User's and Service Guide

Agilent Technologies 11904S
2.4 mm/2.92 mm Adapter Set

This manual applies to 11904S connector adapter set with serial number 2834A00101 or higher.

Agilent Technologies

Agilent Part Number: 11904-90009

Printed in USA
Print Date: January 2002

Supersedes: October 1996

Warranty

This product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Agilent Technologies will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Agilent. Buyer shall prepay shipping charges to Agilent and Agilent shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to Agilent from another country.

Agilent Technologies warrants that its software and firmware designated by Agilent for use with an instrument will execute its programming instructions when properly installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error-free.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. AGILENT TECHNOLOGIES SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE BUYER’S SOLE AND EXCLUSIVE REMEDIES. AGILENT TECHNOLOGIES SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent products.

For any assistance, contact Agilent Technologies. Refer to Table 5-1 on page 5-4.

Contents

Contents

1 General Information

Adapter Set Overview

The Agilent 11904S adapter set is designed to give network analyzer systems with 2.4 mm test ports (such as the Agilent 8510, 8722, and the PNA series) and the ability to perform measurements on devices with 2.92 mm connectors. The set can be used to achieve calibrated measurements of 2.92 mm devices up to 40 GHz, and 2.4 mm devices up to 50 GHz.

Adapter Set Contents

The basic 11904S adapter set includes the following items:

- user's and service guide
- four 2.4 mm to 2.92 mm adapters
- 5/16 in, 56 N-cm (5 in-lb) torque wrench for use on the 2.92 mm connectors
- an open-end wrench for the 7 mm flats on some of the components
- two calibration definitions disks (8510/8722, and PNA series) that contain modified standards to account for the adapters that are inserted after a 2.4 mm calibration is performed

NOTE A backup copy of each calibration definitions disk should be made immediately upon receipt of the adapter set. Refer to your network analyzer user's guide, or embedded help for instructions on duplicating a disk.

Refer to Chapter 6, "Replaceable Parts," for a complete list of contents and their associated part numbers.

Calibration Definitions Disks

The calibration definitions disks contain two sets of calibration definitions for use with your analyzer. Refer to your network analyzer user's guide, or embedded help for information on modifying the calibration kit standard definitions.

8510

- The first set, **2.92 mm A.1**, contains modified standards data to account for the adapters which are inserted after a 2.4 mm calibration is performed.
- The second set, **2.4 mm A.4**, contains calibration definitions for only the 2.4 mm devices.

PNA Series

- The first set, **2.92 mm Model 86056K**, contains modified standards data to account for the adapters which are inserted after a 2.4 mm calibration is performed.
- The second set, **2.4 mm Model 85056**, contains calibration definitions for only the 2.4 mm devices.

8722

- Has these same definitions stored within the internal non-volatile memory labeled as **2.92*** and **2.4 mm**.

Adapters (2.4 mm and 2.92 mm)

Like the other devices in the kit, the adapters are built to very tight tolerances to provide good broadband performance and to ensure stable, repeatable connections.

The adapters are designed so that their nominal electrical lengths are the same, which allows them to be used in calibration procedures for non-insertable devices (such as adapter removal).

The male 2.4 mm and 2.92 mm connectors are metrology grade. The female PSC-2.4 mm is a metrology–grade, precision slotless connector. The female 2.92 mm connectors have slotted contacts and therefore cannot be considered metrology grade. Due to the extremely thin wall of the 2.92 mm female connector, a slotless metrology grade 2.92 mm connector pair does not currently exist.

Compatible Network Analyzers

The 11904S adapter set is intended to be used with any of the following network analyzers.

- 8510 series
- 85106
- 8722
- PNA microwave series

Connector Adapter Sets Documented in This Manual

This manual applies to any 11904S adapter kit with serial number 2834A00101 or higher. The part numbers provided in this manual are the recommended replacement parts for this set. The devices in this set should meet the specifications published in this manual.

Equipment Required but Not Supplied

- 2.4 mm gages (used for measuring 2.4 mm connectors)
- 3.5 mm gages (used for measuring 2.92 mm connectors)
- 08510-10033 Specification and Performance Verification software

Connector cleaning supplies and various electrostatic discharge (ESD) protection devices are not supplied with the adapter set but are required to ensure successful operation of the kit. Refer to Table 6-2 on page 6-4 for their associated part numbers.

Incoming Inspection

Refer to Table 6-1 on page 6-2 to verify a complete shipment. Use Table 1-1 to record the serial numbers of all serialized devices in your adapter set. To verify the electrical performance of the devices in this set, see Chapter 4, “Performance Verification.”

Check for damage. The foam-lined storage case provides protection during shipping. If the case or any device appears damaged, or if the shipment is incomplete, refer to “Contacting Agilent” on page 5-4. Agilent will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company. See “Returning a Kit or Device to Agilent” on page 5-3.

Recording the Device Serial Numbers

In addition to the set serial number, the devices in the kit are individually serialized (serial numbers are labeled onto the body of each device). Record these serial numbers in the following table. Recording the serial numbers will prevent confusing the devices in this kit with similar devices from other kits.

The adapters included in the kit are for measurement convenience only and are not serialized.

Table 1-1 Serial Number Record for the 11904S

Device	Serial Number
Adapter set	______________________
Adapters:	
2.4 mm (m) to 2.92 mm (m)	______________________
2.4 mm (m) to 2.92 mm (f)	______________________
2.4 mm (f) to 2.92 mm (f)	______________________
2.4 mm (f) to 2.92 mm (m)	______________________

Clarifying the Sex of a Connector

In this manual, calibration devices and adapters are referred to in terms of their connector interface. For example, a male open has a male connector.

However, during a measurement calibration, the network analyzer softkey menus label a calibration device with reference to the sex of the analyzer's test port connector—not the calibration device connector. For example, the label **SHORT(F)** on the analyzer's display refers to the short that is to be connected to the female test port. This will be a male short from the calibration kit.

A connector gage is referred to in terms of the connector that it measures. For instance, a male connector gage has a female connector on the gage so that it can measure male devices.

Preventive Maintenance

The best techniques for maintaining the integrity of the devices in the kit include:

- routine visual inspection
- routine cleaning
- proper gaging
- proper connection techniques

All of these are described in Chapter 3. Failure to detect and remove dirt or metallic particles on a mating plane surface can degrade repeatability and accuracy and can damage any connector mated to it. Improper connections, resulting from pin depth values being out of the observed limits (see Table 2-2 on page 2-4) or from bad connection techniques, can also damage these devices.

2 Specifications

Environmental Requirements

Table 2-1 Environmental Requirements

Parameter	Limits
Temperature	
Operating[a]	+20 °C to +26 °C
Storage	–40 °C to +75 °C
Error-corrected range[b]	± 1 °C of measurement calibration temperature
Altitude	
Operating	< 4,500 meters (≈15,000 feet)
Storage	< 15,000 meters (≈50,000 feet)
Relative humidity	Always non-condensing
Operating	0 to 80% (26 °C maximum dry bulb)
Storage	0 to 90%

a. The temperature range over which the calibration standards maintain conformance to their specifications.

b. The allowable network analyzer ambient temperature drift during measurement calibration and during measurements when the network analyzer error correction is turned on. Also, the range over which the network analyzer maintains its specified performance while correction is turned on.

Temperature—What to Watch Out For

Changes in temperature can affect electrical characteristics. Therefore, the operating temperature is a critical factor in performance. During a measurement calibration, the temperature of the calibration devices must be stable and within the range shown in Table 2-1.

IMPORTANT Avoid unnecessary handling of the devices during calibration because your fingers act as a heat source and may increase the temperature of the device.

Mechanical Characteristics

Mechanical characteristics such as center conductor protrusion and pin depth are *not* performance specifications. They are, however, important supplemental characteristics related to electrical performance. Agilent Technologies verifies the mechanical characteristics of the devices in the kit with special gaging processes and electrical testing. This ensures that the device connectors do not exhibit any center conductor protrusion or improper pin depth when the kit leaves the factory.

"Gaging Connectors" on page 3-9 explains how to use gages to determine if the kit devices have maintained their mechanical integrity. Refer to Table 2-2 for *typical* and *observed* pin depth limits.

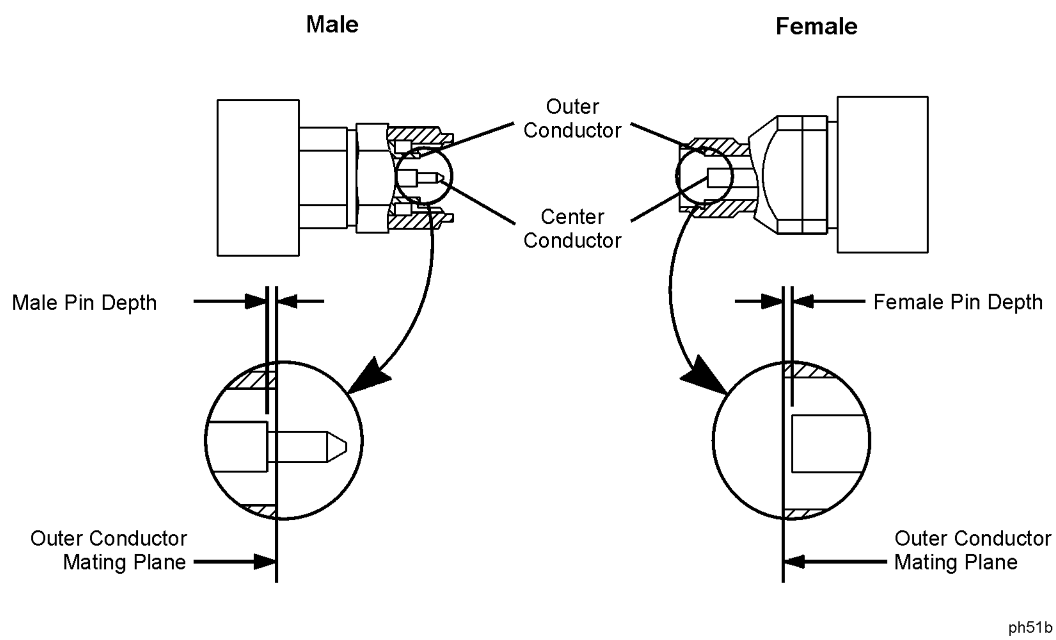
Pin Depth

Pin depth is the distance the center conductor mating plane differs from being flush with the outer conductor mating plane. See Figure 2-1. The pin depth of a connector can be in one of two states: either protruding or recessed.

Protrusion is the condition in which the center conductor extends beyond the outer conductor mating plane. This condition will indicate a positive value on the connector gage.

Recession is the condition in which the center conductor is set back from the outer conductor mating plane. This condition will indicate a negative value on the connector gage.

Figure 2-1 Connector Pin Depth



The pin depth value of each calibration device in the kit is not specified, but is an important mechanical parameter. The electrical performance of the device depends, to some extent, on its pin depth. The electrical specifications for each device in the kit take into account the effect of pin depth on the device's performance. Table 2-2 lists the typical pin depths and measurement uncertainties, and provides observed pin depth limits for the devices in the kit. If the pin depth of a device does not measure within the *observed* pin depth limits, it may be an indication that the device fails to meet electrical specifications. Refer to Figure 2-1 on the previous page for a visual representation of proper pin depth (slightly recessed).

Table 2-2 Pin Depth Limits

Device	**Typical Pin Depth**	**Measurement Uncertainty**[a]	**Observed Pin Depth Limits**[b]
Opens	0 to –0.0127 mm 0 to –0.00050 in	+0.0030 to –0.0030 mm +0.00012 to –0.00012 in	+0.0030 to –0.0157 mm +0.00012 to –0.00062 in
Shorts	0 to –0.0127 mm 0 to –0.00050 in	+0.0015 to –0.0015 mm +0.00006 to –0.00006 in	+0.0015 to –0.0142 mm +0.00006 to –0.00056 in
Fixed Loads	–0.0025 to –0.0203 mm –0.0001 to –0.00080 in	+0.0030 to –0.0030 mm +0.00012 to –0.00012 in	+0.00050 to –0.0234 mm +0.00002 to –0.00092 in
Adapters (2.4 to 2.4)	–0 to –0.0381 mm –0 to –0.00150 in	+0.0030 to –0.0030 mm +0.00012 to–0.00012 in	+0.0030 to –0.0411 mm +0.00012 to –0.00162 in
Adapter (2.4 to 2.92)[c]	0 to –0.0381 mm 0 to –0.00150 in	+0.0030 to –0.0030 mm +0.00012 to–0.00012 in	+0.0030 to –0.0411 mm +0.00012 to –0.00162 in
Sliding loads	0 to –0.0127 mm 0 to –0.00050 in	+0.0015 to –0.0015 mm +0.00006 to –0.00006 in	+0.0015 to –0.0142 mm +0.00006 to –0.00056 in

a. Approximately +2 sigma to –2 sigma of gage uncertainty based on studies done at the factory according to recommended procedures.

b. Observed pin depth limits are the range of observation limits seen on the gage reading due to measurement uncertainty. The depth could still be within specifications.

c. 2.4 mm to 2.92 mm adapters require a 3.5 mm connector gage to measure the 2.92 mm end. Refer to Table 6-1 on page 6-2 for associated part numbers.

When measuring pin depth, the measured value (resultant average of three or more measurements) is not the true value. Always compare the measured value with the observed pin depth limits in Table 2-2 to evaluate the condition of device connectors.

Electrical Specifications

The electrical specifications in Table 2-2 apply to the devices in your calibration kit when connected with an Agilent precision interface.

Table 2-3 Electrical Specifications

Device	Frequency	Parameter	Specification
Adapter	dc to 40 GHz	return loss	≤ 24 dB

Residual Errors after Calibration

The 8510 “Specifications and Performance Verification” software can be used to obtain a printout of the residual errors after a calibration has been performed. Refer to the “Specifications and Performance Verification” section of the 8510C On-Site Service Manual for information on how to use the software.

Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST) to the extent allowed by the institute’s calibration facility, and to the calibration facilities of other International Standards Organization members. See “How Agilent Verifies the Devices in Your Kit” on page 4-2 for more information.

3 Use, Maintenance, and Care of the Devices

Electrostatic Discharge

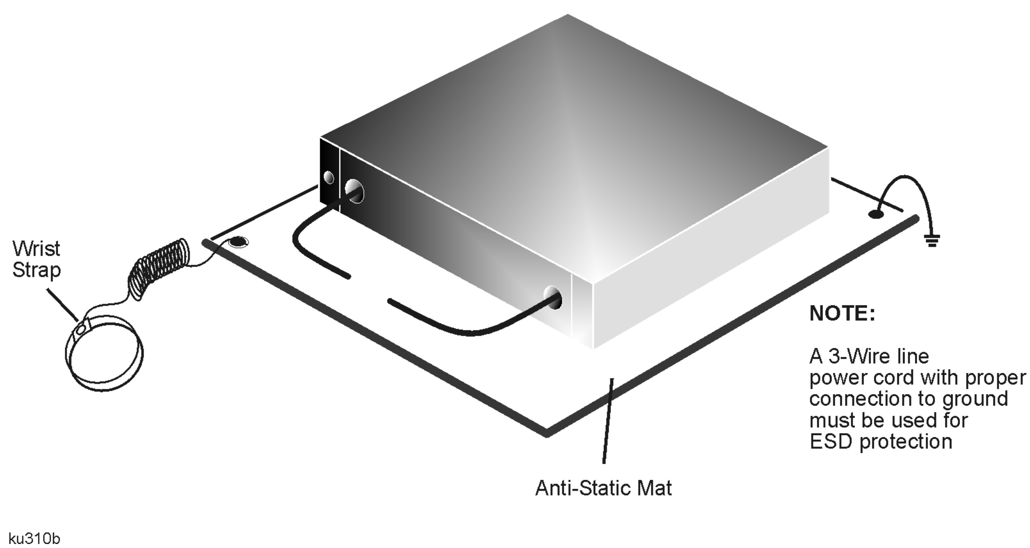
Protection against electrostatic discharge (ESD) is essential while connecting, inspecting, or cleaning connectors attached to a static-sensitive circuit (such as those found in test sets).

Static electricity can build up on your body and can easily damage sensitive internal circuit elements when discharged. Static discharges too small to be felt can cause permanent damage. Devices such as calibration components and devices under test (DUT), can also carry an electrostatic charge. To prevent damage to the test set, components, and devices:

- *Always* wear a grounded wrist strap having a 1 MΩ resistor in series with it when handling components and devices or when making connections to the test set.
- *Always* use a grounded antistatic mat in front of your test equipment.
- *Always* wear a heel strap when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.

Figure 3-1 shows a typical ESD protection setup using a grounded mat and wrist strap. Refer to Table 6-2 on page 6-4 for information on ordering supplies for ESD protection.

Figure 3-1 ESD Protection Setup



Visual Inspection

Visual inspection and, if necessary, cleaning should be done every time a connection is made. Metal particles from the connector threads may fall into the connector when it is disconnected. One connection made with a dirty or damaged connector can damage both connectors beyond repair.

In some cases, magnification is necessary to see damage to a connector; a magnifying device with a magnification of ≥ 10x is recommended. However, not all defects that are visible only under magnification will affect the electrical performance of the connector. Use the following guidelines when evaluating the integrity of a connector.

Look for Obvious Defects and Damage First

Examine the connectors first for obvious defects and damage: badly worn plating on the connector interface, deformed threads, or bent, broken, or misaligned center conductors. Connector nuts should move smoothly and be free of burrs, loose metal particles, and rough spots.

What Causes Connector Wear?

Connector wear is caused by connecting and disconnecting the devices. The more use a connector gets, the faster it wears and degrades. The wear is greatly accelerated when connectors are not kept clean, or are not connected properly.

Connector wear eventually degrades performance of the device. Calibration devices should have a long life if their use is on the order of a few times per week. Replace devices with worn connectors.

The test port connectors on the network analyzer test set may have many connections each day, and are, therefore, more subject to wear. It is recommended that an adapter be used as a test port saver to minimize the wear on the test set’s test port connectors.

Inspect the Mating Plane Surfaces

Flat contact between the connectors at all points on their mating plane surfaces is required for a good connection. See Figure 2-1 on page 2-3. Look especially for deep scratches or dents, and for dirt and metal particles on the connector mating plane surfaces. Also look for signs of damage due to excessive or uneven wear or misalignment.

Light burnishing of the mating plane surfaces is normal, and is evident as light scratches or shallow circular marks distributed more or less uniformly over the mating plane surface. Other small defects and cosmetic imperfections are also normal. None of these affect electrical or mechanical performance.

If a connector shows deep scratches or dents, particles clinging to the mating plane surfaces, or uneven wear, clean and inspect it again. Devices with damaged connectors should be discarded. Determine the cause of damage before connecting a new, undamaged connector in the same configuration.

Slotted Connectors (2.92 mm)

When using slotted connectors, inspect the contact fingers in the female center conductor carefully. These can be bent or broken, and damage to them is not always easy to see. A connector with damaged contact fingers will not make good electrical contact and must be replaced.

NOTE This is particularly important when mating nonprecision to precision devices.

Precision Slotless Connectors (2.4 mm)

The female 2.4 mm connectors in this set are metrology-grade, precision slotless connectors (PSC). Precision slotless connectors are used to improve accuracy. A characteristic of metrology-grade connectors is directly traceability to national measurement standards through their well-defined mechanical dimensions. With PSCs on test ports and standards, the accuracy achieved when measuring at 50 dB return loss levels is comparable to using conventional slotted connectors measuring devices having only 30 dB return loss. This represents an accuracy improvement of about 10 times.

The female 2.92 mm connectors have slotted contacts and, therefore, cannot be considered metrology-grade. Due to the extremely thin wall of the 2.92 mm female connector, a slotless metrology-grade 2.92 mm connector pair does not currently exist.

Conventional female center conductors are slotted and, when mated, are flared by the male pin. Because physical dimensions determine connector impedance, this change in physical dimension affects electrical performance, making it very difficult to perform precision measurements with conventional slotted connectors.

The precision slotless connector was developed to eliminate this problem. The PSC has a center conductor with a solid cylindrical shell, the outside diameter of which does not change when mated. Instead, the center conductor has an internal contact that flexes to accept the male pin.

Calibration Information

The calibration procedure for using the Agilent 11904S adapters requires that a 2.4 mm calibration be done using the calibration definitions disk included in this adapter set *instead* of the data disk provided in the Agilent 85056A 2.4 mm calibration kit. Although response, 1-Port, and 1-Path 2-Port calibrations may also be done, the following section is a general overview of a full 2-Port calibration, as it is the most complex of the calibrations.

When performing a response calibration, leave the adapters connected and do *not* load the calibration definitions disk included in this 11904S adapter set.

Refer to your network analyzer documentation or embedded help for step-by-step calibration procedures and system uncertainty information.

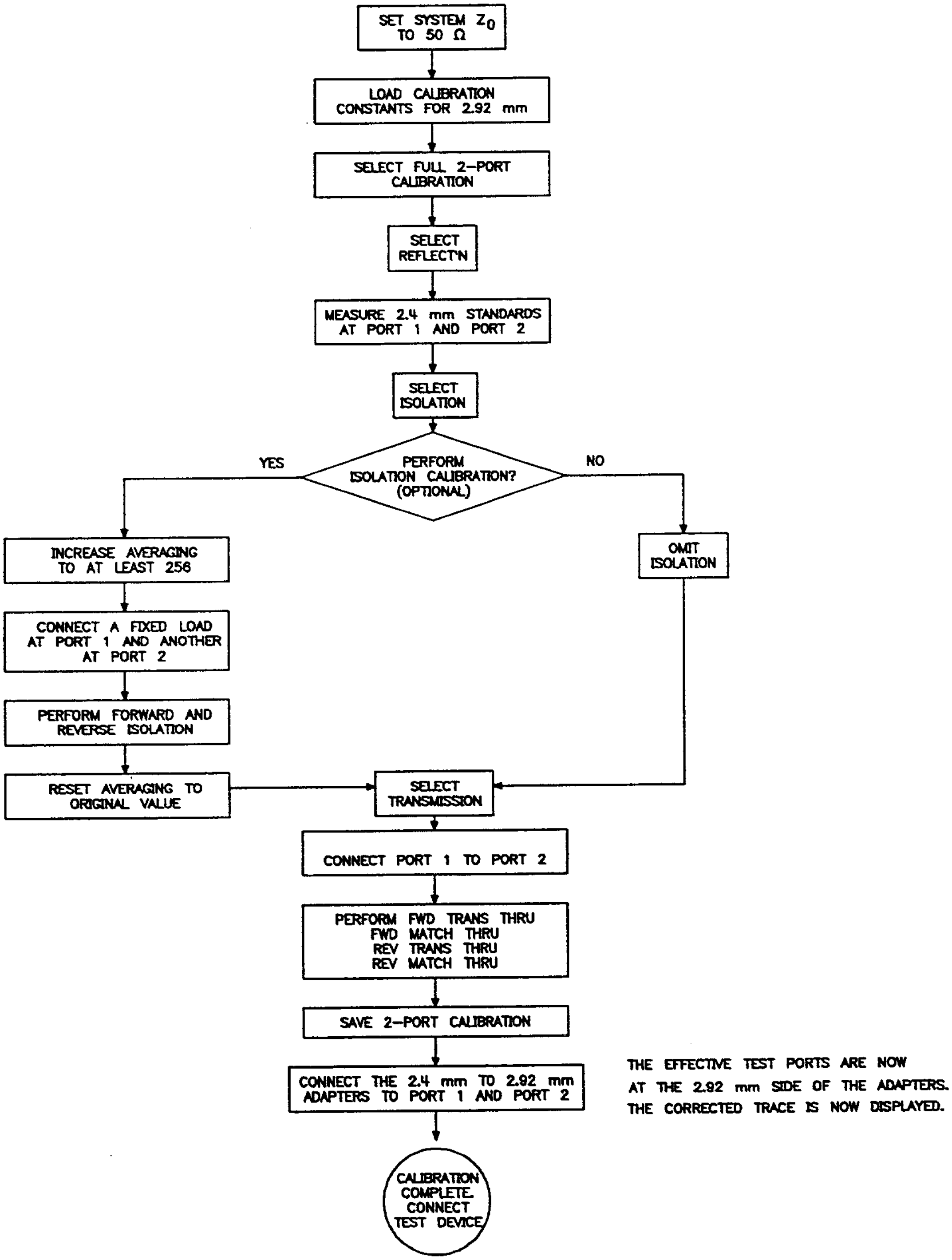
Full 2-Port Calibration Overview

The method used to achieve calibrated 2.92 mm connector measurements involves performing a full 2.4 mm 2-Port calibration and then inserting the 2.4 mm to 2.92 mm adapters. The metrology-grade 2.4 mm standards (opens, shorts, and loads) from the 85056A calibration kit are connected to the 2.4 mm test ports of the system during the reflection calibration. The 2.4 mm test ports are connected together for the transmission calibration. The 2.4 mm to 2.92 mm adapters are inserted after the calibration is done. These high quality adapters have excellent return loss, and therefore have a minimal effect upon the final measurement. When the calibration is complete, and the 2.4 mm to 2.92 mm adapters are inserted, the test ports are effectively translated to the 2.92 mm side of the adapters.

The key to this calibration method lies in the fact that the 11904S adapter set calibration definitions disk contains modified standard definitions. The nominal 2.4 mm open and short circuit standard definitions are modified to account for the presence of the 2.4 mm to 2.92 mm adapters after calibration. The measurements of the 2.4 mm standard are effectively translated to the ends of the adapters so that the directivity, source match, and tracking error terms are indirectly characterized at the ends of the adapters. Likewise, the thru measurement made with the 2.4 mm test ports connected together is modified to account for the length and loss of the adapters that are inserted after the 2.4 mm calibration. The thru measurement effectively translated to the ends of the adapter so that load match and transmission tracking error terms are indirectly characterized at the ends of the adapters. It is the return loss of the adapters and the 2.4 mm calibration kit that determines the effective directivity and source match of the system after calibration.

This calibration method assumes that the adapters being used have equal length and loss, and that they are reflectionless. The metrology-grade adapters in this adapter set are designed to have equal length and loss. The return loss of these precision adapters is specified at > 28 dB (worst case). So although the 2.4 mm to 2.92 mm adapters are inserted after the calibration, their high return loss guarantees that they will have only a small effect on the final measurement results.

Figure 3-2 Full 2-Port Calibration Flowchart



Cleaning Connectors

1. **Use Compressed Air or Nitrogen**

WARNING **Always use protective eyewear when using compressed air or nitrogen.**

Use compressed air (or nitrogen) to loosen particles on the connector mating plane surfaces. Clean air cannot damage a connector or leave particles or residues behind.

You can use any source of clean, dry, low-pressure compressed air or nitrogen that has an effective oil-vapor filter and liquid condensation trap placed just before the outlet hose.

Ground the hose nozzle to prevent electrostatic discharge, and set the air pressure to less than 414 kPa (60 psi) to control the velocity of the air stream. High-velocity streams of compressed air can cause electrostatic effects when directed into a connector. These electrostatic effects can damage the device. Refer to "Electrostatic Discharge" earlier in this chapter for additional information.

2. **Clean the Connector Threads**

WARNING **Keep isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. It is extremely flammable. In case of fire, use alcohol foam, dry chemical, or carbon dioxide; water may be ineffective.**

Use isopropyl alcohol with adequate ventilation and avoid contact with eyes, skin, and clothing. It causes skin irritation, may cause eye damage, and is harmful if swallowed or inhaled. It may be harmful if absorbed through the skin. Wash thoroughly after handling.

In case of spill, soak up with sand or earth. Flush spill area with water.

Dispose of isopropyl alcohol in accordance with all applicable federal, state, and local environmental regulations.

Use a lint-free swab or cleaning cloth moistened with isopropyl alcohol to remove any dirt or stubborn contaminants on a connector that cannot be removed with compressed air or nitrogen. Refer to Table 6-2 on page 6-4 for part numbers for isopropyl alcohol and cleaning swabs.

a. Apply a small amount of isopropyl alcohol to a lint-free cleaning swab.

b. Clean the connector threads.

c. Let the alcohol evaporate, then blow the threads dry with a gentle stream of clean, low-pressure compressed air or nitrogen. Always completely dry a connector before you reassemble or use it.

3. **Clean the Mating Plane Surfaces**

   a. Apply a small amount of isopropyl alcohol to a lint-free cleaning swab.

   b. Clean the center and outer conductor mating plane surfaces. Refer to Figure 2-1 on page 2-3. When cleaning a female connector, avoid snagging the swab on the center conductor contact fingers by using short strokes.

   c. Let the alcohol evaporate, then blow the connector dry with a gentle stream of clean, low-pressure compressed air or nitrogen. Always completely dry a connector before you reassemble or use it.

4. **Inspect**

   Inspect the connector to make sure that no particles or residue remain. Refer to "Visual Inspection" on page 3-3.

Gaging Connectors

The gages available from Agilent Technologies are intended for preventive maintenance and troubleshooting purposes only. They are effective in detecting *excessive* center conductor protrusion or recession and conductor damage on DUTs, test accessories, and the calibration kit devices. They are especially useful in determining if the pin depths of sliding loads are grossly out of adjustment. Do *not* use the gages for precise pin depth measurements. See Table 6-2 on page 6-4 for part number information.

Connector Gage Accuracy

The connector gages are only capable of performing coarse measurements. They do not provide the degree of accuracy necessary to precisely measure the pin depth of the kit devices. This is partially due to the repeatability uncertainties that are associated with the measurement. Only the factory—through special gaging processes and electrical testing—can accurately verify the mechanical characteristics of the devices.

With proper technique, the gages are useful in detecting gross pin depth errors on device connectors. To achieve maximum accuracy, random errors must be reduced by taking the average of at least three measurements having different gage orientations on the connector. Even then, the resultant average can be in error by as much as ± 0.0001 inch due to systematic (biasing) errors usually resulting from worn gages and gage masters. The information in Table 2-2 on page 2-4 assumes new gages and gage masters, therefore, these systematic errors were not included in the uncertainty analysis. As the gages undergo more use, the systematic errors can become more significant in the accuracy of the measurement.

The measurement uncertainties are primarily a function of the assembly materials and design, and the unique interaction each device type has with the gage. Therefore, these uncertainties can vary among the different devices. For example, note the difference between the uncertainties of the Open and Short in Table 2-2 on page 2-4.

The *observed* pin depth limits add these uncertainties to the *typical* factory pin depth values to provide practical limits that can be referenced when using the gages.

NOTE When measuring pin depth, the measured value (resultant average of three or more measurements) is not the true value. Always compare the measured value with the observed pin depth limits in Table 2-2 on page 2-4 to evaluate the condition of device connectors.

When to Gage Connectors

Gage a connector at the following times:

- Prior to using a device for the first time, record the pin depth measurement so that it can be compared with future readings. (It will serve as a good troubleshooting tool when you suspect damage may have occurred to the device.)
- If either visual inspection or electrical performance suggests that the connector interface may be out of typical range (due to wear or damage, for example).
- If a calibration device is used by someone else or on another system or piece of equipment.
- Initially, after every 100 connections, and after that, as often as experience indicates.

Gaging Procedures

Gaging 2.4 mm and 2.92 mm Connectors

CAUTION *Never* connect a 2.4 mm gage to a 2.92 mm device. You must use 3.5 mm gages to measure the pin depth of 2.92 mm devices.

NOTE Always hold a connector gage by the gage barrel, below the dial indicator. This gives the best stability, and improves measurement accuracy. (Cradling the gage in your hand, or holding it by the dial applies stress to the gage plunger mechanism through the dial indicator housing.)

1. Select the proper gage for your connector. The 2.92 mm connectors are gaged with the same gages and in the same way as the precision 3.5 mm connectors. These are *not* the same gages that are used for the 2.4 mm connectors. Refer to Table 6-2 on page 6-4 for gage set part numbers.
2. Inspect and clean the gage, gage master, and device to be gaged. Refer to "Visual Inspection" and "Cleaning Connectors" earlier in this chapter.
3. Zero the connector gage (refer to Figure 3-3):
   a. While holding the gage by the barrel, and without turning the gage or the device, connect the gage to the gage master by interconnecting the male and female connectors. Connect the nut finger-tight. Do *not* overtighten.

NOTE Refer to Table 3-1, "Torque Wrench Information," on page 3-14 for connector type and torque setting information.

b. Using an open-end wrench to keep the device body from rotating, use the torque wrench, included in the kit, to tighten the connecting nut to the specified torque. Refer to "Final Connection Using a Torque Wrench" on page 3-14 for additional information.

c. As you watch the gage pointer, gently tap the barrel of the gage to settle the reading.

   The gage pointer should line up exactly with the zero mark on the gage. If not, adjust the zero set knob until the gage pointer lines up exactly with the zero mark.

d. Remove the gage master.

4. Gage the device connector (refer to Figure 3-3):

   a. While holding the gage by the barrel, and without turning the gage or the device, connect the gage to the device by interconnecting the male and female connectors. Connect the nut finger-tight. Do *not* overtighten.

   b. Using an open-end wrench to keep the device body from rotating, use the torque wrench, included in the kit, to tighten the connecting nut to the specified torque. Refer to "Final Connection Using a Torque Wrench" on page 3-14 for additional information.

   c. Gently tap the barrel of the gage with your finger to settle the gage reading.

   d. Read the gage indicator dial. Read *only* the black ± signs; *not* the red ± signs.

      For maximum accuracy, measure the connector a minimum of three times and take an average of the readings. After each measurement, rotate the gage a quarter-turn to reduce measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.

   e. Compare the average reading with the *observed* pin depth limits in Table 2-2 on page 2-4.

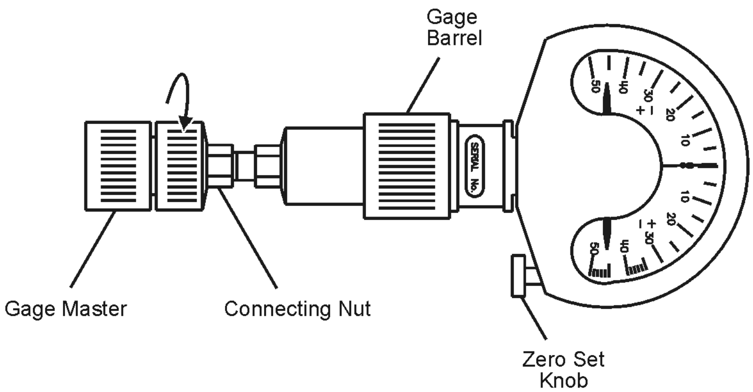
Figure 3-3 Gaging 2.4 mm and 2.92 mm Connectors

Note:

Although male devices are shown in this illustration,
the procedure is essentially the same for female devices.

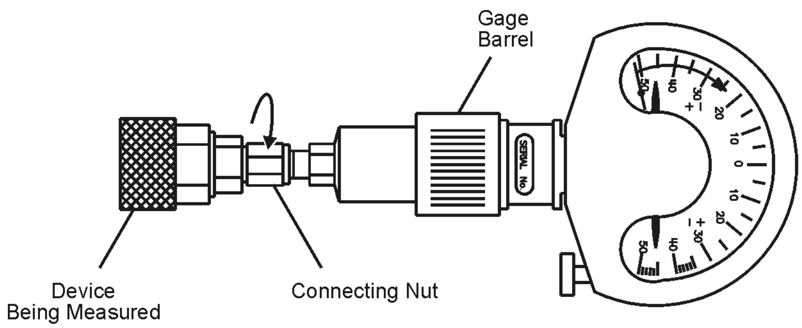
Zero the Connector Gage

- Connect the gage to the gage master.
- Torque the connecting nut.
- Gently tap the gage barrel to settle the reading.
- Using the zero set knob, adjust the gage pointer to line up exactly with the zero mark.
- Remove the gage master.



Gage the Device Connector

- Connect the gage to the device being measured.
- Torque the connecting nut.
- Gently tap the gage barrel to settle the reading.
- Read recession or protrusion from the gage.
- Remove the device.
- Repeat two additional times and average the three readings.



ph71a

Connections

Good connections require a skilled operator. *The most common cause of measurement error is bad connections.* The following procedures illustrate how to make good connections.

How to Make a Connection

Preliminary Connection

1. Ground yourself and all devices. Wear a grounded wrist strap and work on a grounded, conductive table mat. For ESD precautions refer to "Electrostatic Discharge" on page 3-2.
2. Visually inspect the connectors. Refer to "Visual Inspection" on page 3-3.
3. If necessary, clean the connectors. Refer to "Cleaning Connectors" on page 3-7.
4. Use a connector gage to verify that all center conductors are within the *observed* pin depth values in Table 2-2 on page 2-4.
5. Carefully align the connectors. The male connector center pin must slip concentrically into the contact finger of the female connector.

CAUTION Do *not* turn the device body. Only turn the connector nut. Damage to the center conductor can occur if the device body is twisted.

6. Push the connectors straight together and tighten the connector nut finger tight. As the center conductors mate, there is usually slight resistance.
7. The preliminary connection is tight enough when the mating plane surfaces make uniform, light contact. Do not overtighten this connection.

   A connection in which the outer conductors make gentle contact at all points on both mating surfaces is sufficient. Very light finger pressure is enough to accomplish this.
8. Make sure the connectors are properly supported. Relieve any side pressure on the connection from long or heavy devices or cables.

Final Connection Using a Torque Wrench

Use the appropriate torque wrench to make the final connection. Table 3-1 provides information about the torque wrench required for the connector types found in this set. Refer to Table 6-1 on page 6-2 for replacement part numbers and ordering information.

Table 3-1 Torque Wrench Information

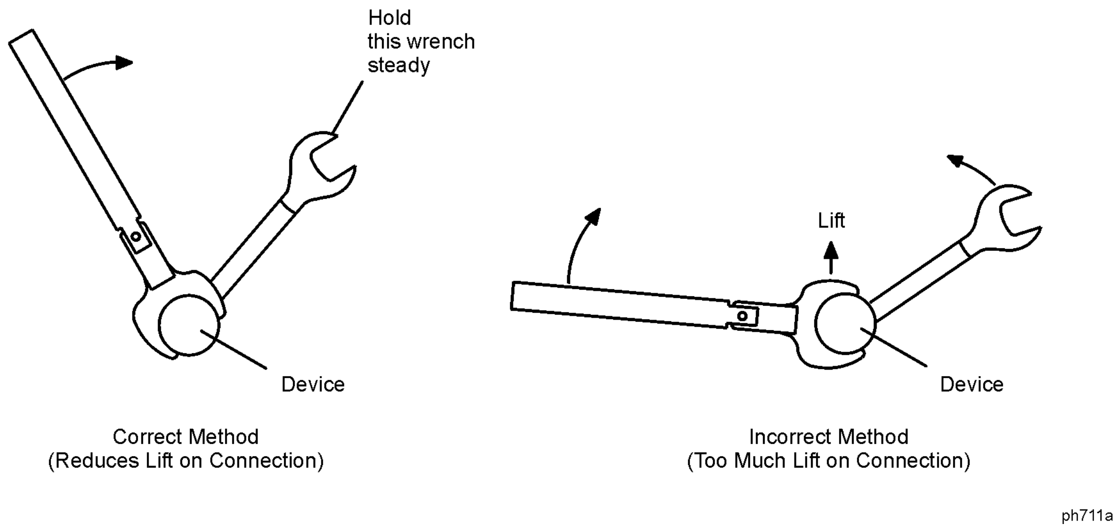
Connector Type	Torque Setting	Torque Tolerance
2.92 mm	56 N-cm (5 in-lb)	±5.6 N-cm (±0.5 in-lb)
2.4 mm	90 N-cm (8 in-lb)	±9.0 N-cm (±0.8 in-lb)

Using a torque wrench guarantees that the connection is not too tight, preventing possible connector damage. It also guarantees that all connections are equally tight each time.

Prevent the rotation of anything other than the connector nut that you are tightening. It may be possible to do this by hand if one of the connectors is fixed (as on a test port). However, it is recommended that you use an open-end wrench to keep the body of the device from turning.

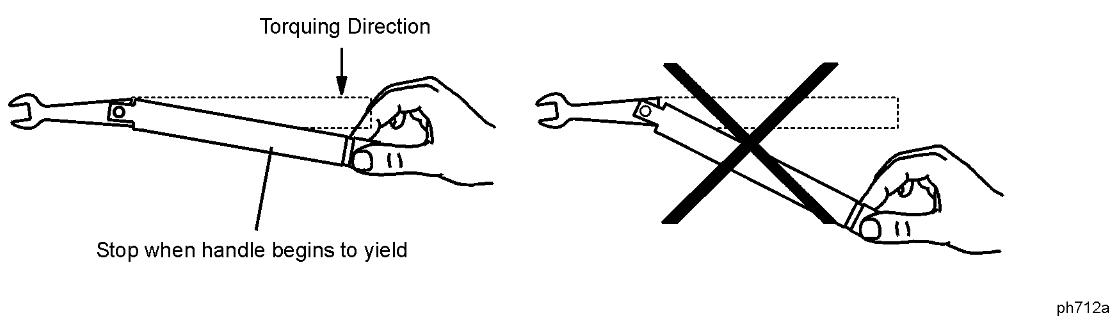
1. Position both wrenches within 90 degrees of each other before applying force. See Figure 3-4. Wrenches opposing each other (greater than 90 degrees apart) will cause a lifting action which can misalign and stress the connections of the devices involved. This is especially true when several devices are connected together.

Figure 3-4 Wrench Positions



2. Hold the torque wrench lightly, at the end of the handle only (beyond the groove), as shown in Figure 3-5.

Figure 3-5 Using the Torque Wrench



3. Apply downward force perpendicular to the wrench handle. This applies torque to the connection *through* the wrench.

   Do not hold the wrench so tightly that you push the handle straight down along its length rather than pivoting it; otherwise, you apply an unknown amount of torque.

4. Tighten the connection just to the torque wrench "break" point. The wrench handle gives way at its internal pivot point. Do not tighten the connection further. See Figure 3-5.

CAUTION You don't have to fully break the handle of the torque wrench to reach the specified torque; doing so can cause the handle to kick back and loosen the connection. Any give at all in the handle is sufficient torque.

How to Separate a Connection

To avoid lateral (bending) force on the connector mating plane surfaces, always support the devices and connections.

CAUTION Do *not* turn the device body. Only turn the connector nut. Damage to the center conductor can occur if the device body is twisted.

1. Use an open-end wrench to prevent the device body from turning.
2. Use another open-end wrench to loosen the connecting nut.
3. Complete the separation by hand, turning only the connecting nut.
4. Pull the connectors straight apart without twisting, rocking, or bending either of the connectors.

Operational Check

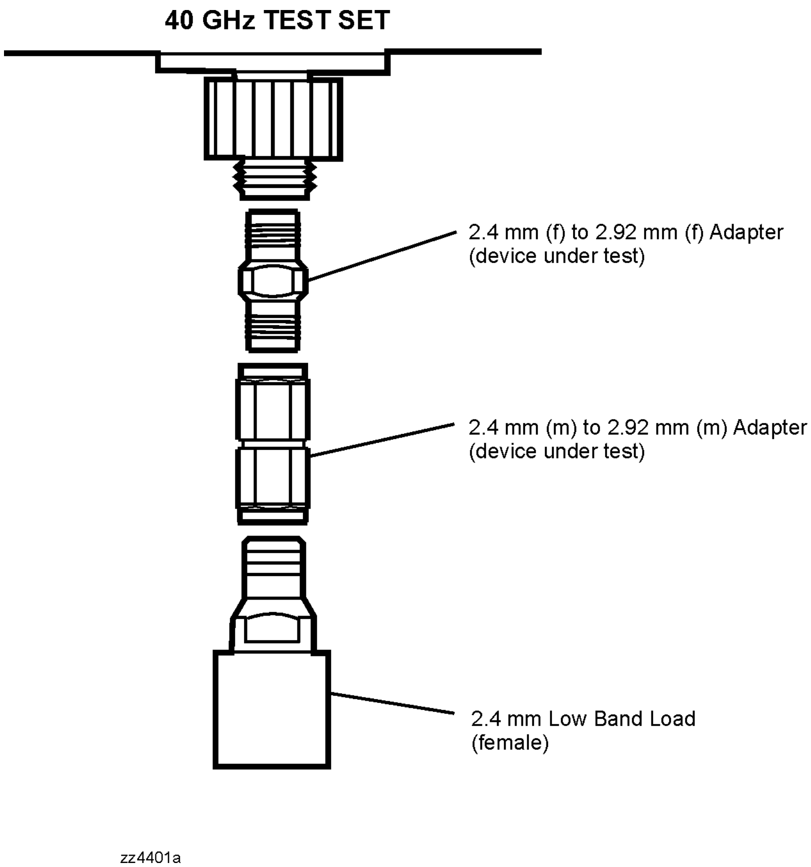
The following procedure will give an indication of whether or not the adapters in this set are operating properly. This procedure does *not* verify any specification, but rather gives an indication of the return loss characteristics of the adapters. Any gross errors obtained after performing this check could indicate that the performance of one or both of the adapters checked is in question (two are checked at the same time).

Connect the 2.4 mm Lowband Load

Refer to Figure 3-6 for the following steps:

1. Perform an S_{11} 1-Port calibration in 2.4 mm to 40 GHz using the calibration definitions disk included in the 85056A 2.4 mm calibration kit. The calibration conditions are:
   - 250 ms sweep
   - 201 points
   - 16 averages
   - 2.4 mm sliding load cal

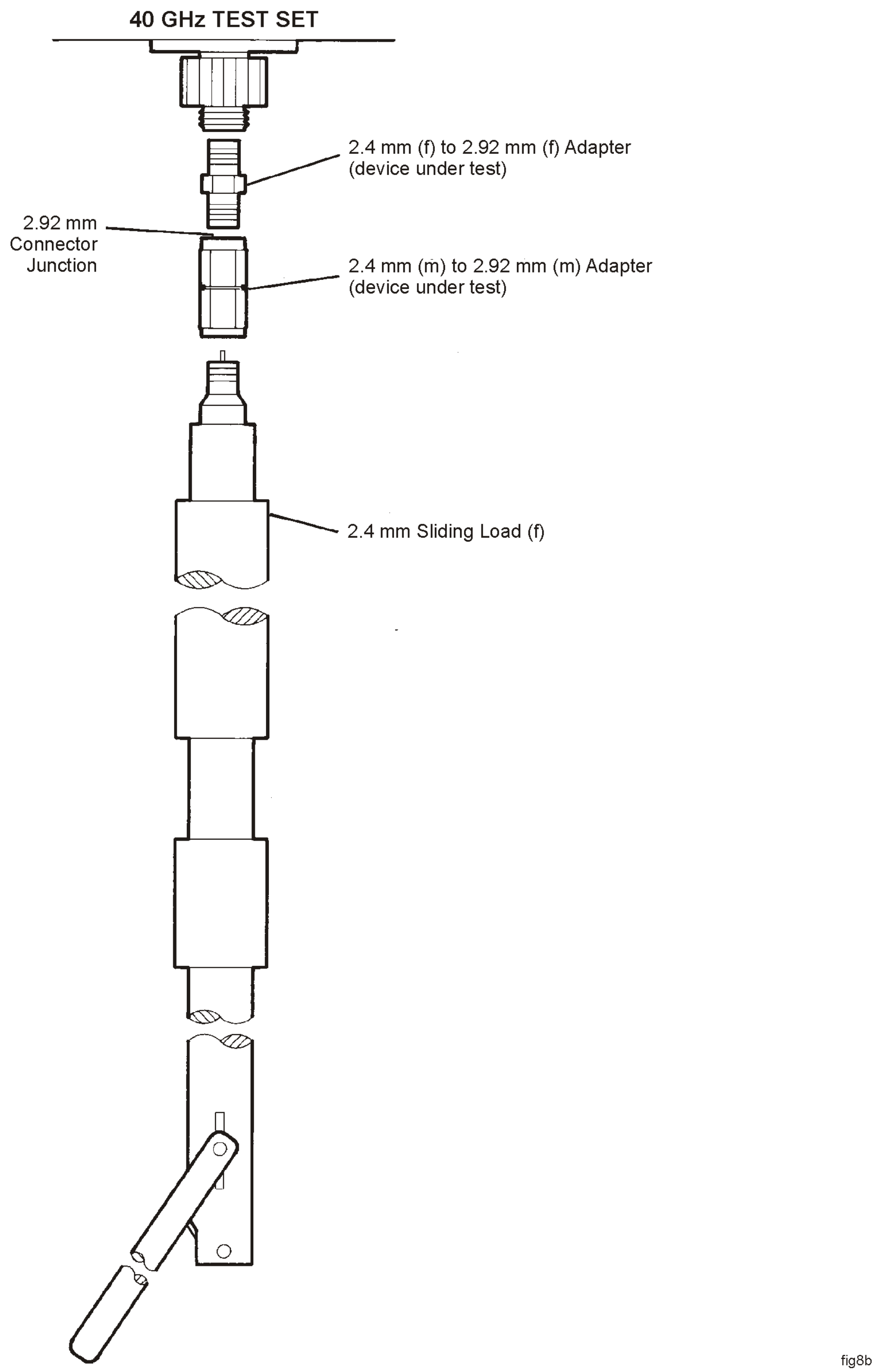
Figure 3-6 2.4 mm to 2.92 mm Adapter to Lowband Load



2. Connect the 2.4 mm (f) to 2.92 mm (f) adapter to the calibrated test port.
3. Connect the 2.4 mm (m) to 2.92 mm (m) adapter to the adapter on the test port.
4. Connect the 2.4 mm lowband load (f) to the end of the adapter connected in step 3. The measured return loss should be > 28 dB from 45 MHz to 4 GHz.

   Refer to Figure 3-7 for the following step:
5. Remove the lowband load and connect a 2.4 mm sliding load (f) to the adapter. Refer to the *85056A 2.4 mm Precision Calibration Kit* for information on connecting a sliding load. The return loss should be > 20 dB from 4 GHz to 40 GHz.

Figure 3-7 2.4 mm to 2.92 mm Adapter to Sliding Load



Handling and Storage

- Install the protective end caps and store the calibration devices in the foam-lined storage case when not in use.
- Never store connectors loose in a box, or in a desk or bench drawer. This is the most common cause of connector damage during storage.
- Keep connectors clean.
- Do not touch mating plane surfaces. Natural skin oils and microscopic particles of dirt are easily transferred to a connector interface and are very difficult to remove.
- Do not set connectors contact-end down on a hard surface. The plating and the mating plane surfaces can be damaged if the interface comes in contact with any hard surface.

4 Performance Verification

Introduction

The performance of your adapter set can only be verified by returning the kit to Agilent Technologies for recertification. The equipment and calibration standards required to verify the specifications of the devices in the kit have been specially manufactured and are not commercially available.

To confirm that your Agilent 85056A or 85056D Calibration Kit is performing accurate calibrations, use the Agilent 85057A Verification Kit with the “Specifications and Performance Verification” disk. For ordering information refer to Chapter 6, “Replaceable Parts.”

How Agilent Verifies the Devices in Your Kit

Agilent verifies the specifications of these devices as follows:

1. The residual microwave error terms of the test system are verified with precision airlines and shorts that are directly traced to the National Institute of Standards and Technology (NIST). The airline and short characteristics are developed from mechanical measurements. The mechanical measurements and material properties are carefully modeled to give very accurate electrical representation. The mechanical measurements are then traced to NIST through various plug and ring gages and other mechanical measurements.
2. Each calibration device is electrically tested on this system. For the initial (before sale) testing of the calibration devices, Agilent includes the test measurement uncertainty as a guardband to guarantee each device meets the published specification. For recertifications (after sale), no guardband is used and the measured data is compared directly with the specification to determine the pass or fail status. The measurement uncertainty for each device is, however, recorded in the calibration report that accompanies recertified kits.

These two steps establish a traceable link to NIST for Agilent to the extent allowed by the institute’s calibration facility. The specifications data provided for the devices in the kit is traceable to NIST through Agilent Technologies.

Recertification

The following will be provided with a recertified kit:

- a new calibration sticker affixed to the case
- a certificate of calibration
- a calibration report for each device in the kit listing measured values, specifications, and uncertainties

NOTE A list of NIST traceable numbers may be purchased upon request to be included in the calibration report.

Agilent Technologies offers a *Standard* calibration for the recertification of the kit. For more information, contact Agilent Technologies. Refer to "Contacting Agilent" on page 5-4 for a list of offices.

How Often to Recertify

The suggested initial interval for recertification is 12 months or sooner. The actual need for recertification depends on the use of the kit. After reviewing the results of the initial recertification, you may establish a different recertification interval that reflects the usage and wear of the kit.

NOTE The recertification interval should begin on the date the kit is *first used* after the recertification date.

Where to Send a Kit for Recertification

Contact Agilent Technologies for information on where to send your kit for recertification. Contact information is listed on page 5-4. Refer to "Returning a Kit or Device to Agilent" on page 5-3 for details on sending your kit.

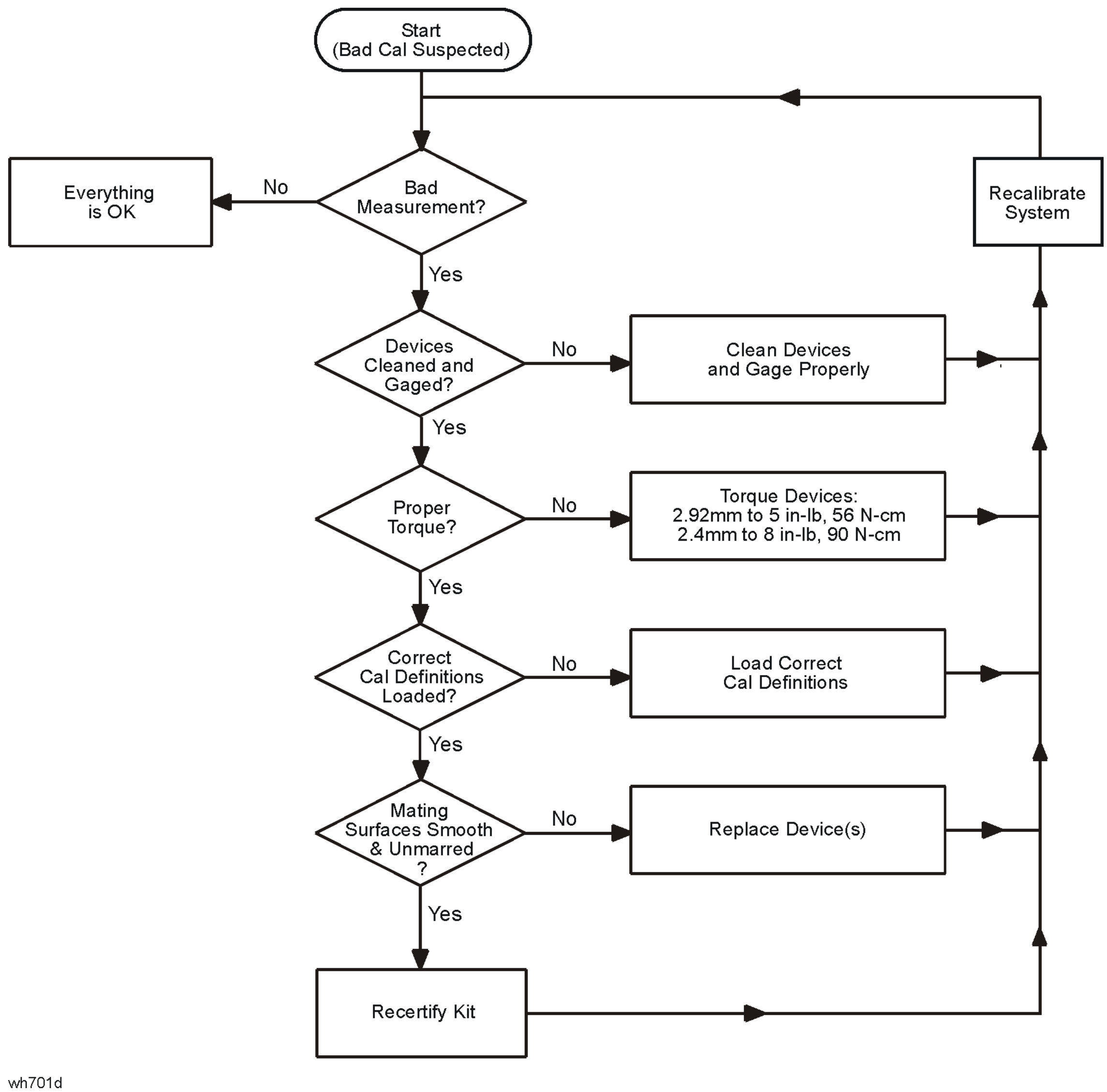
5 Troubleshooting

Troubleshooting Process

This manual contains limited information about network analyzer system operation. For complete information, refer to the instrument documentation.

If you suspect a bad calibration, or if your network analyzer does not pass performance verification, follow the steps in Figure 5-1.

Figure 5-1 Troubleshooting Flowchart



Returning a Kit or Device to Agilent

If your kit or device requires service, contact Agilent Technologies for information on where to send it. See Table 5-1 for contact information. Include a service tag (located near the end of this manual) on which you provide the following information:

- your company name and address
- a technical contact person within your company, and the person's complete telephone number
- the model number and serial number of the kit
- the part number and serial number of each device
- the type of service required
- a *detailed* description of the problem and how the device was being used when the problem occurred (such as calibration or measurement)

Where to Look for More Information

This manual contains limited information about network analyzer system operation. For complete information, refer to the instrument documentation. If you need additional information, contact Agilent Technologies.

Contacting Agilent

Table 5-1 Contacting Agilent

Online assistance: `www.agilent.com/find/assist`			
United States *(tel)* 1 800 452 4844	**Latin America** *(tel)* (305) 269 7500 *(fax)* (305) 269 7599	**Canada** *(tel)* 1 877 894 4414 *(fax)* (905) 282-6495	**Europe** *(tel)* (+31) 20 547 2323 *(fax)* (+31) 20 547 2390
New Zealand *(tel)* 0 800 738 378 *(fax)* (+64) 4 495 8950	**Japan** *(tel)* (+81) 426 56 7832 *(fax)* (+81) 426 56 7840	**Australia** *(tel)* 1 800 629 485 *(fax)* (+61) 3 9210 5947	**Singapore** *(tel)* 1 800 375 8100 *(fax)* (65) 836 0252
Malaysia *(tel)* 1 800 828 848 *(fax)* 1 800 801 664	**Philippines** *(tel)* (632) 8426802 *(tel) (PLDT subscriber only):* 1 800 16510170 *(fax)* (632) 8426809 *(fax) (PLDT subscriber only):* 1 800 16510288	**Thailand** *(tel) outside Bangkok:* (088) 226 008 *(tel) within Bangkok:* (662) 661 3999 *(fax)* (66) 1 661 3714	**Hong Kong** *(tel)* 800 930 871 *(fax)* (852) 2506 9233
Taiwan *(tel)* 0800-047-866 *(fax)* (886) 2 25456723	**People's Republic of China** *(tel) (preferred):* 800-810-0189 *(tel) (alternate):* 10800-650-0021 *(fax)* 10800-650-0121	**India** *(tel)* 1-600-11-2929 *(fax)* 000-800-650-1101	

6 Replaceable Parts

Introduction

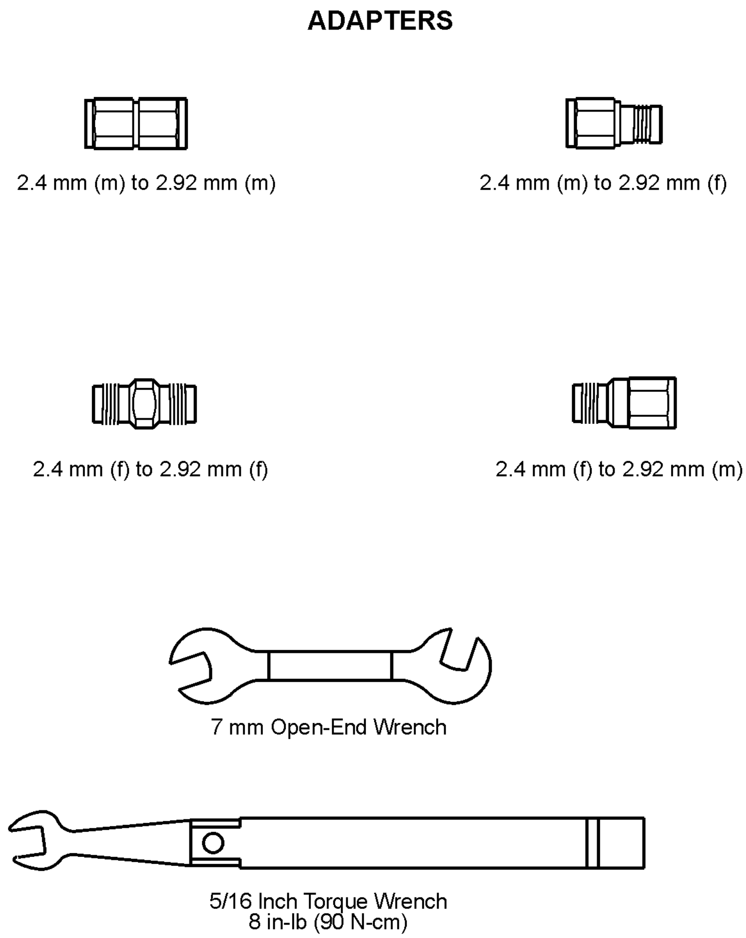
Table 6-1 lists the replacement part numbers for the 11904S adapter set. Table 6-2 lists the replacement part numbers for items *not* included in the calibration kit that are either required or recommended for successful operation of the kit.

To order a listed part, note the description, the part number, and the quantity desired. Telephone or send your order to Agilent Technologies. See Table 5-1 on page 5-4 for contact information.

Table 6-1 Replaceable Parts for the 11904S Adapter Set

Description	Qty Per Set	Agilent Part Number
Adapters		
2.4 mm (m) to 2.92 mm (m)	1	11904-60001
2.4 mm (m) to 2.92 mm (f)	1	11904-60003
2.4 mm (f) to 2.92 mm (m)	1	11904-60004
2.4 mm (f) to 2.92 mm (f)	1	11904-60002
Wrench		
5/16 in, 56 N-cm (5 in-lb) torque	1	8710-1582
7 mm open-end wrench	1	8710-1761
Adapter Set Storage Case		
Storage case	1	11904-60005
Foam pad	1	5181-5544
Miscellaneous Items		
User's and service guide	1	11904-90009
Connector care-quick reference card	1	08510-90360
Calibration definitions disk (PNA series)	1	11904-90010
Calibration definitions disk (8510 and 8722)	1	11904-10002

Figure 6-1 Identification Sheet for the 11904S Adapter Set



NOT SHOWN:

- Calibration definitions disk
- Disk holder
- Documentaion
- Storage case

zz402a

Table 6-2 Items Not Included in the 11904S Adapter Set

Description	Qty Per Set	Agilent Part Number
ESD Protection Devices		
Grounding wrist strap	1	9300-1367
5 ft grounding cord for wrist strap	1	9300-0980
2 ft by 4 ft conductive table mat with 15 ft grounding wire	1	9300-0797
ESD heel strap	1	9300-1308
Connector Cleaning Supplies		
Isopropyl alcohol	30 ml	8500-5344
Foam-tipped cleaning swabs	100	9301-1243
Miscellaneous Items		
Specifications and performance verification disk[a]	1	08510-10033
Tube package	1	1540-0803
2.4 mm (m/f) gage set	1	11752E
Centering bead (for gaging 2.4 mm sliding load)	1	85056-20001
3.5 mm (m/f) gage set (used for 2.92 mm)	1	11752D
3.5 mm (f) gage set (used for 2.92 mm)	1	85052-60042
Centering bead (for gaging 3.5 mm sliding load)	1	85052-60042

a. See the 8510C *On-Site Service Manual* for instructions on using this disk.

A Standard Definitions

Standard Class Assignments

Class assignment organizes calibration standards into a format compatible with the error models used in the measurement calibration. A class or group of classes corresponds to the systematic errors to be removed from the measured network analyzer response. Tables A-1 through A-3 list the classes used by the following network analyzers. This information resides on the calibration definitions disk included in the kit.

Table A-1 Standard Class Assignments for the 8510 Network Analyzer

Disk File Name: CK_292mmA1 **Calibration Label:** 2.92 mm A.1

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$	2							Open
$S_{11}B$	1							Short
$S_{11}C$	9	10	12					Loads
$S_{22}A$	2							Open
$S_{22}B$	1							Short
$S_{22}C$	9	10	12					Loads
Forward transmission	11							Thru
Reverse transmission	11							Thru
Forward match	11							Thru
Reverse match	11							Thru
Forward isolation[a]	9							Isolation standard
Reverse isolation	9							Isolation standard
Frequency response	1	2	11					Response
TRL thru	1							Undefined
TRL reflect	1							Undefined
TRL line	1							Undefined
Adapter	1	5	6	7	8			Adapter

TRL Option

Cal Z_0: _____System Z_0 __X__Line Z_0

Set ref: __X__Thru _____Reflect

Lowband frequency: __________

Disk File Name: CK_24mmA4 **Calibration Label:** 2.4 mm A.4

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$	2							Open
$S_{11}B$	1							Short
$S_{11}C$	9	10	12					Loads
$S_{22}A$	2							Open
$S_{22}B$	1							Short
$S_{22}C$	9	10	12					Loads
Forward transmission	11							Thru
Reverse transmission	11							Thru
Forward match	11							Thru
Reverse match	11							Thru
Forward isolation[a]	9							Isolation standard
Reverse isolation	9							Isolation standard
Frequency response	1	2	11					Response
TRL thru	14							Undefined
TRL reflect	1							Undefined
TRL line	15							Undefined
Adapter	13	5	6	7	8			Adapter

TRL Option

Cal Z_0: _____System Z_0 __X__Line Z_0

Set ref: __X__Thru _____Reflect

Lowband frequency: __________

a. The forward isolation standard is also used for the isolation part of a response and isolation calibration.

Table A-2 Standard Class Assignments for the 8722 Network Analyzer

Calibration Label:[2.92*]

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$	2							Open
$S_{11}B$	1							Short
$S_{11}C$	3	5	6					Loads
$S_{22}A$	2							Open
$S_{22}B$	1							Short
$S_{22}C$	3	5	6					Loads
Forward transmission	4							Thru
Reverse transmission	4							Thru
Forward match	4							Thru
Reverse match	4							Thru
Response	1	2	4					Response
Response & isolation	1	2	4					Response
TRL thru	4							Undefined
TRL reflect	2							Undefined
TRL line	3	5	6					Undefined
TRL Option								
Cal Z_0: ____System Z_0 __X__Line Z_0								
Set ref: __X__Thru ____Reflect								

Calibration Label:[2.4 mm]

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$	2							Open
$S_{11}B$	1							Short
$S_{11}C$	3	5	6					Loads
$S_{22}A$	2							Open
$S_{22}B$	1							Short
$S_{22}C$	3	5	6					Loads
Forward transmission	4							Thru
Reverse transmission	4							Thru
Forward match	4							Thru
Reverse match	4							Thru
Response	1	2	4					Response
Response & isolation	1	2	4					Response
TRL thru	4							Undefined
TRL reflect	2							Undefined
TRL line	3	5	6					Undefined
TRL Option								
Cal Z_0: ____System Z_0 __X__Line Z_0								
Set ref: __X__Thru ____Reflect								

Table A-3 Standard Class Assignments for the PNA Network Analyzer

Calibration Kit Label: 2.4 mm Model 11904S	
Class	A[a]
$S_{11}A$	8
$S_{11}B$	7
$S_{11}C$	3
$S_{21}T$	4
$S_{22}A$	2
$S_{22}B$	1
$S_{22}C$	3
$S_{12}T$	4
TRL 'T'	4
TRL 'R'	8
TRL 'L'	3

Calibration Kit Label: 2.92 mm Model 11904S	
Class	A[a]
$S_{11}A$	2
$S_{11}B$	1
$S_{11}C$	3,5,6
$S_{21}T$	4
$S_{22}A$	2
$S_{22}B$	1
$S_{22}C$	3,5,6
$S_{12}T$	4
TRL 'T'	4
TRL 'R'	2
TRL 'L'	3,5,6

a. For additional ports, make sure values match the correct sex of the port.

Notes:

The following calibration are only supported by certain PNA analyzers. See your PNA network analyzer embedded help system.

1. **If you are performing a TRL calibration:**
   - $S_{21}T$ and $S_{12}T$ must be defined as *thru* standards.
   - $S_{11}A$ and $S_{22}A$ must be defined as *reflection* standards.
   - $S_{11}B$, $S_{11}C$, $S_{22}B$, and $S_{22}C$ must be defined as *line* standards.
2. **If you are performing a TRM calibration:**
   - $S_{21}T$ and $S_{12}T$ must be defined as *thru* standards.
   - $S_{11}A$ and $S_{22}A$ must be defined as *reflection* standards.
   - $S_{11}B$, $S_{11}C$, $S_{22}B$, and $S_{22}C$ must be defined as *match* standards.
3. **If you are performing an LRM calibration:**
   - $S_{21}T$ and $S_{12}T$ must be defined as *line* standards.
   - $S_{11}A$ and $S_{22}A$ must be defined as *reflection* standards.
   - $S_{11}B$, $S_{11}C$, $S_{22}B$, and $S_{22}C$ must be defined as *match* standards.
4. **$S_{11}B$ and $S_{11}C$ must be defined as the same standard.**
5. **$S_{22}B$ and $S_{22}C$ must be defined as the same standard.**

Blank Forms

The standard class assignments may be changed to meet your specific requirements. Tables A-4 through A-6 are provided to record the modified standard class assignments.

Table A-4 Blank Form for the 8510 Network Analyzer

Disk File Name:				**Calibration Label:**				
Class	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Standard Class Label**
S_{11}A								
S_{11}B								
S_{11}C								
S_{22}A								
S_{22}B								
S_{22}C								
Forward transmission								
Reverse transmission								
Forward match								
Reverse match								
Forward isolation[a]								
Reverse isolation								
Frequency response								
TRL thru								
TRL reflect								
TRL line								
Adapter								
TRL Option								
Cal Z_0: _____System Z_0 _____Line Z_0								
Set ref: ____Thru ____Reflect								
Lowband frequency: __________								

Disk File Name:				**Calibration Label:**				
Class	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**Standard Class Label**
S_{11}A								
S_{11}B								
S_{11}C								
S_{22}A								
S_{22}B								
S_{22}C								
Forward transmission								
Reverse transmission								
Forward match								
Reverse match								
Forward isolation								
Reverse isolation								
Frequency response								
TRL thru								
TRL reflect								
TRL line								
Adapter								
TRL Option								
Cal Z_0: _____System Z_0 _____Line Z_0								
Set ref: ____Thru ____Reflect								
Lowband frequency: __________								

a. The forward isolation standard is also used for the isolation part of a response and isolation calibration.

Table A-5 Blank Form for the 8722 Network Analyzer

Calibration Label:

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$								
$S_{11}B$								
$S_{11}C$								
$S_{22}A$								
$S_{22}B$								
$S_{22}C$								
Forward transmission								
Reverse transmission								
Forward match								
Reverse match								
Response								
Response & isolation								
TRL thru								
TRL reflect								Undefined
TRL line								Undefined

TRL Option

Cal Z_0: _____System Z_0 ____Line Z_0

Set ref: ____Thru ____Reflect

Calibration Label:

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$								Open
$S_{11}B$								Short
$S_{11}C$								Loads
$S_{22}A$								Open
$S_{22}B$								Short
$S_{22}C$								Loads
Forward transmission								Thru
Reverse transmission								Thru
Forward match								Thru
Reverse match								Thru
Response								Response
Response & isolation								Response
TRL thru								Undefined
TRL reflect								Undefined
TRL line								Undefined

TRL Option

Cal Z_0: _____System Z_0 ____Line Z_0

Set ref: ____Thru ____Reflect

Table A-6 Blank Form for the PNA Network Analyzer

Calibration Label: ____________		Calibration Label: ____________	
Class	**A[a]**	**Class**	**A[a]**
S_{11}A		S_{11}A	
S_{11}B		S_{11}B	
S_{11}C		S_{11}C	
S_{21}T		S_{21}T	
S_{22}A		S_{22}A	
S_{22}B		S_{22}B	
S_{22}C		S_{22}C	
S_{12}T		S_{12}T	
TRL ‘T’		TRL ‘T’	
TRL ‘R’		TRL ‘R’	
TRL ‘L’		TRL ‘L’	

a. For additional ports, make sure values match the correct sex of the port.

Notes:

The following calibration are only supported by certain PNA analyzers. See your PNA network analyzer embedded help system.

1. **If you are performing a TRL calibration:**
   - S_{21}T and S_{12}T must be defined as *thru* standards.
   - S_{11}A and S_{22}A must be defined as *reflection* standards.
   - S_{11}B, S_{11}C, S_{22}B, and S_{22}C must be defined as *line* standards.
2. **If you are performing a TRM calibration:**
   - S_{21}T and S_{12}T must be defined as *thru* standards.
   - S_{11}A and S_{22}A must be defined as *reflection* standards.
   - S_{11}B, S_{11}C, S_{22}B, and S_{22}C must be defined as *match* standards.
3. **If you are performing an LRM calibration:**
   - S_{21}T and S_{12}T must be defined as *line* standards.
   - S_{11}A and S_{22}A must be defined as *reflection* standards.
   - S_{11}B, S_{11}C, S_{22}B, and S_{22}C must be defined as *match* standards.
4. **S_{11}B and S_{11}C must be defined as the same standard.**
5. **S_{22}B and S_{22}C must be defined as the same standard**.

Nominal Standard Definitions

Standard definitions provide the constants needed to mathematically model the electrical characteristics (delay, attenuation, and impedance) of each calibration standard. The nominal values of these constants are theoretically derived from the physical dimensions and material of each calibration standard, or from actual measured response. These values are used to determine the measurement uncertainties of the network analyzer. The standard definitions in Tables A-7 through A-12 list typical calibration parameters used by the following network analyzers to specify the mathematical model of each device. This information must be loaded into the network analyzer to perform valid calibrations. Refer to your network analyzer user's guide for instructions on loading calibration definitions.

NOTE The values in the standard definitions table are valid *only* over the specified operating temperature range.

Setting the System Impedance

This contains only 50 ohm devices. Ensure the system impedance (Z_0) is set to 50 ohms. Refer to your network analyzer user's guide for instructions on setting system impedance.

Version Changes

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. The disk shipped with the kit for use with the 8510 will contain the most recent version. The default version that comes with the 8722 network analyzers firmware may be outdated.

Table A-7 8510 Network Analyzer with 2.92 mm Devices

System Z_0[a] = 50.0 Ω
Disk File Name: CK_292MMA2

Calibration Label: 2.92 mm A.2

Standard[b] Number	Type	$C0 \times 10^{-15}$ F / $L0 \times 10^{-12}$ H	$C1 \times 10^{-27}$ F/Hz / $L1 \times 10^{-24}$ H/Hz	$C2 \times 10^{-36}$ F/Hz^2 / $L2 \times 10^{-33}$ H/Hz^2	$C3 \times 10^{-45}$ F/Hz^3 / $L3 \times 10^{-42}$ H/Hz^3	Fixed[c] or Sliding	Offset: Delay in ps	Offset: Z_0 in Ω	Offset: Loss in GΩ/s	Frequency (GHz)[d]: Min	Frequency (GHz)[d]: Max	Coax or Waveguide	Standard Label
1	Short[e]	0	0	0	0		–17.047	50	0	0	999	Coax	Short
2	Open[e]	33.17	–208.65	7.34	–0.020		–18.764	50	0	0	999	Coax	Open
3													
4													
5	Open	6.9558	–1.0259	–0.01435	0.0028		0	50	0	0	999	Coax	3.5/2.92
6	Open	5.9588	–11.195	0.5076	–0.00243		0	50	0	0	999	Coax	3.5/SMA
7	Open	13.4203	–1.9452	0.5459	0.01594		0	50	0	0	999	Coax	2.92/SMA
8	Open	8.9843	–13.9923	0.3242	–0.00112		0	50	0	0	999	Coax	2.4/1.85
9	Load					Fixed	0	50	0	0	999	Coax	Broadband
10	Load					Sliding	0	50	0	3.999	999	Coax	Sliding
11	Delay/ thru						–79.262	50	3.843	0	999	Coax	Thru
12	Load					Fixed	0	50	0	0	4.001	Coax	Lowband
13													
14													
15													
16													
17													
18													
19													
20													
21													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.
e. Typical values only. Disk values may be different.

Table A-8 8510 Network Analyzer with 2.4 mm Devices

System Z_0[a] = 50.0 Ω
Disk File Name:CK_24MMA4

Calibration Label: 2.4 mm A.4

Standard[b] Number	Standard[b] Type	$C0 \times 10^{-15}$ F / $L0 \times 10^{-12}$ H	$C1 \times 10^{-27}$ F/Hz / $L1 \times 10^{-24}$ H/Hz	$C2 \times 10^{-36}$ F/Hz^2 / $L2 \times 10^{-33}$ H/Hz^2	$C3 \times 10^{-45}$ F/Hz^3 / $L3 \times 10^{-42}$ H/Hz^3	Fixed[c] or Sliding	Offset Delay in ps	Offset Z_0 in Ω	Offset Loss in GΩ/s	Frequency (GHz)[d] Min	Frequency (GHz)[d] Max	Coax or Waveguide	Standard Label
1	Short[e]	2.1636	−146.35	4.0443	−0.0363		22.548	50	3.554	0	999	Coax	Short
2	Open[e]	29.722	165.78	−3.5385	0.0710		20.837	50	3.23	0	999	Coax	Open
3													
4													
5	Open	6.9558	−1.0259	−0.01435	0.0028		0	50	0	0	999	Coax	3.5/2.92
6	Open	5.9588	−11.195	0.5076	−0.00243		0	50	0	0	999	Coax	3.5/SMA
7	Open	13.4203	−1.9452	0.5459	0.01594		0	50	0	0	999	Coax	2.92/SMA
8	Open	8.9843	−13.9923	0.3242	−0.00112		0	50	0	0	999	Coax	2.4/1.85
9	Load					Fixed	0	50	0	0	999	Coax	Broadband
10	Load					Sliding	0	50	0	3.999	999	Coax	Sliding
11	Delay/ thru						0	50	0	0	999	Coax	Thru
12	Load					Fixed	0	50	0	0	4.001	Coax	Lowband
13	Delay/ thru						43.240	50	7.0	0	999	Coax	Adapter
14													
15													
16													
17													
18													
19													
20													
21													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.
e. Typical values only. Disk values may be different.

Table A-9 8722 Network Analyzer with 2.92 mm Devices

System Z_0[a] = 50.0 Ω									Calibration Label: [2.92*]					
Standard[b]		$C0 \times 10^{-15}$ F	$C1 \times 10^{-27}$ F/Hz	$C2 \times 10^{-36}$ F/Hz^2	$C3 \times 10^{-45}$ F/Hz^3	Fixed[c] or Sliding	Offset			Frequency (GHz)[d]		Coax or Waveguide	Standard Label
Number	Type						Delay in ps	Z_0 in Ω	Loss in GΩ/s	Min	Max		
1	Short						–17.047	50	0	0	999	Coax	Short
2	Open	33.17	–208.65	7.34	–0.020		–18.764	50	0	0	999	Coax	Open
3	Load					Fixed	0	50	0	0	999	Coax	Broadband
4	Delay/ thru						–79.262	50	3.843	0	999	Coax	Thru
5	Load					Sliding	0	50	0	3.999	999	Coax	Sliding
6	Load					Fixed	0	50	0	0	4.001	Coax	Lowband
7													
8													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.

Table A-10 8722 Network Analyzer with 2.4 mm Devices

System Z_0[a] = 50.0 Ω **Calibration Kit Label: [2.4 mm]**

Standard[b]		C0 ×10^−15 F	C1 ×10^−27 F/Hz	C2 ×10^−36 F/Hz²	C3 ×10^−45 F/Hz³	Fixed[c] or Sliding	Offset			Frequency in GHz[d]		Coax or Waveguide	Standard Label
Number	Type						Delay in ps	Z_0 in Ω	Loss in GΩ/s	Min	Max		
1	Short	0	0	0	0		22.548	50	3.554	0	999	Coax	Short
2	Open	29.72	165.78	–3.54	0.07		20.837	50	3.23	0	999	Coax	Open
3	Load					Fixed	0	50	3.554	0	999	Coax	Broadband
4	Delay/ thru						0	50	3.554	0	999	Coax	Thru
5	Load					Sliding	0	50	3.554	3.999	999	Coax	Sliding
6	Load					Fixed	0	50	3.554	0	4.001	Coax	Lowband
7													
8													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.

Table A-11 PNA Series Network Analyzer with 2.92 mm Devices

System Z_0[a] = 50.0 Ω														Calibration Kit Label: 2.92 mm Model 11904S
Standard[b]		$C0 \times 10^{-18}$ F	$C1 \times 10^{-30}$ F/Hz	$C2 \times 10^{-39}$ F/Hz^2	$C3 \times 10^{-48}$ F/Hz^3		Offset			Frequency in GHz[d]				
Number	Type	$L0 \times 10^{-12}$ H	$L1 \times 10^{-24}$ H/Hz	$L2 \times 10^{-33}$ H/Hz^2	$L3 \times 10^{-45}$ H/Hz^3	Fixed[c] or sliding	Delay in ps	Z_0 Ω	Loss in GΩ/s	Min	Max	Coax or Waveguide	Standard Label	
1	Short						–17.047	50	0	0	999	Coax	Short	
2	Open	33.17	–208.65	7.34	–0.020		–18.764	50	0	0	999	Coax	Open	
3	Broadband load					Fixed	0	50	3.554	0	999	Coax	Broadband	
4	Thru						–79.262	50	3.843	0	999	Coax	Thru	
5	Load					Sliding	0	50	0	3.999	999	Coax	Sliding	
6	Lowband load					Fixed	0	50	3.554	0	4.001	Coax	Lowband	
7														
8														

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.

Table A-12 PNA Series Network Analyzer with 2.4 mm Devices

System Z_0[a] = 50.0 Ω | **Calibration Kit Label: 2.4 mm Model 11904S**

Standard[b]		$C0 \times 10^{-18}$ F	$C1 \times 10^{-30}$ F/Hz	$C2 \times 10^{-39}$ F/Hz^2	$C3 \times 10^{-48}$ F/Hz^3	Fixed[c] or sliding	Offset			Frequency in GHz[d]		Coax or Waveguide	Standard Label
Number	Type	$L0 \times 10^{-12}$ H	$L1 \times 10^{-24}$ H/Hz	$L2 \times 10^{-33}$ H/Hz^2	$L3 \times 10^{-45}$ H/Hz^3		Delay in ps	Z_0 Ω	Loss in GΩ/s	Min	Max		
1	Short	2.1636	–146.35	4.0443	–0.0363		22.558	50	3.554	0	999	Coax	Short
2	Open	29.722	165.78	–315.385	0.0710		20.837	50	3.230	0	999	Coax	Open
3	Broadband load					Fxd	0	50	3.554	0	999	Coax	Broadband
4	Thru						0	50	0	0	999	Coax	Zero length
5	Thru						0	50	1.3	0	999	Coax	Custom adapter
6	Broadband load					Fxd	0	50	3.554	0	999	Coax	Broadband
7	Short	2.1636	–146.35	4.0443	–0.0363		22.558	50	3.554	0	999	Coax	Short
8	Open	29.722	165.78	–315.385	0.0710		20.837	50	3.230	0	999	Coax	Open

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.

Blank Forms

The standard definitions may be changed to meet your specific requirements. Tables A-13 through A-15 are provided to record the modified standard definitions.

Table A-13 Blank Form for the 8510 Network Analyzer

System Z_0[a] = ________________
Disk File Name: ____________________________ **Calibration Kit Label: ________________**

Standard[b]		$C0 \times 10^{-15}$ F	$C1 \times 10^{-27}$ F/Hz	$C2 \times 10^{-36}$ F/Hz^2	$C3 \times 10^{-45}$ F/Hz^3	Fixed[c] or sliding	Offset			Frequency in GHz[d]		Coax or Waveguide	Standard Label
Number	Type	$L0 \times 10^{-12}$ H	$L1 \times 10^{-24}$ H/Hz	$L2 \times 10^{-33}$ H/Hz^2	$L3 \times 10^{-42}$ H/Hz^3		Delay	Z_0 in Ω	Loss in GΩ/s	Min	Max		
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as F_{CO}.

Table A-14 Blank Form for the 8722 Network Analyzer

System Z_0[a] = __________														Calibration Label:________
Standard[b]		$C0 \times 10^{-15}$ F	$C1 \times 10^{-27}$ F/Hz	$C2 \times 10^{-36}$ F/Hz^2	$C3 \times 10^{-45}$ F/Hz^3	Fixed[c] or Sliding	Offset			Frequency in GHz[d]		Coax or Waveguide	Standard Label
Number	Type						Delay in ps	Z_0 in Ω	Loss in GΩ/s	Min	Max		
1													
2													
3													
4													
5													
6													
7													
8													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. Load or arbitrary impedance only.
d. For waveguide, the lower frequency is the same as $F_{CO.}$

Table A-15 Blank Form for the PNA Series Network Analyzers

System Z_0[a] = ____________								Calibration Kit Label: ________________					
Standard[b]		C0 $\times 10^{-18}$ F	C1 $\times 10^{-30}$ F/Hz	C2 $\times 10^{-39}$ F/Hz^2	C3 $\times 10^{-48}$ F/Hz^3		Offset			Frequency in GHz[c]			
Number	Type	L0 $\times 10^{-12}$ H	L1 $\times 10^{-24}$ H/Hz	L2 $\times 10^{-33}$ H/Hz^2	L3 $\times 10^{-45}$ H/Hz^3	Fixed or sliding	Delay in ps	Z_0 Ω	Loss in GΩ/s	Min	Max	Coax or Waveguide	Standard Label
1													
2													
3													
4													
5													
6													
7													
8													

a. Ensure system Z_0 of network analyzer is set to this value.
b. Open, short, load, delay/thru, or arbitrary impedance.
c. For waveguide, the lower frequency is the same as F_{CO}.

Index

Index