User's and Service Guide

Agilent Technologies 85072A
10 GHz Split-Cylinder Resonator

Agilent Technologies

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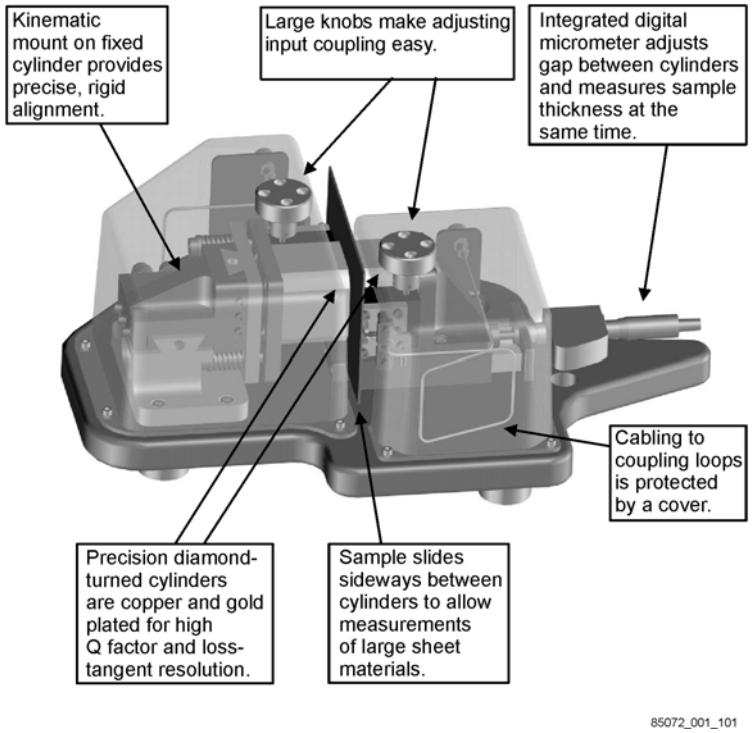
1 General Information

Overview of the 10 GHz Split-Cylinder Resonator

The Agilent 85072A 10 GHZ Split-Cylinder Resonant Cavity offers fast and easy measurements of complex permittivity and loss tangent - critical design parameters for manufacturers of thin film, un-clad substrate, and low-loss sheet materials used for high-speed printed-circuit boards. These measurements comply with IPC test method TM-650 2.5.5.13.

The split cylinder resonator is a cylindrical resonant cavity separated into two halves. Both half-cylinders are diamond turned for the best possible surface finish. One half-cylinder is fixed and the other half-cylinder is movable. These features allow for a high Q cavity and the best loss tangent resolution. The sample is loaded in a gap between the two cylinder halves. The side mounting of the cylinders allows for large samples to be measured. An integrated digital micrometer measures the sample thickness at the time of the measurement.

Electrical coupling into the cavity is adjustable. Large coupling adjustment knobs are on the top of the fixture, while the coupling loops and cabling are located under protective covers. Measurements can be made at modes from ~ 5 GHz to ~ 28 GHz. For more technical information, go to www.agilent.com and search for Agilent pub number 5989-6182EN, “Technical Overview of the 85072A 10 GHz Split Cylinder Resonator”.



Equipment Supplied

- 85072A 10 GHZ Split-Cylinder Resonant Cavity
- Teflon® PTFE sample
- 2 mm and 3mm ball-end hex keys
- Feeler gauge

Equipment Required but Not Supplied

The following items are required for making measurements, but are *not* included with the resonator.

- 85071E Materials Measurement Software with Option 300 Resonant Cavity Software (To get ordering information of this software, see "Contacting Agilent" on page 5-15.)
- N4419AK20 3.5 mm male-to-female cables or equivalent, quantity 2
- Any PNA, PNA-X, or PNA-L Network Analyzer or equivalent (If analyzer frequency range exceeds 40 GHz, add 85130-60010 adapters, quantity 2)
- ESD protection devices
- Connector cleaning supplies

Incoming Inspection

Check the contents of the shipping container. If any part of the resonator appears damaged, or if the shipment is incomplete, refer to "Contacting Agilent" on page 5-15. Agilent will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company. Refer to "Returning a Resonator to Agilent Technologies" on page 5-14 for instructions.

IMPORTANT Save the original inner-box and foam along with the original or comparable outer-box and foam for reuse to ensure shipment safety.

Recording the Resonator Serial Number

Record the resonator serial number in Table 1-1.

Table 1-1 Serial Number Record for the Resonator

Resonator Serial Number

Preparing the Resonator for Use

Unlock the Linear Slide

The resonator is shipped with the linear slide locked to prevent the movable cylinder-half from moving. To unlock it, locate the small, knurled screw on the stage (see the following graphic) and turn it counterclockwise until the linear slide moves easily when the micrometer is adjusted.

Figure 1-1 Resonator Features (Back View)

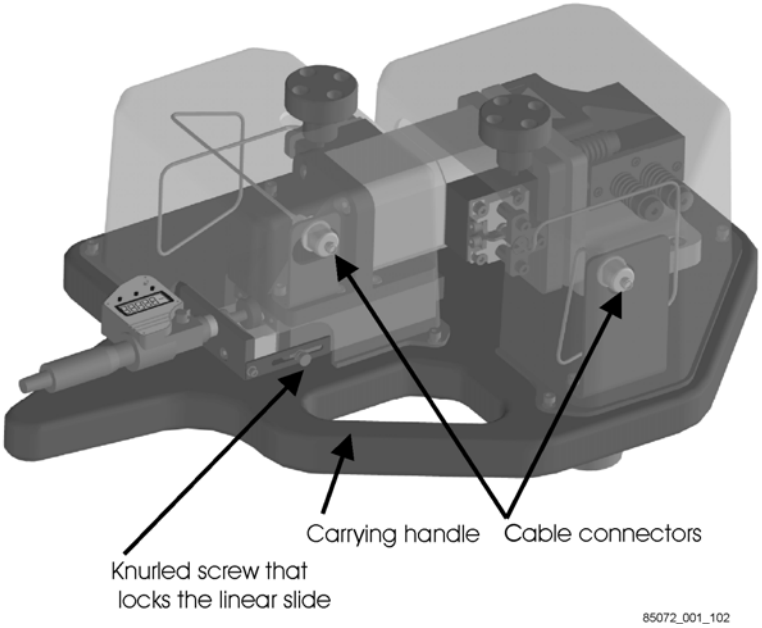
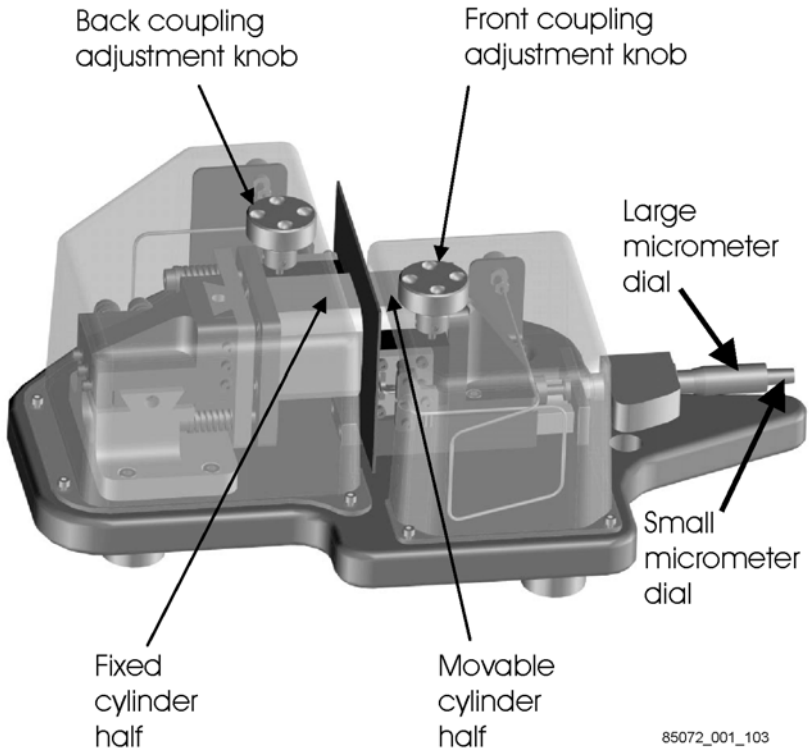


Figure 1-2 Resonator Features (Front View)



Remove the Teflon PTFE Sample

The resonator is shipped with a rectangular Teflon PTFE sample held between the two cylinder halves. The Teflon PTFE prevents the mating surfaces of the cylinder halves from accidentally hitting together. Turn the micrometer's large dial (see Figure 1-2 on page 1-6) counterclockwise to loosen the cylinder halves, and then remove the Teflon PTFE sample.

Check the Cleanliness of the Cylinder Halves

Inspect the mating surfaces and the inside of the cylinder halves for dust and debris. For cleaning instructions, refer to "Cylinders Halves" on page 5-3.

Carrying the Resonator

The resonator has a carrying handle built into the base (see Figure 1-1 on page 1-6). Before using this handle to move the resonator, close the cylinder halves together by following steps 1 and 2 in "Performing the Operator's Check with the PNA Series Network Analyzer" on page 3-2, then lock the linear slide by tightening the knurled screw.

2 Before Making Measurements

Verify the Operating Temperature

Ensure the operating temperature meets the following requirements.

- Split cylinder resonator: 0 °C to +60 °C
- Micrometer: +5 °C to +40 °C

NOTE Some network analyzer performance parameters are specified for 25 °C. Refer to the Help system in the analyzer for the complete specifications.

NOTE Samples of this product have been type-tested in accordance with the Agilent Environmental Test Manual and verified to be robust against the environmental stresses of storage, transportation and end-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power-line conditions. Test methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

Protect Against Electrostatic Discharge (ESD)

Protection against ESD is essential while connecting cables to the network analyzer. Refer to the Help system in the analyzer for complete instructions. Refer to Table 6-2 on page 6-3 for ESD supplies ordering information.

Install the Software

Refer to the Installation Guide that is included with your 85071E Materials Measurement Software with Option 300 Resonant Cavity Software for complete instructions. Refer to Table 6-2 on page 6-3 for ordering information.

Allow the Network Analyzer to Warm-Up

To achieve the maximum system stability, allow the analyzer to warm-up for at least 90 minutes.

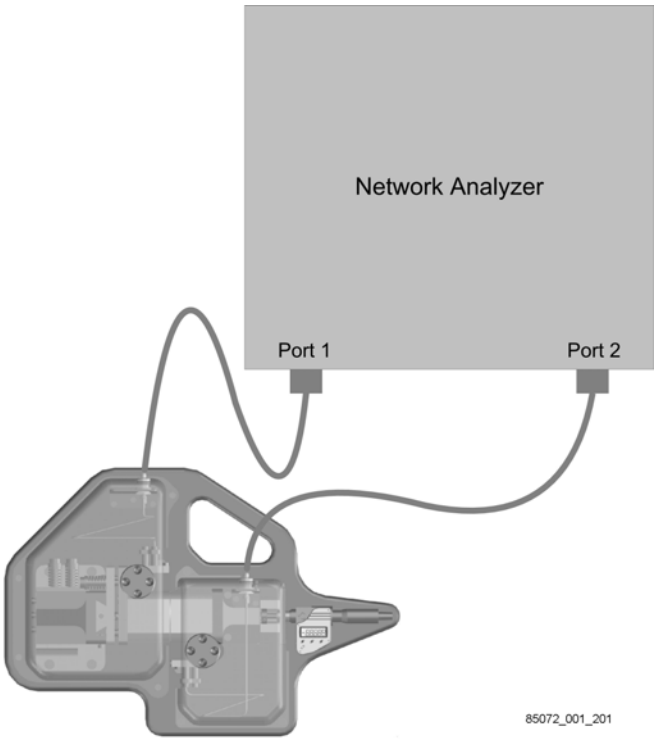
Review the Principles of Connector Care

Proper connector care and connection techniques are critical for accurate and repeatable measurements. Refer to the Help system in the analyzer for complete information.

Connect the Resonator to the Network Analyzer

As shown in Figure 1-1, connect the resonator between ports 1 and 2 of the network analyzer with two N4419AK20 flexible cables or equivalent.

Figure 2-1 Resonator Connections to Network Analyzer



Familiarize Yourself with the Micrometer

If you need help in learning to use the micrometer, go to www.mitutoyo.com.

3 Making Measurements

Operator's Check

The Operator's Check tests the F_s (resonant frequency) and Q of the resonator's cavity with the half cylinders closed and no sample installed. It is recommended for verifying the performance of the resonator before making sample measurements.

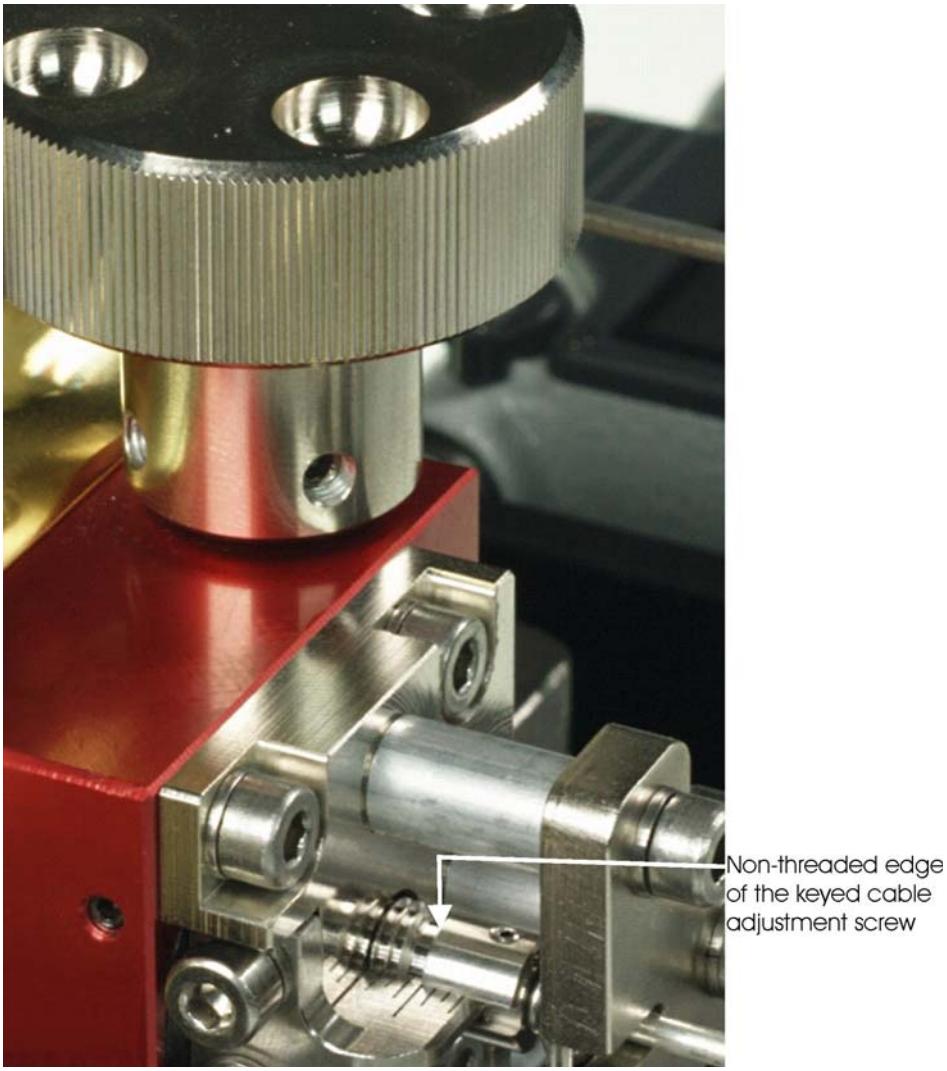
Perform the Operator's Check:

- daily
- when the operating temperature changes by 1 °C or more
- after transporting the resonator

Performing the Operator's Check with the PNA Series Network Analyzer

1. Verify that the linear slide is unlocked by loosening the knurled screw on the back of the slide. Refer to Figure 1-1 on page 1-6.
2. Turn the micrometer's large dial (see Figure 1-1 on page 1-6) clockwise to carefully move the cylinder halves *loosely* together. It is very important not to overtighten the halves together when using the large dial.
3. Turn the micrometer's small dial (see Figure 1-1 on page 1-6) clockwise to further move the cylinder halves together. When the halves are fully closed together, the small dial will continue to turn while making a clicking sound, but will not allow you to overtighten the halves.
4. Zero the micrometer by pressing its middle button.
5. Turn the front coupling adjustment knob (see Figure 1-1 on page 1-6) to adjust its coupling loop so that the non-threaded edge of the keyed cable adjustment screw is at the center mark of the scale. This center mark is the longest mark on the scale. See Figure 3-1 on page 3-3.

Figure 3-1 Keyed Cable Adjustment Screw and Feeler Gage

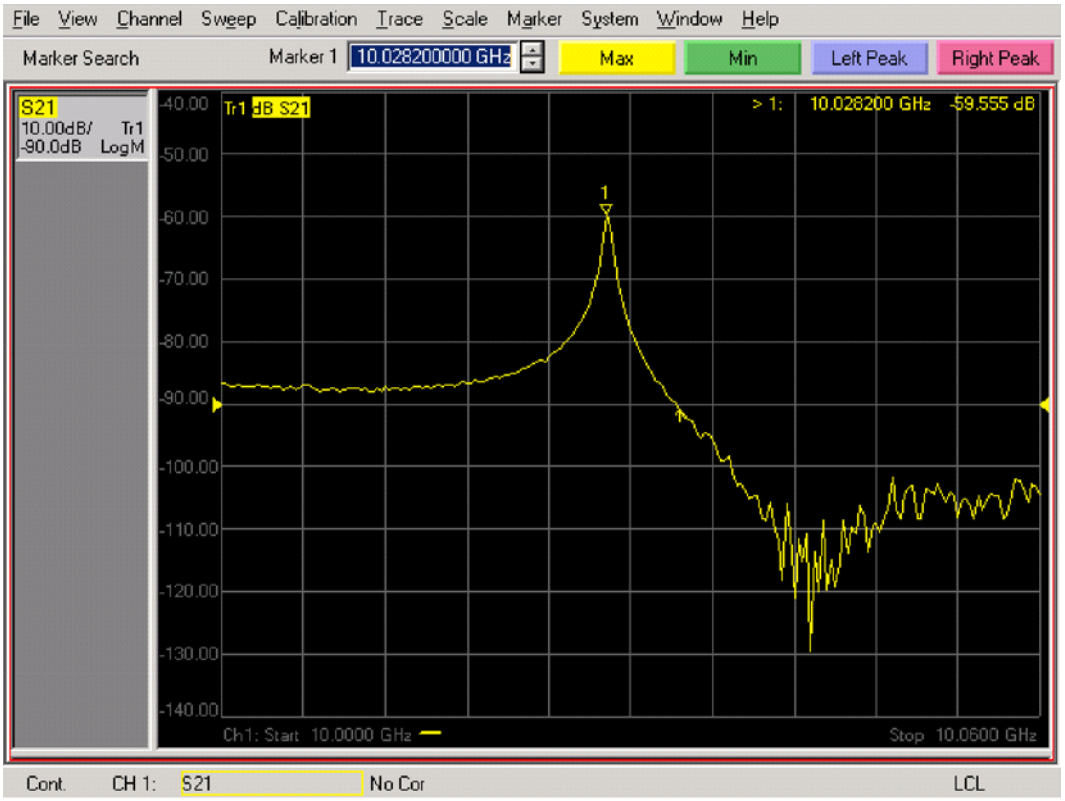


6. Repeat the previous step for the back coupling adjustment knob.
7. If not already done, start the PNA application by clicking on the Network Analyzer icon on the PNA display.
8. Make the following PNA settings. Refer to the Help system in the analyzer for complete information.
   - Measurement: S_{21}
   - Start frequency: 10 GHz
   - Stop frequency: 10.06 GHz
   - Scale: Autoscale

IMPORTANT When instructed to adjust both coupling adjustment knobs, always rotate them together SLOWLY at the same time. Also, rotate them in the same direction and at the same speed so that the coupling loops are always at the same depth inside the cavity. Clockwise rotation increases coupling, and counter clockwise rotation decreases it.

9. The PNA should display a trace with a resonant peak. Adjust both of the coupling adjustment knobs so that the peak measures between -55 to-65 dB. See Figure 3-2 on page 3-4.

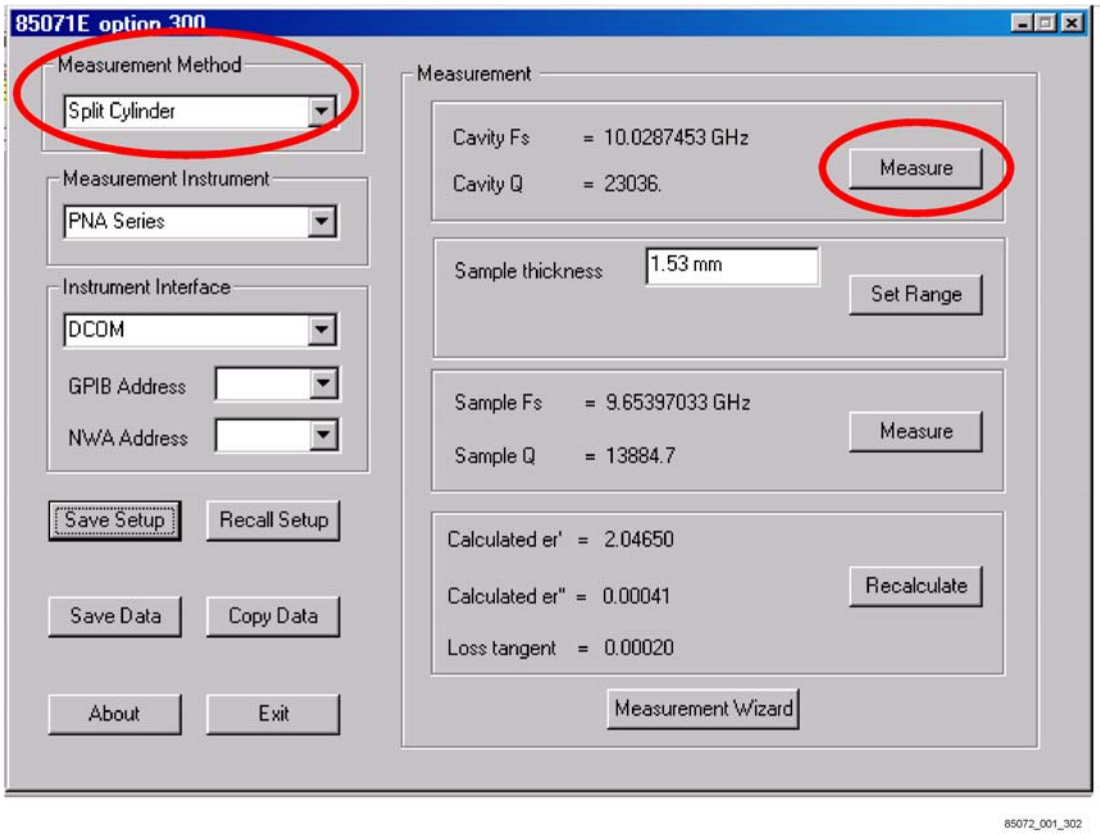
Figure 3-2 Measurement Trace for the Operator's Check



85072_001_307

10. On the PNA toolbar, click View > Minimize Application.
11. Start the 85071E Materials Measurement Software application by clicking the 85071E Cavity icon on the PNA display.
12. On the 85071E Option 300 dialog box, use the Measurement Method drop-down menu to select **Split Cylinder**. See Figure 3-3 on page 3-5.

Figure 3-3 85071E Option 300 Menu



13. Locate the menu section titled "Measurement" and click the top **Measure** button. See Figure 3-3 on page 3-5.

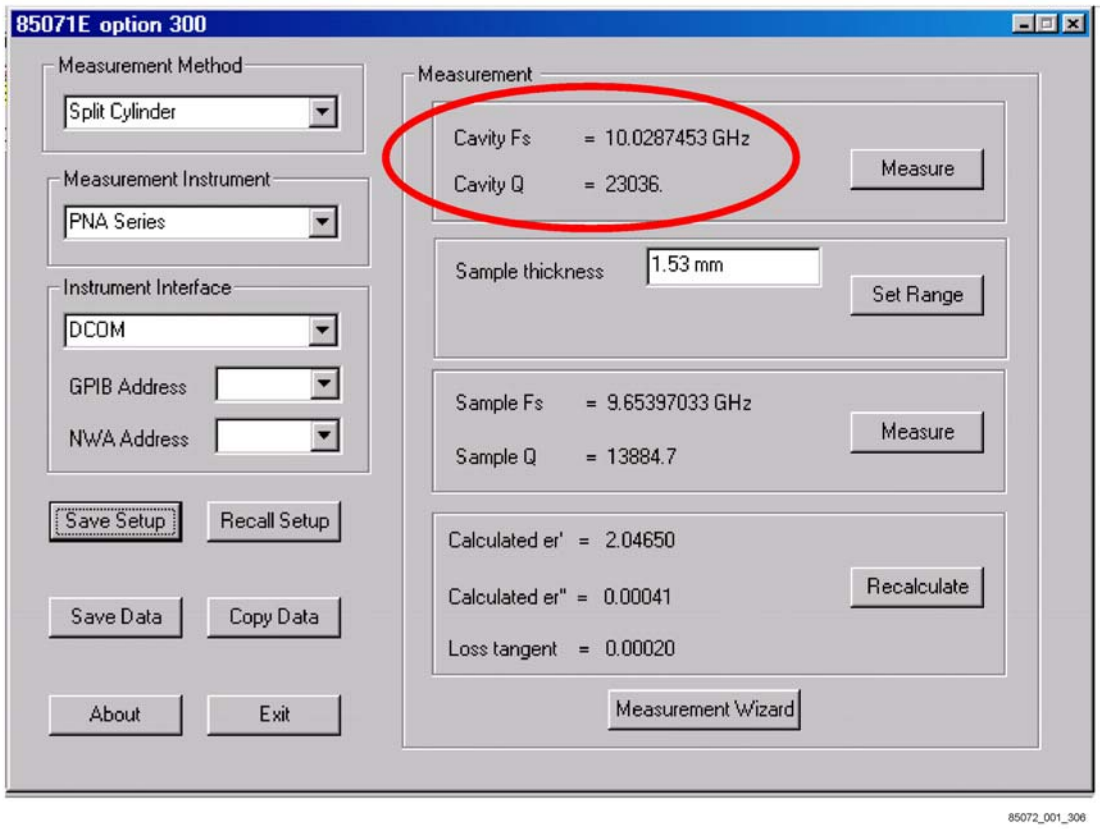
14. Follow the prompts to complete the measurement. At the prompt, "Adjust the coupling to center the bar below," stop rotating the coupling adjustment knobs when the arrow graphic disappears. **Reminder**: *when using the two coupling adjustment knobs, rotate both knobs together SLOWLY at the same time. Also, rotate them in the same direction and at the same speed so that the coupling loops are always at the same depth inside the cavity. Clockwise rotation increases coupling, and counter clockwise rotation decreases it.*

15. Find the empty cavity F_s (resonant frequency) and Q measurement results in the 85071E Option 300 dialog box, at the top of the section titled "Measurement." See Figure 3-4 on page 3-6. To pass the Operator's Check, you must get the following results:

    - F_s (resonant frequency) between 10 GHz and 10.06 GHz

- Cavity Q ≥ 20,000
- Maximum S_{21} peak value at ~ 10 GHz between -55 dB and -65 dB

Figure 3-4 Measurement Results for Operator's Check



If the resonator fails the Operator's Check, refer to Chapter 5 for troubleshooting information.

NOTE Reference materials can be purchased from N.I.S.T.

Sample Requirements

Ensure the sample meets the following requirements:

- non-magnetic (μr* = 1 - j0)
- free of traces
- free of copper clad
- free of sticky residue or dust (if necessary, use a lint-free cloth moistened with alcohol to clean samples, and allow them to dry)
- non-abrasive (cylinder mating surfaces must NOT be scratched)
- homogeneous and isotropic
- flat parallel sides
- minimum diameter: 56 mm, ideally 60 mm or more for easier handling
- uniform thickness: 0.05 mm to 5 mm, typically 1 mm
- suggested values for 1 mm thick sample are:
  - — real part of permittivity < 100
  - — loss tangent < 0.01

NOTE Actual values of permittivity and loss tangent that can be measured with the split cylinder resonator are dependent on thickness.

Measurement Example

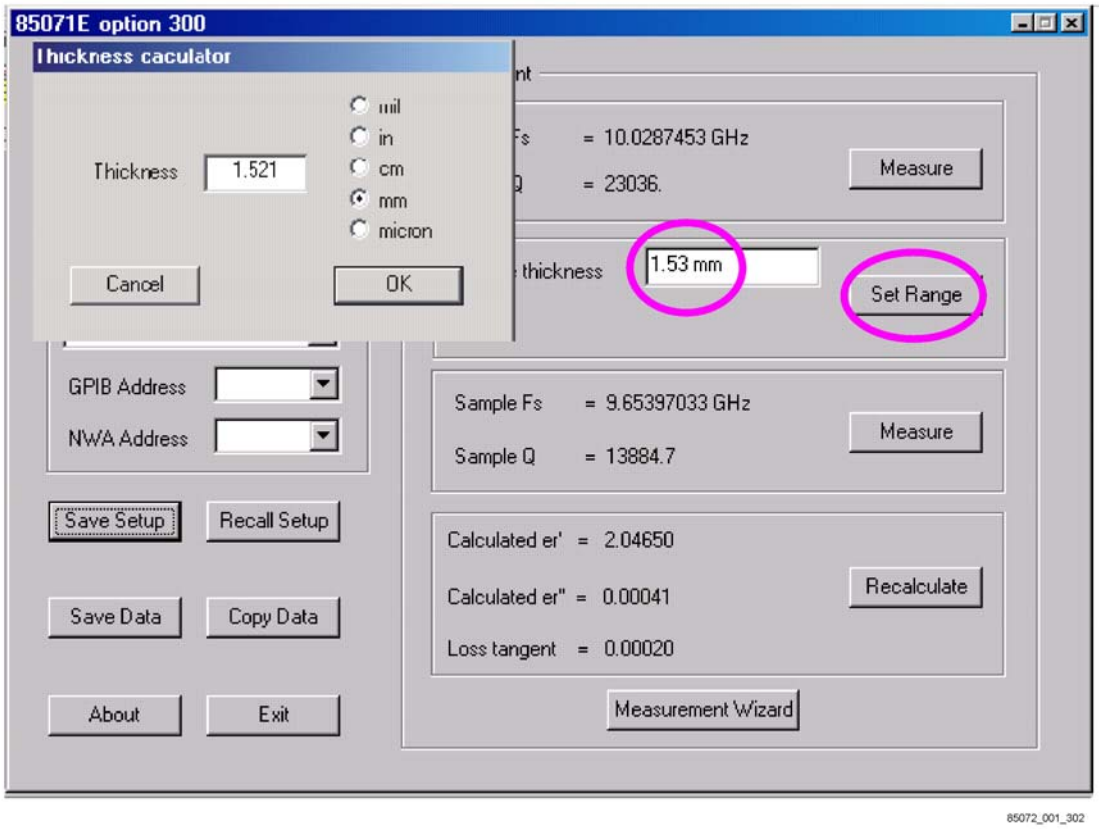
Measuring the Teflon PTFE with the PNA Series Network Analyzer

1. If not already done, complete the steps in the Operator's Check to measure the F_s (resonant frequency) and Q of the empty cavity. See "Operator's Check" on page 3-2.
2. Clean the Teflon PTFE sample with a lint-free cloth and compressed air. If necessary, use anhydrous isopropyl alcohol (>92% pure) to lightly dampen the lint-free cloth, allowing 5 minutes for the alcohol to evaporate from the Teflon PTFE after cleaning.

NOTE The Teflon PTFE sample must be cleaned before it is measured so that contaminants don't affect measurement results or damage the cylinder faces.

3. Insert the Teflon PTFE between the cylinder halves.
4. Measure the Teflon PTFE thickness using the micrometer.
5. On the 85071E Option 300 dialog box, click in the **Sample Thickness** cell to open the Thickness Calculator dialog box. Enter the Teflon PTFE thickness value and click **OK**. See Figure 3-5.

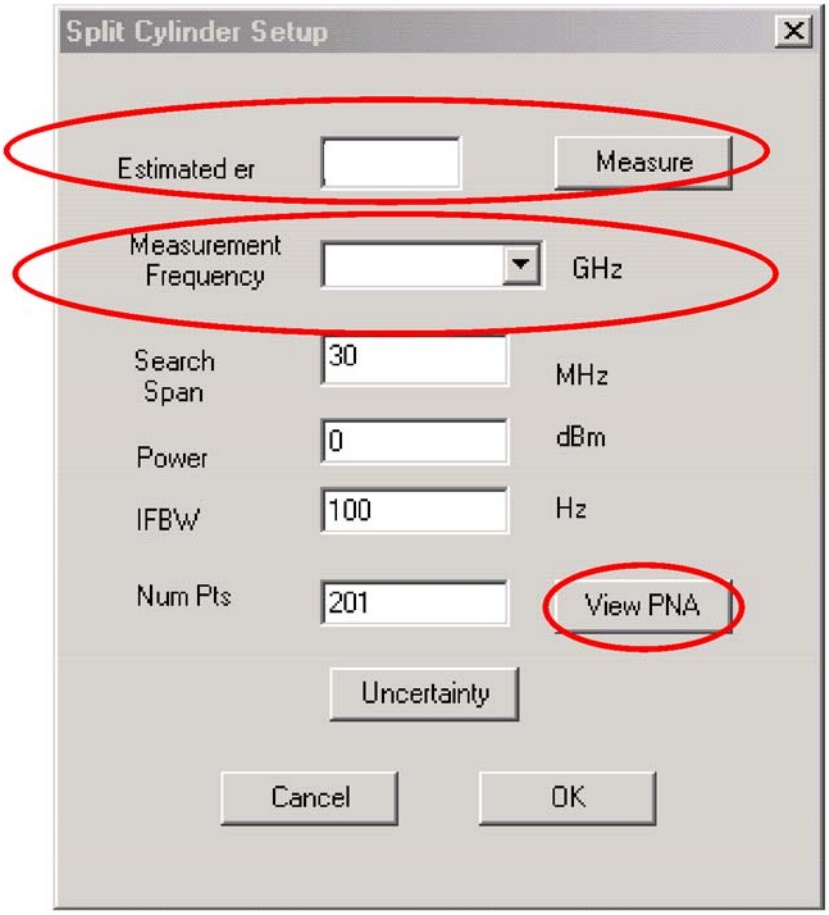
Figure 3-5 85071E Option 300 Menu



6. On the 85071E Option 300 dialog box, click **Set Range**. See Figure 3-5. Wait a few seconds while the program performs some calculations and opens the Split Cylinder Setup dialog box.
7. In the Split Cylinder Setup dialog box, enter a value for the real part of permittivity in the **Estimated er** cell or click **Measure** and follow the measurement prompts as the program finds an estimate using the TE_{111} mode. See Figure 3-6.

   er is the real part of permittivity that the program uses as an estimate in calculations. For more technical information, go to www.agilent.com and search for Agilent pub number 5989-6182EN, “Technical Overview of the 85072A 10 GHz Split Cylinder Resonator”.

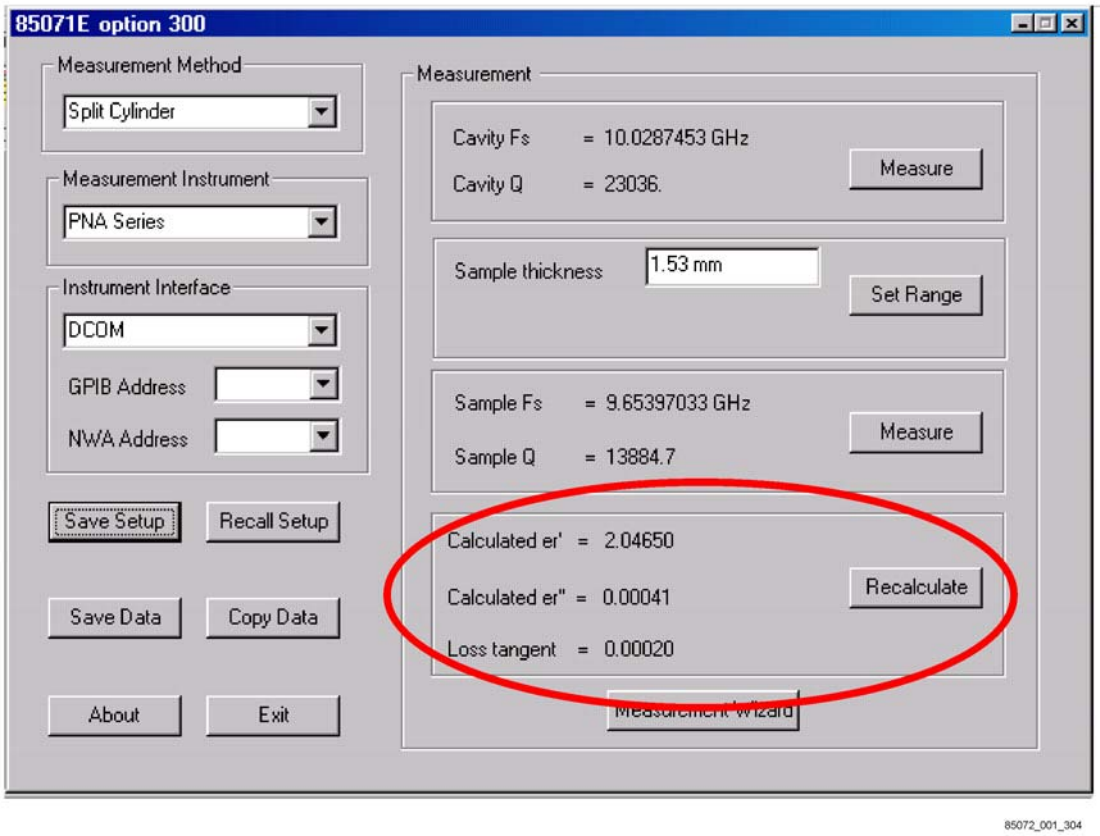
Figure 3-6 Split Cylinder Setup Dialog Box



8. In the Split Cylinder Setup dialog box, use the Measurement Frequency drop-down menu to select one of the TE_{0np} modes. See Figure 3-6. For your first measurement of any sample, Agilent recommends selecting the lowest frequency mode (TE_{011}).
9. If running the program on a PNA Series Network Analyzer, click **View PNA** to see the PNA display for 5 seconds, or use windows functions to switch to the PNA application. The trace on the PNA display should include only one peak, and that peak should be nearly symmetrical. If there is more than one peak or if the peak is not nearly symmetrical, refer to "Advanced Measurement Techniques" on page 3-11.
10. Press OK and follow the prompts to complete the measurement.
11. When the measurement is completed, the 85071E Option 300 dialog box reappears with the calculated values displayed above the Measurement Wizard button. See Figure 3-7. Typical values for the Teflon PTFE sample should be approximately:
    - Calculated $er^{|} \approx 2.05$
    - Calculated $er^{||} \approx 0.0004$
    - Loss Tangent ≈ 0.0002

If your measurement values aren't close to the values above, refer to "Advanced Measurement Techniques" on page 3-11.

Figure 3-7 Measurement Results for a Teflon PTFE Sample



Advanced Measurement Techniques

If the displayed trace includes two peaks, try the following suggestions in the order listed. If one of the suggestions gives you expected measurement results, it is not necessary to use the remainder.

- ❏ In the Split Cylinder Setup dialog box, use the Measurement Frequency drop-down menu to select a *different* TE_{0np} mode than the one you selected for the first measurement. See Figure 3-6.
- ❏ Choose the most likely peak.

1. Use the network analyzer marker functions to select the desired peak. If using a PNA Series network analyzer, refer to the PNA Help system in the analyzer for complete information.
2. In the Split Cylinder Setup dialog box, enter the frequency of the peak in the **Measurement Frequency** cell. See Figure 3-6 on page 3-10.
3. In the Split Cylinder Setup dialog box, enter values in the **Search Span** cell until the peak you selected is the only peak visible on the display.
4. Click OK and check the new measurement results.

❑ Try changing the sample thickness. An easy way to do this is measuring two sheets of the sample, being careful to minimize any air gaps between the two sheets.

4 Specifications

Electrical Characteristics

- TE_{011} Resonant mode of closed empty cylinders
  - ❏ Frequency = 10.03 + 0.03 GHz
  - ❏ Q >= 20,000 (input coupling at -60 dB)
- Additional, possibly usable, higher order TE_{0np} modes exist in the empty cylinders approximately at the following frequencies (GHz):

13.1	22.8	27.0
17.8	22.9	27.1
19.7	25.6	28.2

Usability of TE_{onp} modes depends on dielectric properties and thickness of the sample. For some samples, interference from other non-TE modes can make one or more higher order TE_{onp} modes unusable. Increasing or decreasing the thickness of the sample may shift the measurement frequency away from the interfering mode.

Typical Uncertainty

- TE_{011} mode
  - ❏ Real part of permittivity: +/- 1%
  - ❏ Loss tangent: +0.0001
- Usable higher order TE_{onp} modes:
  - ❏ Real part of permittivity: +/- 1 - 2%
  - ❏ Loss tangent: +0.0005

Mechanical Characteristics

Cylinder

Cylinders are precision diamond-turned AI 6061-T6 plated with 0.5 um Cu., 0.25 Um PdNi, and 2.0 um Au.

Figure 4-1 Cylinder Dimensions

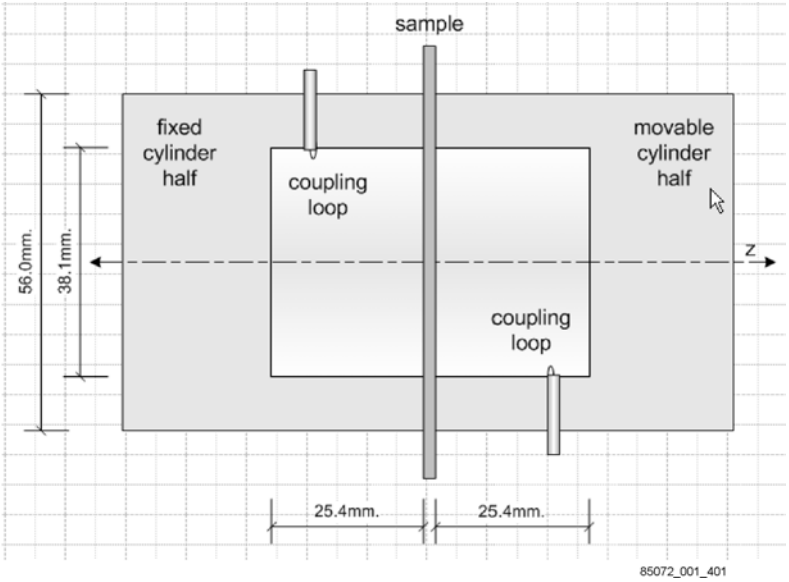
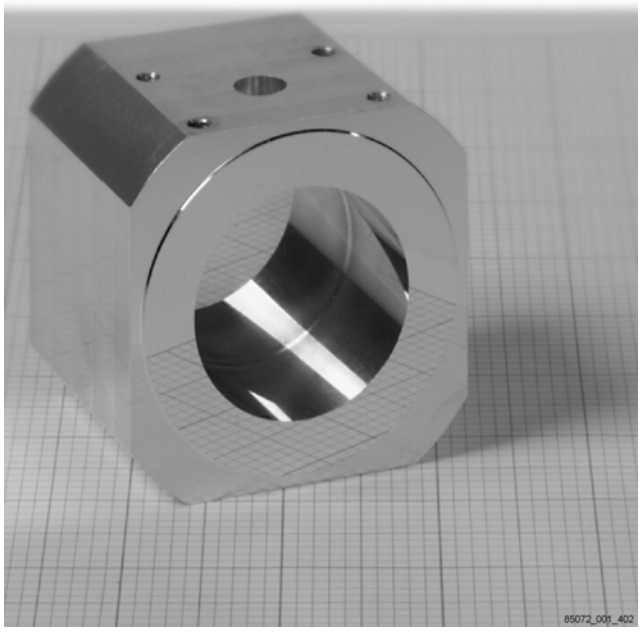


Figure 4-2 One Half of a Split Cylinder



Split Cylinder Resonator

Figure 4-3. Split Cylinder Resonator Dimensions: Top View

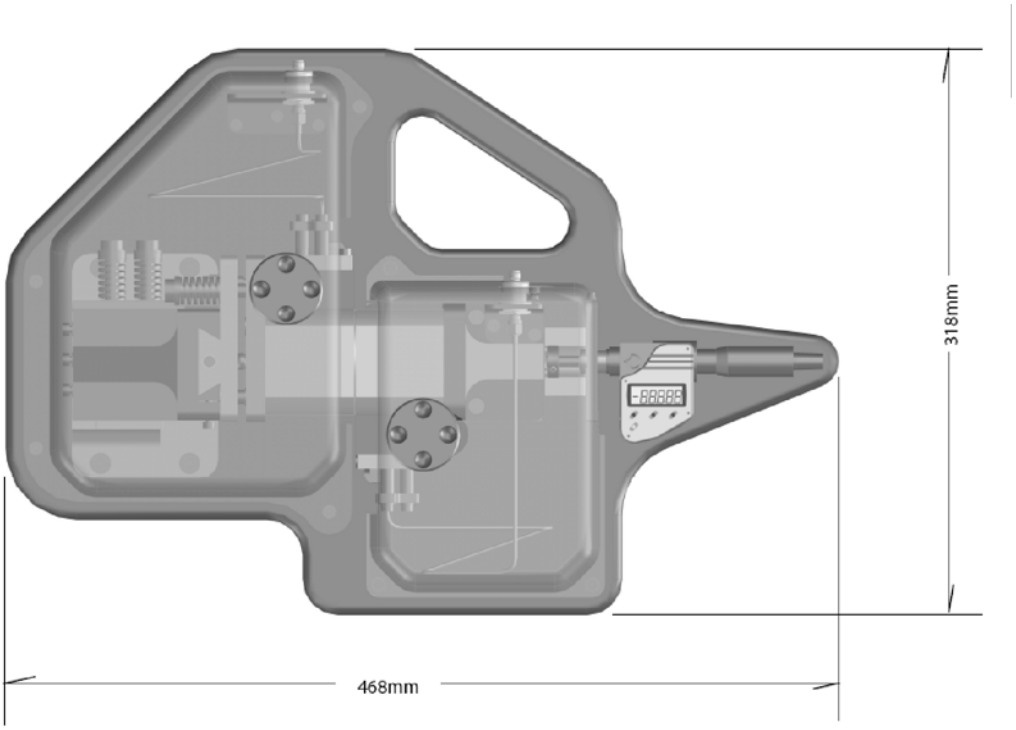
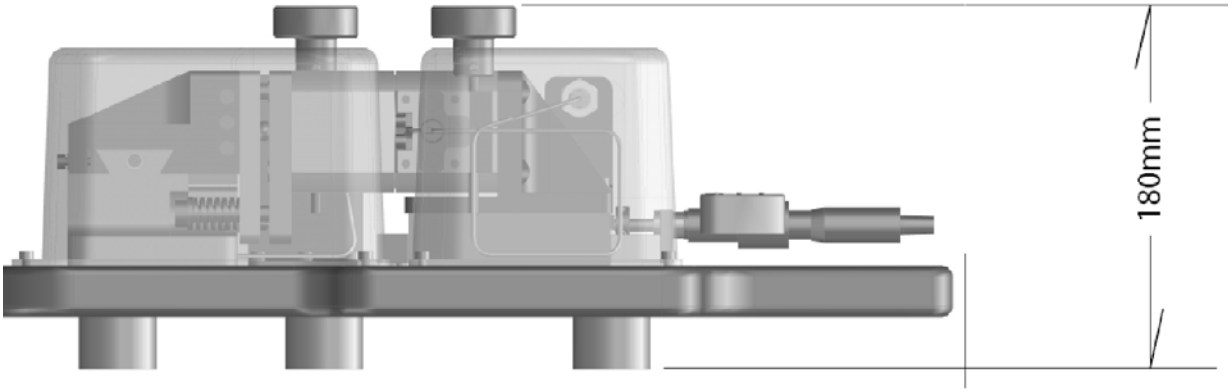


Figure 4-4. Split Cylinder Resonator Dimensions: Side View



- Connectors: 3.5 mm female
- Weight: 25 lbs ((11.25 kg)

Micrometer Characteristics

Micrometer resolution: 0.001 mm

Micrometer typical accuracy: 0.01 mm

5 Maintenance and Troubleshooting

Instrument Markings

The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Agilent office, or see http://www.agilent.com/environment/product/ for more information.

Physical Maintenance

Connectors

The best techniques for maintaining the integrity of the connectors on the resonator include:

- routine visual inspection
- cleaning
- proper cable connection techniques

For complete information on connectors, go to www.agilent.com and type “Connector Care” in the search function.

Cylinders Halves

Clean the Mating Surfaces of the Cylinder Halves

- Dampen a large portion of a lint-free cloth with anhydrous isopropyl alcohol (>92% pure).
- Insert the damp part of the cloth between the cylinder halves, where the Teflon PTFE was previously located.
- Turn the micrometer’s large dial (see Figure 1-2 on page 1-6) clockwise to carefully move the cylinder halves *loosely* together. It is very important not to overtighten the cylinder halves together when using the large dial.
- Turn the micrometer’s small dial (see Figure 1-2 on page 1-6) clockwise to further move the cylinder halves together. When the halves are fully closed together, the small dial will continue to turn while making a clicking sound, but will not allow you to overtighten the halves.
- Turn the micrometer’s small dial counterclockwise to open the closed cylinder halves by 0.02 mm. This space between the halves allows the damp cloth to be moved around.
- Move the cloth back and forth between the cylinder halves and then pull the cloth out from between the cylinders.

Clean Inside the Cylinder Halves

- Separate the cylinders fully, using the large micrometer dial.
- Spray compressed air inside both cylinder halves to remove any particulate matter.
- Leave the cylinder open for five minutes to allow the alcohol to evaporate fully.

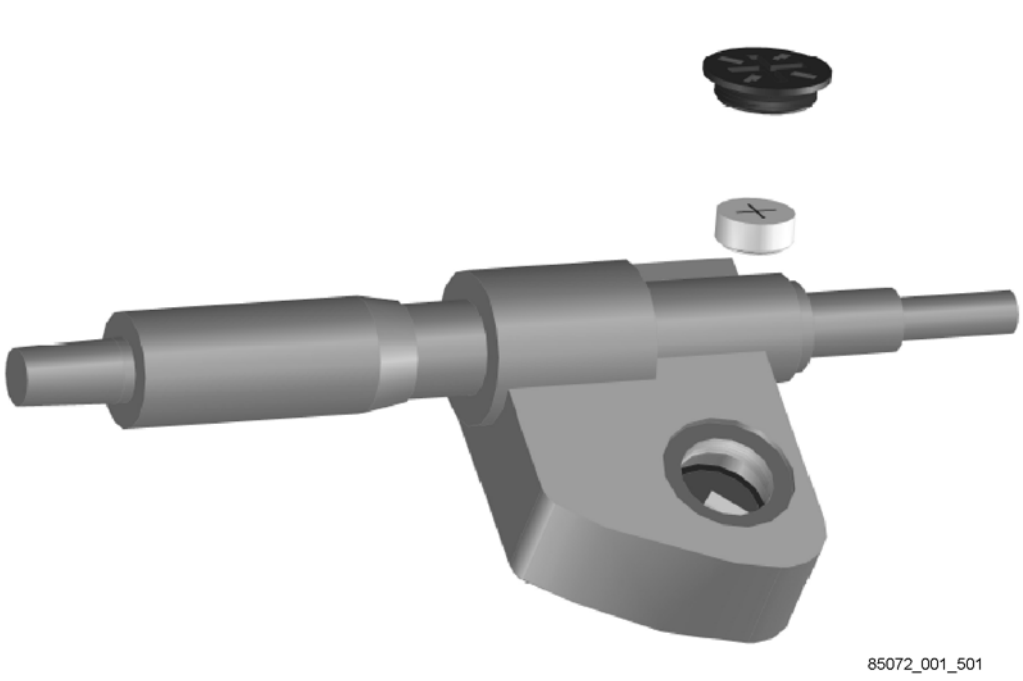
Protective Covers and Base

Clean the protective covers and the base using a dry or slightly damp cloth only. Do not use abrasive cleaners or cloths.

Changing the Micrometer SR-44 Battery

1. Locate the hole in the base underneath the micrometer. Look through the hole and locate the round, black cover on the micrometer.
2. Insert a flat-blade screwdriver through the hole and into the slot in the black cover.
3. Turn the screwdriver blade counter-clockwise until the black cover and the battery can be removed through the hole.
4. Recycle the old battery.
5. Place the new SR-44 battery inside the black cover with the inscribed "+" on the battery facing down.
6. Use your fingers to lift the black cover/battery through the base hole and into the micrometer.
7. Holding the black cover in place with your finger, use the screwdriver to tighten the cover.

Figure 5-1. Changing the Micrometer Battery



Troubleshooting Process

- The most likely cause of resonator problems is the cylinder halves not being clean. For instructions on cleaning them, refer to:
  - ❑ "Clean the Mating Surfaces of the Cylinder Halves" on page 5-3, and
  - ❑ "Clean Inside the Cylinder Halves" on page 5-3

Perform the "Operator's Check" on page 3-2 to see if the problem has been fixed.

- The second most likely cause of resonator problems is the cylinder halves being out of alignment with each other. Use the following procedure to align the cylinder halves.

Alignment Procedure

The goal of the alignment process is to have the two cylinder halves aligned to a common central axis. In order to accomplish this, two rotational errors and two translational errors must be minimized. The only tools needed are 2 mm and 3 mm ball-end hex keys, and a feeler gage (all supplied with the resonator).

The resonator's movable cylinder half (see Figure 1-1 on page 1-6) is attached to the ball bearing slide, as is the micrometer. The fixed cylinder half (see Figure 1-1 on page 1-6) is attached to the kinematic/dovetail (K/D) mount. The alignment process involves making small adjustments to the K/D mount until the cylinders are aligned to a common central axis.

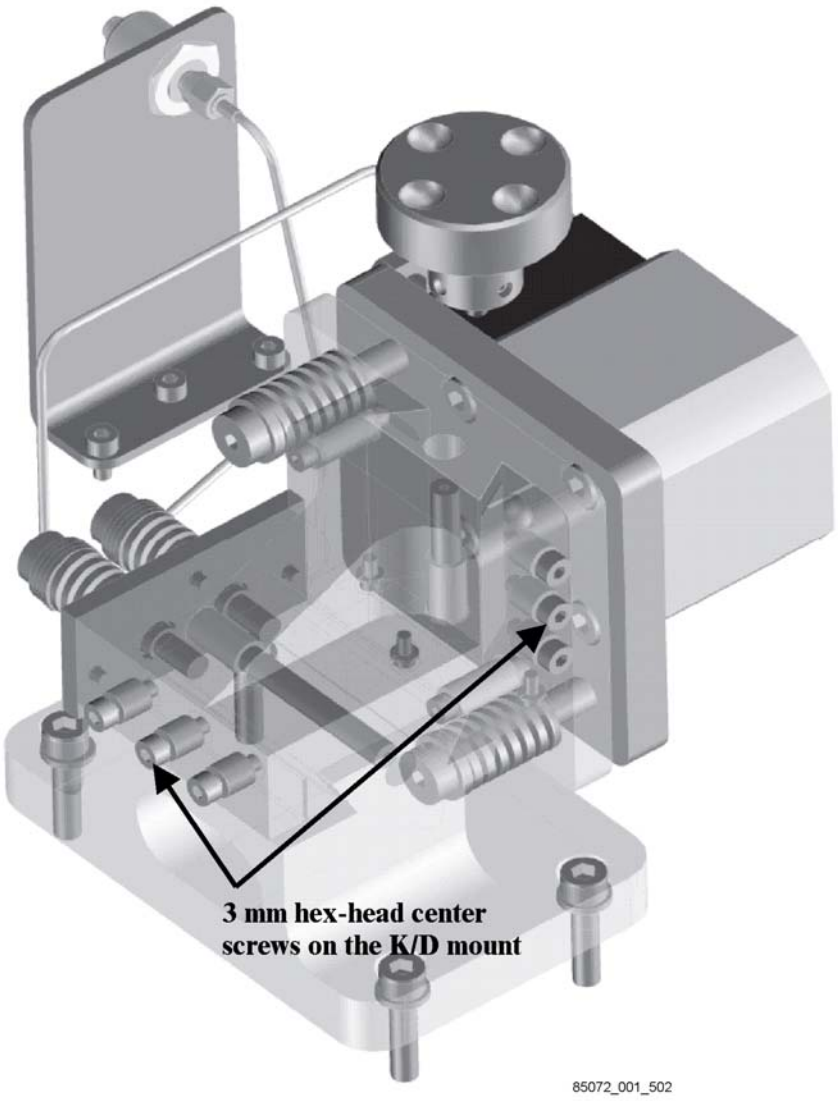
The K/D mount has four adjustments — two rotational and two translational — one for each error in position. See Figure 5-3 on page 5-7, showing the adjustment screws and associated error corrections.

Pre-Alignment

1. Use the 2 mm ball-end hex key (supplied) to loosen, but not remove, the two 2 mm hexhead setscrews in both coupling adjustment knobs. The setscrews can be accessed below the clear plastic covers.
2. Remove both coupling adjustment knobs.
3. Remove the seven sockethead cap screws using the 3 mm ball-end hex key (supplied), along with the lock washers and flat washers that secure both clear plastic covers.
4. Remove both clear plastic covers.
5. Remove the shipment security screw, located on the underside of the stage. It should only be finger tight.
6. Loosen the center screw on each K/D mount using a 3 mm ball-end hex key. If the K/D mount still won't move freely, loosen the screws on both sides of the center screw. See Figure 5-2 on page 5-6.

NOTE Keep the system security screw in a safe location so that you can install it if you need to ship the resonator.

Figure 5-2 3 mm Hex-Head Center Screws on K/D mount

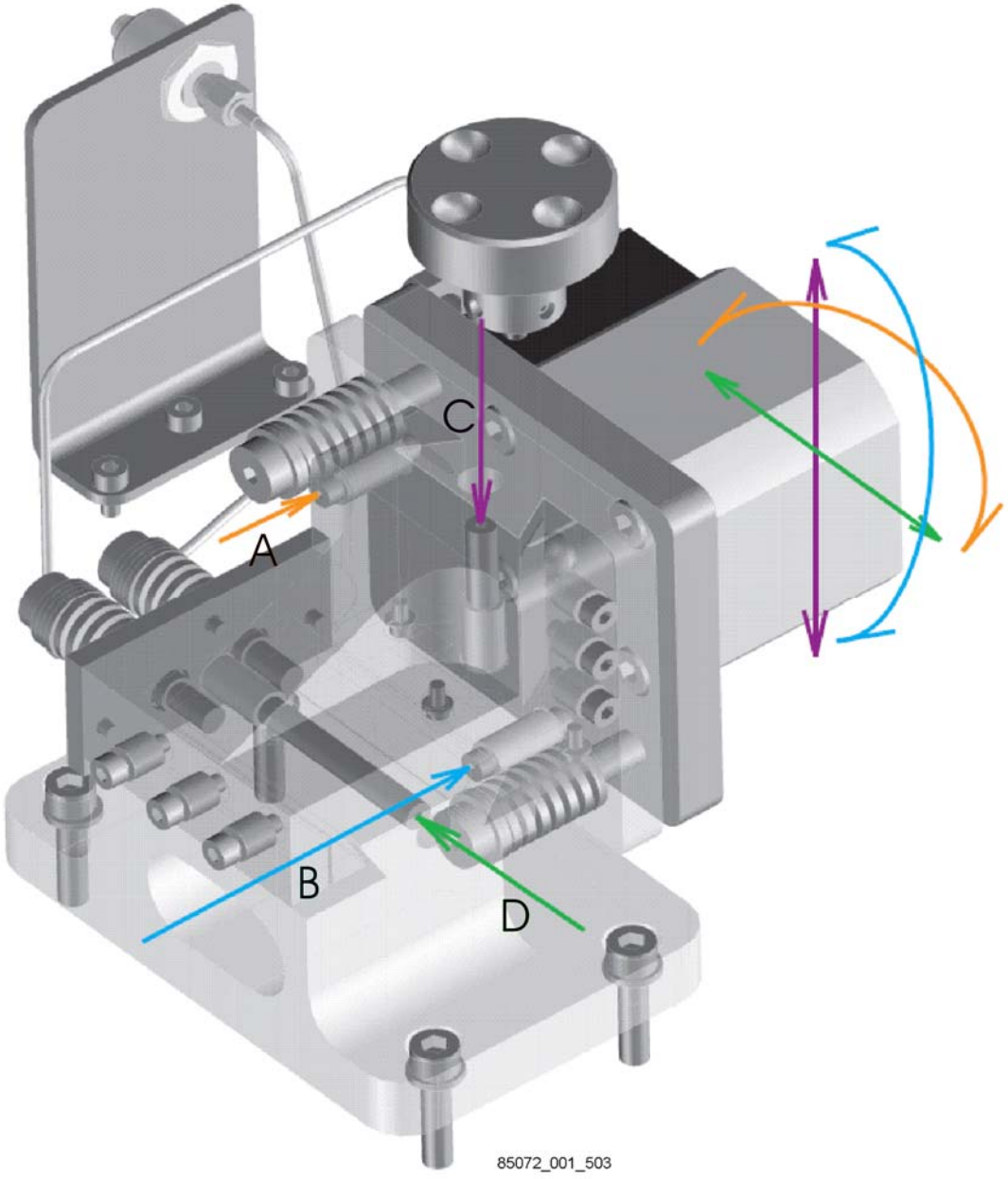


Coarse Alignment

1. Move the cylinder halves together by following steps 1 and 2 in "Performing the Operator's Check with the PNA Series Network Analyzer" on page 3-2.
2. Looking down from the top of the resonator, notice any gaps between the cylinder halves.
3. Find the micro adjuster identified with the orange arrow [A] in Figure 5-3 on page 5-7. Using the 2 mm ball-end hex key, turn this micro adjuster until the gap between the cylinder halves is minimized.

NOTE The following graphic includes color and should be viewed online or printed using a color printer.

Figure 5-3 Location and Action of the Four Hex Adjusters



4. Looking from the front of the resonator, notice any gaps between the cylinder halves. When you're facing the front of the resonator, the micrometer is to your right
5. Find the micro adjuster identified with the blue arrow [B] in Figure 5-3 on page 5-7. Using the 2 mm ball-end hex key, turn this micro adjuster until the gap between the cylinder halves is minimized.

6. Find the micro adjuster identified with the purple arrow [C] in Figure 5-3 on page 5-7. Using the 2 mm ball-end hex key, turn this micro adjuster counterclockwise (loosen) and press down on the K/D mount with your thumb until the cylinder halves are at the same height. If you need to raise the fixed cylinder half, turn the micro adjuster clockwise.
7. Find the micro adjuster identified with the green arrow [D] in Figure 5-3 on page 5-7. Using the 2 mm ball-end hex key, turn this micro adjuster until the cylinder halves are aligned back-to-front.

Repeat the Coarse Alignment steps until the gap between the cylinder halves is barely visible.

Fine Alignment

1. Slowly turn the micrometer's small dial (see Figure 1-1 on page 1-6) clockwise to further move the cylinder halves together. When the halves are fully closed together, the small dial will continue to turn while making a clicking sound, but will not allow you to overtighten the halves.
2. Zero the micrometer by pressing its middle button.
3. Slowly turn the micrometer's small dial counterclockwise until there is at least a 2 mm gap between the cylinder halves.
4. Insert the feeler gage (supplied) into the gap at the center line between the cylinder halves from the front of the resonator. When you're facing the front of the resonator, the micrometer is to your right. See Figure 5-4 on page 5-9.

Figure 5-4 Feeler Gage in the Gap Between Cylinder Halves

5. Slowly turn the micrometer's small dial clockwise until the cylinder halves tightly clamp the feeler gage and the dial clicks.
6. Record the micrometer reading.
7. Slowly turn the micrometer's small dial counterclockwise and remove the feeler gage.
8. Insert the feeler gage into the gap at the center line between the cylinder halves from the back of the resonator. When you're facing the back of the resonator, the micrometer is to your left.
9. Slowly turn the micrometer's small dial clockwise until the cylinder halves tightly clamp the feeler gage and the dial clicks.
10. Again, record the micrometer reading.
    The difference between the two micrometer readings is an indication of the rotational error between the two cylinders.
11. Find the micro adjuster identified with the orange arrow [A] in Figure 5-3 on page 5-7.

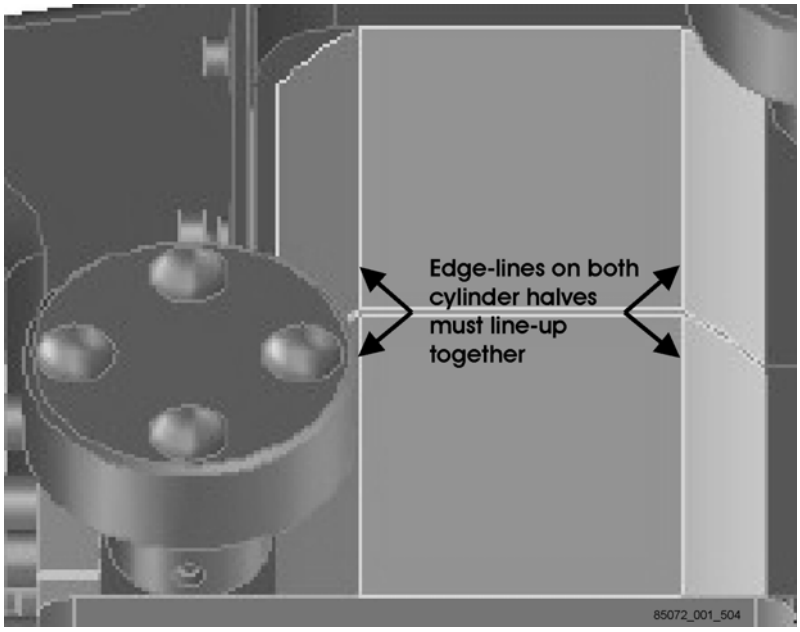
Using the 2 mm ball-end hex key, turn this micro adjuster until the rotational error between the cylinder halves is minimized.

12. Repeat Step 1 through Step 11 until the rotational error is less than 5 µm.
13. Record the micrometer reading for later use.
14. Slowly turn the micrometer's small dial counterclockwise until there is at least a 2 mm gap between the cylinder halves.
15. Insert the feeler gage into the gap at the center line between the cylinder halves from the top of the resonator.
16. Slowly turn the micrometer's small dial clockwise until the cylinder halves tightly clamp the feeler gage and the dial clicks.
17. Record the micrometer reading.
18. Using the 2 mm ball-end hex key, turn the micro adjuster (blue arrow [B] in Figure 5-3 on page 5-7) until the gap between the cylinder halves is the same as that recorded in Fine Alignment Step 13. It may be necessary to repeat Fine Alignment Step 1 through Step 18 to reduce the total rotational errors to less than 5 µm.
19. Slowly turn the micrometer's small dial counterclockwise until there is approximately a 0.5 mm gap between the cylinder halves.
20. Using the 2 mm ball-end hex key, turn the micro adjuster (purple arrow [C] in Figure 5-3 on page 5-7) counterclockwise (loosen) and press down on the K/D mount with your thumb until the fixed cylinder half is slightly lower than the movable cylinder half. If you need to raise the fixed cylinder half, turn the micro adjuster clockwise.
21. Holding the feeler gage, place its long edge on top of the fixed cylinder half at the center line. See Figure 5-5.

Figure 5-5 Using the Feeler Gage

22. Using the 2 mm ball-end hex key, turn the micro adjuster (purple arrow [C] in Figure 5-3 on page 5-7) clockwise to slowly tighten as you gently slide the feeler gage from left to right across the center line of the fixed cylinder half until it bumps gently against the movable cylinder half. See Figure 5-5.
23. Repeat this motion while continuing to slowly tighten the micro adjuster (purple arrow [C] in Figure 5-3 on page 5-7) until the feeler gage no longer bumps against the movable cylinder.
24. Now slide the feeler gage from right to left across the center line of the movable cylinder half to verify that is does not bump against the fixed cylinder half.
25. Repeat Step 20 to Step 24 until the feeler gage slides across the center line from either direction without bumping into a cylinder half.
26. Look down the cylinder halves top flats from the side of the resonator with the fixed cylinder half. Notice if the horizontal edge-lines on each cylinder half line-up together, appearing straight as shown in Figure 5-6 Minimize the straightness error using the 2 mm ball wrench to tune the micro adjuster (green arrow [D] in Figure 5-3 on page 5-7).

Figure 5-6 Edge-Lines on Both Cylinder Halves Must Line-Up Together



27. Verify the alignment by measuring the feeler gage as in Fine Alignment Step 1 through Step 18.
28. If the variation is more than 5 µm, repeat Fine Alignment Step 1 through Step 26.
29. Tighten the center screws on the K/D mount.
30. Replace covers and cover screws.
31. Replace the coupling adjustment knobs and tighten setscrews.
32. Perform the "Operator's Check" on page 3-2 to see if the alignment was successful.

Preparing the Resonator for Shipment

Install the Teflon PTFE Sample

The resonator must be shipped with a rectangular Teflon PTFE sample held between the two cylinder halves. The Teflon PTFE prevents the mating surfaces of the cylinder halves from accidentally hitting together. To install the Teflon PTFE:

- Turn the micrometer's large dial (see Figure 1-1 on page 1-6) clockwise to move the cylinder halves towards each other, leaving enough space between them to insert the Teflon PTFE sample.
- Insert the Teflon PTFE sample between the cylinder halves.
- Turn the micrometer's small dial (see Figure 1-1 on page 1-6) clockwise to tighten the cylinder halves on the Teflon PTFE. When the halves are fully tightened, the small dial will continue to turn while making a clicking sound, but will not allow you to overtighten the halves.

Lock the Linear Slide

The resonator must be shipped with the linear slide locked to prevent the movable cylinder-half from moving. To lock it, locate the small, knurled screw on the stage (see Figure 1-1 on page 1-6) and turn it clockwise until the linear slide won't move when the micrometer is adjusted.

Install the Shipment Security Screw

The resonator must be shipped with the shipment security screw in place. Having the screw in place helps prevent the cylinder halves from moving out of alignment with each other. Hand tighten the screw only - no wrench needed or supplied.

Returning a Resonator to Agilent Technologies

If your resonator requires service, contact Agilent Technologies for information on where to send it. See "Contacting Agilent" on page 5-15. Include the following information:

- your company name and address
- a technical contact person within your company, and the person's complete telephone number including country code and area code
- the serial number of the resonator
- the type of service required
- a *detailed* description of the problem (if applicable) and how the resonator was being used when the problem occurred

IMPORTANT Save the original inner-box and foam along with the original or comparable outer-box and foam for reuse to ensure shipment safety.

Contacting Agilent

Assistance with test and measurements needs and information on finding a local Agilent office are available on the Web at:
www.agilent.com/find/assist

If you do not have access to the Internet, please contact your Agilent field engineer.

NOTE 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.

6 Replaceable Parts

Introduction

Table 6-1 lists the replacement part numbers for items included in the 85072A Split Cylinder Resonator.

Table 6-1 Replaceable Parts for the 85072A Split Cavity Resonator

Description	Qty	Agilent Part Number
User's and service guide[a]	1	85072-90001
Coupling adjustment knobs	2	5023-0181
Screw-set M4 x 0.7 6MM-LG HEX-SKT-HD	4	0515-2129
F cover (for fixed cylinder half)	1	5023-0184
M cover (for movable cylinder half)	1	5023-0185
3.5 mm bulkhead connector - female	2	5062-6618
Washer-FL MTLC 4.0 4.4-MM-ID 8.85-MM-OD	7	3050-0893
Washer-LK HLCL 4.0.4.1-MM-ID 7.6-MM-OD	7	2190-0586
Washer-LK INTL T 7/16 IN 0.439-IN-ID	2	2190-0104
Nut-HEX-DBL-CHAM UNEF-2B-THD 0.094-IN-THK	2	2950-0132

a. This document is available online for a free download. Refer to See "Printing Copies of This Document" on page iii.

NOTE To purchase extra Teflon PTFE samples, go to www.mcmaster.com and order part number 8545K13.

Table 6-2 Items Not Included with the Split Cylinder Resonator

Description	Qty	Agilent Part or Model Number
Misc.		
85071E Materials Measurement Software with Option 300 Resonant Cavity Software	1	85071E-300 UL7 (parallel key) –or– UL8 (USB key)
N4419AK20 3.5 mm male-to-female flexible cable	2	E7342-60004
PNA Series, PNA-X Series, or PNA-L Series Network Analyzer	1	varies[a]
Wrenches		
1/2 inch and 9/16 inch, open-end wrench	1	8710-1770
5/16 inch (8 mm), open-end torque wrench; 0.9 N-m (8 in-lb)	1	8710-1765
ESD Protection Devices		
Grounding wrist strap	1	9300-1367
5 ft grounding cord for wrist strap	1	9300-0980
2 x 4 ft conductive table mat and 15 ft ground wire	1	9300-0797
Connector Cleaning Supplies		
Anhydrous isopropyl alcohol (>92% pure)[b]	--	--
Compressed air	--	--
Cleaning swabs	100	9301-1243

a. For more information, go to www.agilent.com and type “PNA Network Analyzer” in the search function.
b. Agilent can no longer safely ship isopropyl alcohol, so customers should purchase it locally.

7 Replacement Procedures

Replacing Parts in the Resonator

This chapter contains procedures for replacing the following resonator parts:

- 3.5 mm connectors
- Clear plastic covers
- Coupling adjustment knobs

For replacement of all other parts, the resonator must be returned to Agilent. See "Contacting Agilent" on page 5-15.

Replacing the 3.5 mm Connectors

Required Tools

- 2 mm ball-end hex key (supplied)
- 3 mm ball-end hex key (supplied)
- 5/16" torque wrench (not supplied)
- 9/16" open-end wrench (not supplied)

Required Parts

Table 7-1 Required Parts for Replacing the 3.5 mm Connectors

Part Number	Quantity	Description
5023-0181	2	Coupling adjustment knobs
0515-2129	4	Screw-set M4 x 0.7 6MM-LG HEX-SKT-HD
5023-0184	1	F cover (for fixed cylinder half)
5023-0185	1	M cover (for movable cylinder half)
5062-6618	2	3.5 mm bulkhead connector - female
3050-0893	7	Washer-FL MTLC 4.0 4.4-MM-ID 8.85-MM-OD
2190-0586	7	Washer-LK HLCL 4.0.4.1-MM-ID 7.6-MM-OD
2190-0104	2	Washer-LK INTL T 7/16 IN 0.439-IN-ID
2950-0132	2	Nut-HEX-DBL-CHAM UNEF-2B-THD 0.094-IN-THK

Procedure

1. Use the 2 mm ball-end hex key (supplied) to loosen, but not remove, the two 2 mm hexhead setscrews in both coupling adjustment knobs. The setscrews can be accessed below the clear plastic covers.
2. Remove both coupling adjustment knobs.

3. Use the 3 mm ball-end hex key (supplied) to remove the seven M4 sockethead cap screws from the clear plastic covers, and then remove the lock washers, and flat washers.
4. Remove both clear plastic covers.
5. Use a 5/16” torque wrench (not supplied) to unscrew the semi-rigid coaxial cable nuts from the back of the connectors. Be careful not to bend the cables.
6. Use a 9/16” torque wrench (not supplied) to unscrew the nuts from the back of the connectors.
7. Remove and recycle the original connectors and lock washers.
8. Install the new connectors and lock washers.
9. Reinstall the nuts on the back of the connectors.
10. Reinstall semi-rigid coaxial cable nuts and torque to 8 in-lbs.
11. Reinstall the plastic covers, replacing the seven M4 sockethead cap screws, lock washers, and flat washers.
12. Reinstall original (or install new) coupling adjustment knobs. Set the height of the knobs so that there is approximately a 1 mm gap between the underside of the knobs and the clear plastic covers.
13. Tighten the setscrews in both knobs.

Replacing the Clear Plastic Covers

See Step 1 through Step 4, and Step 11 through Step 13 in “Replacing the 3.5 mm Connectors” on page 7-2.

Required Tools

- 2 mm ball-end hex key (supplied)
- 3 mm ball-end hex key (supplied)

Required Parts

Table 7-2 Required Parts for Replacing the Clear Plastic Covers

Part Number	Quantity	Description
5023-0184	1	F cover (for fixed cylinder half)
5023-0185	1	M cover (for movable cylinder half)
3050-0893	7	Washer-FL MTLC 4.0 4.4-MM-ID 8.85-MM-OD
2190-0586	7	Washer-LK HLCL 4.0.4.1-MM-ID 7.6-MM-OD

Replacing the Coupling Adjustment Knobs

See Step 1, Step 2, Step 12, and Step 13 in “Replacing the 3.5 mm Connectors” on page 7-2.

Required Tools

- 2 mm ball-end hex key (supplied)

Required Parts

Table 7-3. Required Parts for Replacing the Coupling Adjustment Knobs

Part Number	Quantity	Description
5023-0181	2	Knob
0515-2129	4	Screw-set M4 x 0.7 6MM-LG HEX-SKT-HD