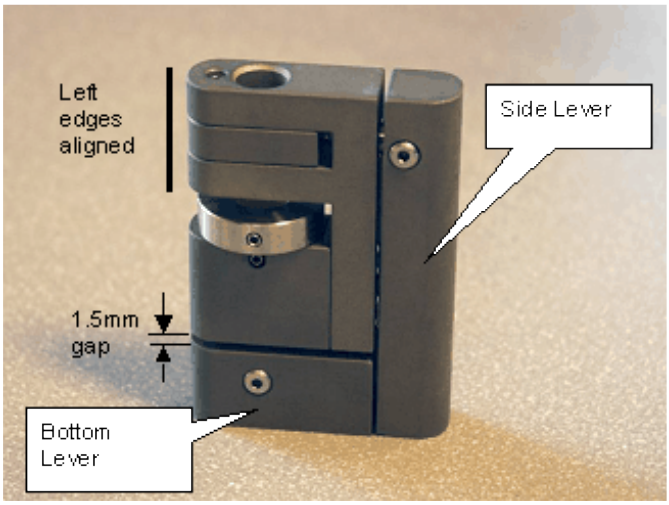
4. Supporting the short from the bottom, slowly release the arms so that cam action presses probe tip into the conductive elastomer disc.

5. Once the short arms are released, steady the short so it does not move excessively. You can now completely let go of the short to make the calibration measurement.

Performance Probe

Steps to connect Performance Probe Short

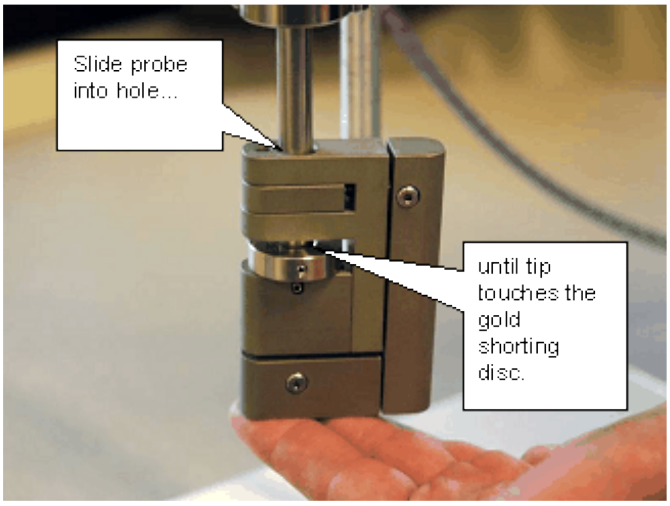
1. Start with short facing you as shown. Make sure the edges on the left side are aligned. If not, rotate lever on right side until they are. Rotating side lever forward will move center edge to the right. Rotating the side lever to the back will move center section edge to the left.



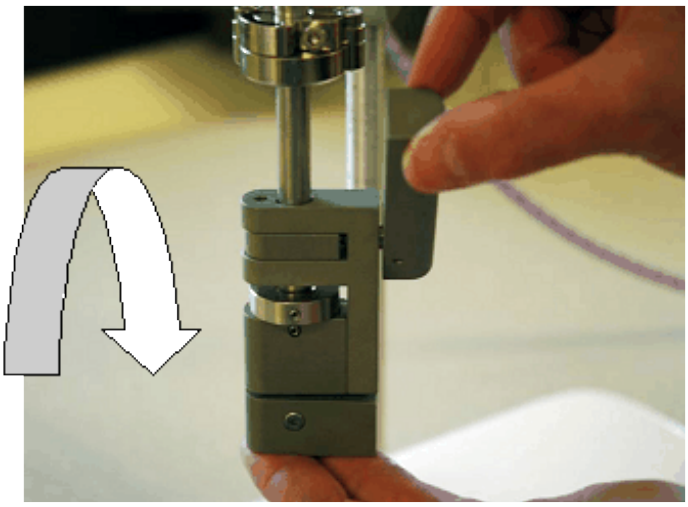
Caution: Do not rotate side lever past the point that resistance is felt.

2. Make sure that there is at least a 1.5mm gap between bottom lever and short body. If not, rotate the bottom lever to the back one or two times.

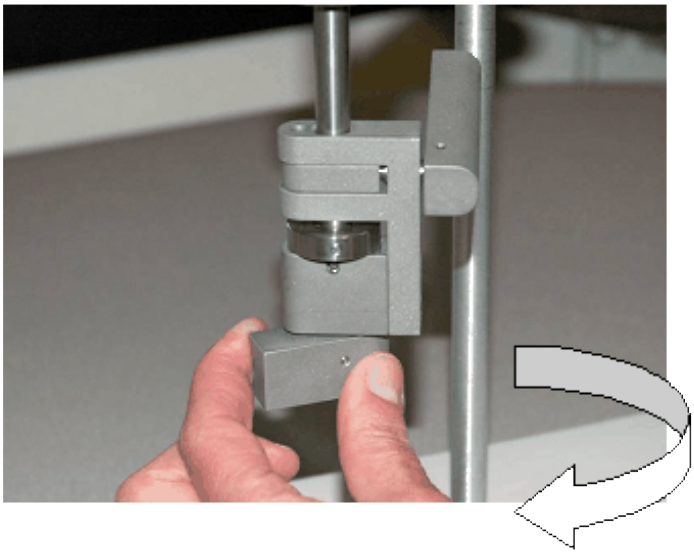
3. Slide probe all the way into hole on top of short until the tip touches the gold shorting disc, gently pressing upwards from bottom of short



4. Still pressing upwards from bottom of short, rotate side lever forward, up and around until short has gripped tightly onto probe. It may take one or two rotations.

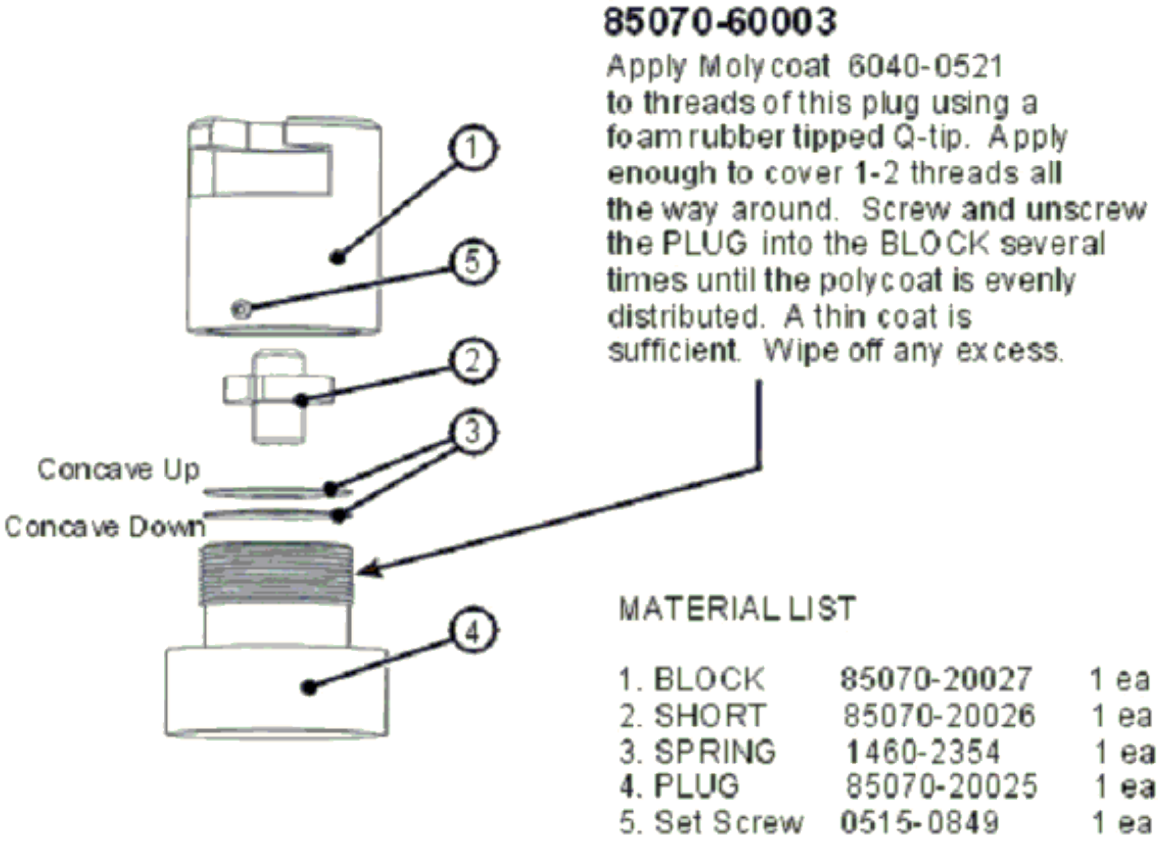


5. To engage the shorting disc, turn bottom lever forward, left and around until resistance is felt as the shorting disc presses tightly up into the probe tip.



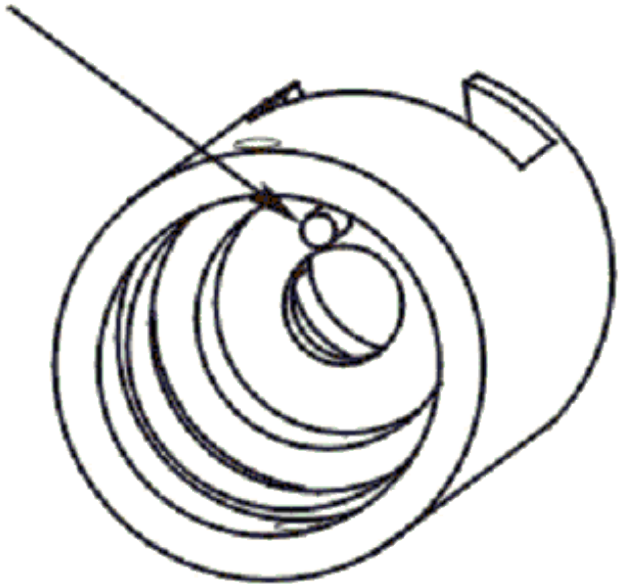
6. To remove short, reverse the process. It is always a good idea to return the short to its starting condition described in step 1 before putting it away, so it will be ready for next time.

Procedure for disassembling the 85070-60003 Probe Short



1. Remove hex screw Item #5 (0515-0849) from Shorting Block.
2. Unscrew Item 4 (08570-20025) from Shorting Block
3. Remove Items 2 and 3.
4. Reverse order to reassemble, but be sure that the slot in Item 2 is aligned with pin in the clamp body Item 1. See figure 2.

This is the view of the clamp body (P/N 85070-20027) which shows the dowel pin. The slot in the shorting block (P/N 85070-20026) fits into this dowel pin.



Importing Data into Other Programs

The data files created by the 85070 dielectric probe software can be imported directly into a spreadsheet for further calculations. This file will also import into many other programs since it is in ASCII format.

Another technique is to copy the table to the clipboard. The data can then be pasted into the spreadsheet or any similar program.

Programming

The 85070E software has an Application Programmable Interface (API) that allows you to create custom automated solutions. This section provides information on how to use it.

- The COM Interface
- Visual Basic Example

Using the 85070 COM Interface

This version of the 85070 has a component object model interface (COM) that allows programs to be written to configure, calibrate and retrieve measurements. Below are a list of the methods available and a description of their use.

HRESULT Init();

Init() must be called before any of the other methods can be used. It opens a copy of the 85070.exe. It returns S_OK if successful and S_FALSE if not.

HRESULT CalibrateProbe();

CalibrateProbe() initiates a measurement calibration. It returns S_OK when complete.

HRESULT TriggerProbe();

This method triggers a measurement. It returns S_OK if successful and S_FALSE if not.

HRESULT GetMeasurement(long num,float * f,float * er,float * ei);

This method allows the measurement results to be returned to the calling program. The variable num is the measurement point of interest provided by the calling program. The variables f, er and ei return the frequency and measurement values for the measurement point specified by num.

HRESULT SetMeasurement(double start, double stop, long num, long mode);

Sets the start and stop frequencies, number of points, and sweep mode.

Sweep Mode

LINEAR_SWEEP = 0,

LOG_SWEEP = 1,

HRESULT GetNumberPoints(long *num);

HRESULT GetStartFrequency(float *start);

HRESULT GetStopFrequency(float *stop);

Returns the start and stop frequencies, number of points.

HRESULT GetS11Data(long num, float * f, float * s11_real, float * s11_imag);

Returns the S11 data from the measurement.

num = Number of data points to read.

HRESULT GetTemperature(float * temperature);

HRESULT SetTemperature(float temperature);

Set and read the temperature of the dielectric.

HRESULT GetRefreshStd(int * std);

HRESULT SetRefreshStd(int std);

Set and read the refresh standard.

AIR_REFRESH = 0

SHORT_REFRESH = 1

WATER_REFRESH = 2

HRESULT GetProbeType(int * probe);

HRESULT SetProbeType(int probe);

Set and read the probe type.

A_PROBE = 0

HIGH_TEMP_PROBE = 1

SLIM_FORM_PROBE = 2

PERFORMANCE_PROBE = 3

HRESULT GetCalType(int * cal);

HRESULT SetCalType(int cal);

Set and read the Cal type.

LOAD_AIR_SHORT_CALTYPE = 0

AIR_SHORT_WATER_CALTYPE = 1

USER_CALTYPE = 0

HRESULT SaveSetupFile(BSTR file);

HRESULT OpenSetupFile(BSTR file);

Save and Open a setup file.

HRESULT AutoRefreshOnOff(long *OnOff);

Read the Auto Refresh state.

AUTO_ON = 1

AUTO_OFF = 0

HRESULT AutoRefreshOn();

HRESULT AutoRefreshOff();

Set the Auto Refresh state.

HRESULT RefreshCal();

Perform Refresh.

See the listing of Visual Basic code for examples of how to use of the I85070 interface. A self-extracting copy of this VB project is in the Visual Basic directory on the 85070 installation CD. Be sure to add the

Automation8507x1.0 Type Library to your Visual Basic Project (Project|References… menu).

The Automation8507x.tlb is in the C:\ProgramFiles\Agilent\85070 directory.

Visual Basic Programming Code

```
Dim material As AUTOMATION8507XLib.Automation85070
Private Sub Calibrate_Click()
Call material.CalibrateProbe
End Sub
Private Sub Form_Load()
' Create the object
Set material = CreateObject("AUTOMATION8507X.Automation85070")
' Initialize the object (starts the 85070.exe)
Call material.Init
' Sets the measurement frequencies
Call material.SetMeasurement(1000000000#, 3000000000#, 101, LOG_SWEEP)
End Sub
Private Sub Measure_Click()
Dim er As Single
Dim ei As Single
Dim f As Single
' Trigger a measurement
Call material.TriggerProbe
'Obtain the frequency and measurement value for the 5th point
Call material.GetMeasurement(5, f, er, ei)
End Sub
```

85070E Technical Support

Other topics in this help file:

- Common Problems and Solutions
- Contact Agilent Technologies
- Additional Equipment Needed
- Public Technical Papers
- Agilent Technologies Literature

Websites and information

Agilent 8507x Series Support Page

http://na.tm.agilent.com/materials

Supported Agilent VNAs

http://na.tm.agilent.com/materials/docs/SupportedVNAs.pdf

Agilent 8507x Series Software Download Page

http://na.tm.agilent.com/materials/downloads.html for free updates, two week demos, and more.

Agilent Materials Test Equipment Page

http://www.agilent.com/find/materials for information about this and other materials test products.

Agilent Contact Page

http://www.agilent.com/find/contactus for information on how to contact Agilent for technical support and ordering additional equipment.

Agilent License Redemption System

http://www.agilent.com/find/softwarelicense for redeeming new licenses and for retrieving previously redeemed licenses should you ever loose or corrupt your license file.

Common Problems and Solutions

Inaccurate or non-repeatable measurements may be the result of:

- **Software Startup**

- **Cable Movement**

  The cable should be held in the same position during measurement as during calibration. Hold the probe and cable with the mounting bracket and probe stand.

- **Probe Flatness**

  The flatness of the probe is crucial for accurate measurements. Visually inspect the measurement surface of the probe, especially the center portion. Look for nicks, dents, discoloration, and other sign of stress. If measuring solid materials, they must also be flat.

- **ECal module**

  If using ECal for Electronic Refresh, make sure it is connected correctly. See Setup with ECal An ECal module that is not switching at all or not switching repeatably will cause severe problems. There is also a ECal Module Check utility in the 85070E help menu to help you troubleshoot. When in doubt, remove ECal from the system and try calibration and measurement again.

- **Temperature**

  Temperature should be constant for best measurement results. Avoid thermal shock. Allow one-half hour for the probe to achieve temperature equalization if it has been subjected to temperature variations. When deionized water is used as a calibration standard, it is important to enter the correct temperature and maintain that temperature during calibration and measurements.

- **Calibration**

  A bad calibration can be caused by the following:

  - **Incorrect Probe Version**

    Make sure you select the correct probe under Configure Cal in the Calibration menu

  - **Calibration Short Connection**

    Connecting the calibration short requires practice to make good repeatable measurements. Also, any damage to the short or probe will cause non repeatable measurements. See Check Calibration Short utility under the Help menu.

  - **Short Damage**

Visually inspect the shorting surface, especially the center portion. On the Performance probe short and High Temperature probe short, look for nicks, dents, discoloration, and other sign of stress. The Performance probe short will have a slight circular dent the size of the outer diameter of the probe which is not a defect. Inspect the Slim Form probe short for damage to the conductive elastomer pad. flat.

- **Air bubbles**

  Tiny air bubbles can cling to the probe tip when measuring the calibration water or liquid samples, which can cause inaccurate and non repeatable measurement results. This is most common with the Slim Form Probe. A glass beaker is recommended so air bubbles can be seen. If they are present, remove them by gently tapping the probe tip on the bottom of the beaker, or lowering the beaker away from the probe. then re-imersing the probe.

- **Calibration Water**

  Deionized water of known temperature should be used for best measurement results. Distilled water can be a substitute if deionized water is not available. Impurities n the water will cause measurement error mostly at the lower frequencies

- **Network Analyzer**

  Refer to the network analyzer manual for help determining if your network analyzer is operating correctly.

Contact Agilent

Although the 8507x software has been designed for convenience and ease of use, problems can arise.

For technical assistance contact Agilent by internet, phone, fax or email.

Complete up to date information for world wide assistance is available on the internet at www.agilent.com/find/contactus.

Before You Contact Agilent Technologies, *first do the following*:

1. Refer to **Common Problems and Solutions**. For problems associated with the network analyzer, computer, or printer please refer to its manual.
2. Save a copy of the setup file
3. Then log this information:
    - 8507xE Software revision
    - Running software on Computer or PC

        If PC
        - PC Operating system
        - Type of HP-IB or GPIB card
    - Network analyzer:
        - Model number
        - Firmware revision
        - Options installed
    - Any additional system hardware, for example ECal
    - Problem description:
        - Error messages?
        - How can the problem be duplicated?
        - Is the problem intermittent?

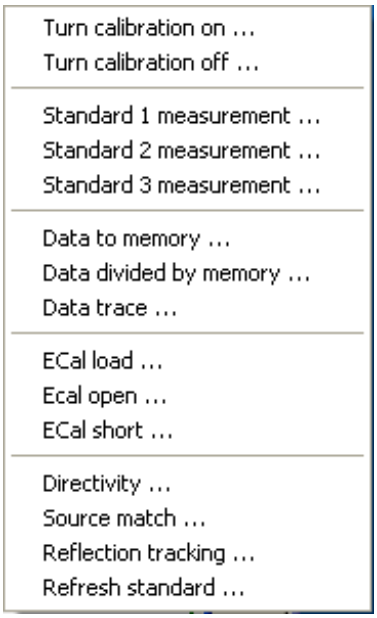
Troubleshooting Utilities

Click **Help** then choose from the following:

ECal Module Check - Set a connected ECal module to various internal standards

Check Calibration Short - Follow the prompts to check the repeatability of the calibration short.

Upload to Analyzer...



Advanced Measurement Techniques

This following topics can help you make more accurate measurements and analyze them.

- Measurement Uncertainty
- The Merits of Relative Measurements
- Importing Data into Other Programs

Overall Measurement Accuracy

In the case where PTFE is measured at 10 GHz using an air/short/water calibration, the total measurement error would be the sum of the errors due to probe model accuracy (typically about 2% to 5%), air, and water.

First compute Δs for air. The only effect to consider is the probe model accuracy of about 5%. Thus

ΔsAIR = 0.05*magnitude of the permittivity of air = 0.05*1 = 0.05

Next compute Δs for water. The model is accurate to within about 1% and the probe model contributes another 3%. The permittivity of water at 10 GHz and 25 $^{\circ}$C is 62.3 – j 30. εrWATER is then the square root of the sum of the squares or 69.

ΔsWATER = (0.05 + 0.01) x magnitude of the permittivity of water at 10 GHz = (0.05 + 0.01) x 69 = 4.14

Next find the sensitivities for the various permittivities at 10 GHz. The values for SSAIR, SSWATER , and SMTEFLON can be generated by first performing an air/short/water calibration. After the calibration, remeasure air and store the measurement data into a data file. Remeasure water and store it into a data file. Then measure teflon and store it into a data file.

Finally, refer to Importing Data into Other Programs, and use a spreadsheet program or notepad.exe to read the sensitivity numbers. Insert those sensitivity numbers in equations as shown below to calculate the uncertainty of the measured permittivity of the MUT.

Assume that the data files yield these sensitivity numbers:

SSAIR = 8.2

SSWATER = 223

SMTEFLON = 8.1

The worst case combination yields:

$$\Delta\varepsilon = \left(\frac{S_{MTEFLON}}{S_{AIR}} \times \Delta S_{AIR}\right) + \left(\frac{S_{MTEFLON}}{S_{WATER}} \times \Delta S_{WATER}\right) + (ModelAccuracy \times MeasuredValue)$$

$$\Delta\varepsilon = \left(\frac{8.1}{8.2} \times 0.05\right) + \left(\frac{8.1}{223} \times 4.14\right) + (0.05 \times 2.1) = 0.305$$

The RRS combination yields:

$$\Delta\varepsilon = \sqrt{\left(\frac{8.1}{8.2} \times 0.05\right)^2 + \left(\frac{8.1}{223} \times 4.14\right)^2 + (0.05 \times 2.1)^2} = 0.19$$

The $\Delta\varepsilon$ error can occur in either of the orthogonal components ε' and ε'' such that

$$\varepsilon' = \varepsilon'_{measured} \pm \Delta\varepsilon$$

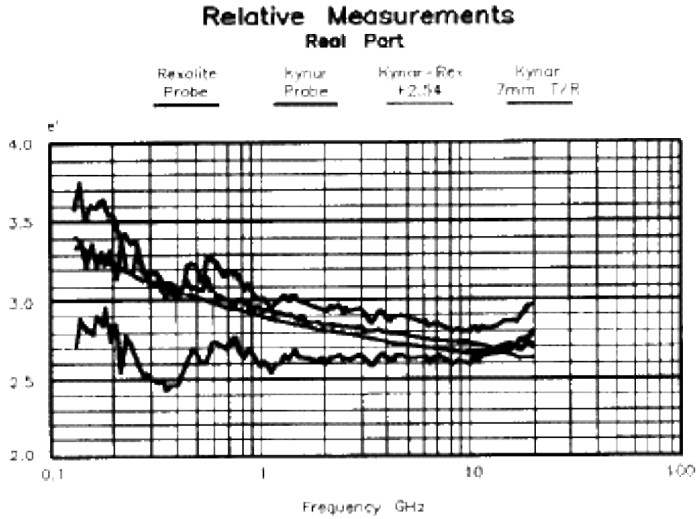
$$\varepsilon'' = \varepsilon''_{measured} \pm \Delta\varepsilon$$

and

$$\frac{(\varepsilon''_{measured} - \Delta\varepsilon)}{(\varepsilon''_{measured} + \Delta\varepsilon)} \leq \frac{\varepsilon''}{\varepsilon'} \leq \frac{(\varepsilon''_{measured} + \Delta\varepsilon)}{(\varepsilon''_{measured} - \Delta\varepsilon)}$$

The Merits of Relative Measurements

Typically, relative measurements are more accurate than absolute measurements. Thus comparing measured results to a known reference of nearly the same permittivity is recommended in general. Relative measurement comparisons are facilitated by the trace math feature Trace-Ref.



Measurement Uncertainty

Uncertainty is an integral part of measurements in this imperfect world, but not an undefineable part. The uncertainty of probe measurements results can be estimated with sensitivity numbers (or data) . Sensitivity numbers represent the slope of the model that relates permittivity to reflection coefficient. Recall that the network analyzer measures the reflection coefficient of the MUT, not its permittivity. The software, through a model, converts the reflection coefficient to permittivity.

Since the actual measurement is a reflection coefficient measurement, the question of measurement uncertainty is this: what effect does a reflection coefficient measurement error have on permittivity?

Sensitivity numbers can show a relative, qualitative indication of uncertainty. For example, if in one instance the sensitivity number is 50 and in a second instance it is 25, the measurement uncertainties of the first instance are twice (50/25 = 2) those of the second.

More precisely, error sources can be divided into two categories: network analyzer error sources and dielectric error sources. Examples of network analyzer error sources are noise (about 0.0006) and the fixed load/probe directivity contribution (0.05 to 0.15, for a LOAD/AIR/SHORT calibration, depending on frequency). Examples of dielectric error sources are probe model accuracy (3% to 5%) and uncertainty due to the accuracy of the permittivity characterization of calibration or reference standards.

The sensitivity numbers are useful in determining the measurement error contributions from both categories.

- Typical Probe Accuracy
- Network Analyzer Error Sources
- Dielectric Error Sources
- Overall Measurement Accuracy

Network Analyzer Error Sources

The effect of network analyzer error sources can be calculated as follows:

$\Delta\varepsilon = N \times S$

where

$\Delta\varepsilon$ is the error (or delta epsilon)

N is network analyzer uncertainty (in linear terms)

S is the sensitivity number (absolute value)

For example, assume PTFE ($\varepsilon r=2.1$) is measured at 10 GHz with a LOAD/AIR/SHORT calibration. At 10 GHz the fixed load/probe directivity contribution would be about 0.05. At 10 GHz for $\varepsilon r=2.1$ the sensitivity is 8.1.

The measurement error due to the fixed load/probe directivity would be computed as:

$\Delta\varepsilon = 0.05 \times 8.1 = 0.4$

Note that this is not total measurement error, only the portion due to the fixed load/probe directivity.

Dielectric Error Sources

The effect of dielectric error sources can be calculated as follows:

$\Delta\varepsilon$ = SM/SS x Δs

$\Delta\varepsilon = S_M/S_S \times \Delta s$

where

$\Delta\varepsilon$ is the error (or delta epsilon)

SM is the sensitivity of the measured material

SS is the sensitivity of the calibration standard

Δs is the delta uncertainty of the material used in calibration

Agilent Technologies Literature

To order for Agilent Technologies literature, visit our web or contact the nearest Agilent Technologies office.

- “Basics of Measuring the Dielectric Properties of Materials,” application note 1217-1, part number 5091-3300E, March 1992.
- “16451B Dielectric Test Fixture,” data sheet, part number 5950-2368, May 1989.
- “LCR Meters, Impedance Analyzers, and Test Fixtures,” selection guide, part number 5952-1430, January 1990.

Public Technical Papers

To obtain copies of these papers, contact the organization or publisher listed.

- M. Afsar et al; “Measurement of the Properties of Materials”; proceedings of the IEEE, volume 74, number 1, January 1986. This is an excellent short survey of many methods across wide frequency range. With its 187 references, it is a good starting point for beginners.

- H. M. Altschuler; “Dielectric Constant”; chapter 9 of “Handbook of Microwave Measurements” by M. Sucher and J. Fox; Wiley, 1963. This is a good technical reference covering high frequency techniques. It contains detailed procedures and equations (but using slotted line instead of a network analyzer).

- ASTM; “Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials”; Standard D-150-87; American Society for Testing and Materials, Philadelphia, PA 19103. The US authority on testing methods features great technical depth on parallel-plate capacitor methods for low frequencies.

- Richard G. Geyer; “Electrodynamics of Materials for Dielectric Measurement Standardization”; proceedings of the IEEE, IM-TC, January 1990. A review of measurement concerns, standards, and traceability with examples of state-of-the-art measurements including NIST X-band cavity and the first public reference to Baker-Jarvis enhancement to S-parameter technique.

- Deepak K. Ghodgaokar et al; “Free Space Method for Measurement of Dielectric Constants and Loss Tangents at Microwave Frequencies”; IEEE Transactions on IM volume 37 number 3, June 1989. This describes the work at Penn States’s Center for Engineering of Electronic/Acoustic Materials. The topic is the free-space method using spot-focusing antennas with an 8510B and TRL calibration.

- Arthur R. von Hippel, ed; “Dielectric Materials and Applications”; MIT Press, 1954. This book is over 45 years old, but still the bible on dielectrics and measurements; a good introduction to basics.

Other Authors

- Stuart O. Nelson, US Department of Agriculture. He has written many articles on microwave measurement of moisture in raw grains.
- Stan Stuchley, U of Ottawa, Canada. He is an authority on dielectric measurements using coax open-ended probe.
- Gordon Kent, Dielectric Lab Inc. He invented novel cavity methods and simplified equations to measure dielectric properties of ceramic substrates.

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Glossary

The following entries are defined in terms of material measurements with the 8507xE software.

absorption

to take in electromagnetic energy, usually as heat.

absorption bands

distinct frequency bands at which electromagnetic energy is strongly coupled into a material and absorbed.

AC loss

dielectric loss (as D for capacitors, but excluding DC “leakage”).

Cole-Cole plot

data format, with ε '' on vertical axis and ε ’ on horizontal axis, with frequency as the independent parameter not displayed; lossy materials with relaxation mechanisms follow a semi-circle on these plots.

conductivity

usually ionic dielectric loss; in dielectric measurements, does not mean true conduction (movement of electrons).

D

dissipation factor; usually measured for capacitors; D = tan δ .

Debye functions

Simplified model to explain dielectric properties versus frequency, assuming that a simple rotational relaxation phenomenon is acting.

δ

angle Delta formed between the x-axis and the permittivity vector; δ is small (nearly 0 °rees; for low-loss materials, and large (up to about 45 °) for lossy materials; see tan δ (used more often)

dielectric after-effect

polarization in a material lags behind the applied field in time; modeled by relaxation process; related to losses

dielectric constant

Κ ratio of electric field storage capacity in a material to that of free space; usually means real (lossless) case only.

dielectric loss

energy lost (absorbed) in material when applying an AC electric field; may be due to ionic, polar, atomic, or electronic mechanisms

dipolar

dielectric mechanism; see “rotational”

dipole

a structure where the net charge distribution can be represented by the two equal and opposite charges separated by distance

dispersion

propagation characteristics change with frequency

dissipation factor

D; ratio of energy lost to energy stored (per cycle) in a system; same as tan δ , inverse of Q.

Electronic

Dielectric mechanism (resonant, very weak, at very high frequencies), where the “orbits” of electrons around a nucleus are stretched”

ε

Epsilon, symbol for absolute permittivity; sometimes also refers to permittivity relative to free space when the subscript r is dropped.

ε $_r$

symbol for permittivity relative to free space, also called relative permittivity. It is a complex number, ε $_r$* = ε $_r$' - j ε $_r$".

free water

water molecules which are not “bound” and are free to orient themselves in an electric field

Homogeneous

having uniform properties throughout; non-homogeneous materials are usually mixtures of two or more materials.

induced dipoles

temporary dipoles, created by electric fields

ionic

a dielectric mechanism (fairly strong, lossy, operating at all frequencies), where mobile ionic charges migrate in a material

isotropic

properties do not vary with orientation; non-isotropic materials are usually fibrous or crystalline

Κ

Kappa, another symbol for permittivity, always relative to free space. If complex, Κ $_r$ * = Κ $_r$ ' - j Κ $_r$ ". Sometimes refers just to the real part of permittivity.

loss angle

see δ

loss factor

The imaginary part of permittivity ε$_r$" or Κ$_r$" .

loss index

The imaginary part of permittivity ε$_r$" or Κ$_r$"

loss tangent

another term for tan δ and Dissipation Factor

MUT

Material Under Test

NDE

Non-Destructive Evaluation

non-destructive

attribute of test method, when material can be used for its end-purpose after testing.

penetration depth

distance through a lossy dielectric over which the field strength falls by 1/e due to energy absorption

permanent dipoles

molecular structures that inherently have a non-symmetrical charge distribution

permeability

measure of effect a material has on magnetic fields; ratio of flux over field

permittivity

measure of effect a material has on electric fields; ratio of flux over field

phase angle

see θ

phase defect angle

see δ

polar

having permanent electric dipoles

polarize

to align dipoles in electric field

power factor

sin δ (or cos θ)

Q

quality factor

Quality factor

ratio of energy stored over the energy lost (per cycle) in a system, inverse of tan δ and D

relative permittivity

permittivity relative to free space. see ε $_r$

relaxation constant

see τ

relaxation time

see τ

relaxation wavelength

free-space wavelength corresponding to the frequency 1/ τ

restricted mobility dipoles

dipoles (such as H2O molecules) which are bound to a host material, and so are restricted in their ability to become oriented in an electric field

rotational

a dielectric mechanism (relaxation, fairly strong, often lossy, at moderate frequencies), where permanent dipoles (often entire molecules) “rotate” to align with an electric field

susceptor

material that can respond to electromagnetic fields

tan δ

ratio of ε $_r$'' over ε $_r$'. Indicates relative lossiness of material

τ

relaxation time constant; for a simple substance, the time it takes for 1/e of the constituent molecules to become aligned in response to an electric field

δ

angle between real-axis and vector representing sum of storage and loss vectors

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