

User's and Service Guide

Agilent Technologies 85056D 2.4 mm Economy Calibration Kit



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1 General Information

Calibration Kit Overview

The Agilent 85056D 2.4 mm calibration kit is used to calibrate Agilent network analyzers up to 50 GHz for measurements of components with 2.4 mm connectors.

Kit Contents

The 85056D calibration kit includes the following items:

- offset opens and shorts
- broadband terminations
- 2.4 mm adapters
- 5/16 in, 90 N-cm (8 in-lb) torque wrench
- 7 mm open-end wrench
- disk that contains the calibration constants of the devices in the calibration kit

Refer to Chapter 6 for a complete list of kit contents and their associated part numbers.

NOTE 85056D kits with serial prefix 3012A did not have the calibration constants disk to support the 8510C network analyzer. The part numbers provided in this manual are the recommended replacement parts for these kits. The devices in these kits should meet the specifications published in this manual.

Broadband Loads

The broadband loads are metrology-grade, 50 Ω terminations that have been optimized for performance up to 50 GHz. The rugged internal structure provides for highly repeatable connections. A distributed resistive element on sapphire provides excellent stability and return loss.

Offset Opens and Shorts

The offset opens and shorts are built from parts that are machined to the current state-of-the-art in precision machining.

The offset short's inner conductors have a one-piece construction, common with the shorting plane. The construction provides for extremely repeatable connections.

The offset opens have inner conductors that are supported by a strong, low-dielectric-constant plastic to minimize compensation values.

Both the opens and shorts are constructed so that the pin depth can be controlled very tightly, thereby minimizing phase errors. The lengths of the offsets in the opens and shorts are designed so that the difference in phase of their reflection coefficients is approximately 180 degrees at all frequencies.

Adapters

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, allowing them to be used in calibration procedures for non-insertable devices.

Calibration Constants

The calibration kit must be selected and the calibration constants for the devices in the kit installed in the network analyzer prior to performing a calibration. Refer to your network analyzer's user's guide for instructions on selecting the calibration kit and performing a calibration.

The calibration constants can be:

- already resident within the analyzer
- loaded from the provided disk
- entered from the front panel

Analyzers with Permanently Stored Calibration Constants

The calibration constants for the kit are permanently installed in the internal memory or hard disk of the following network analyzers.

8719D/ET/ES	8752C
8720D/ET/ES	8753D/E/ET/ES
8722D/ET/ES	

If this calibration kit is used with other network analyzers, the calibration constants must be manually entered into the network analyzer. Refer to your network analyzer's user's guide for instructions.

Options

The following options are available for the 85056D:

Option 002

This option adds a data tape that contains the calibration constants of the devices in the calibration kit.

Option 1BN

This option adds a MIL-STD 45662 certificate of calibration for the devices in the calibration kit.

Option 1BP

This option adds a MIL-STD 45662 certificate of calibration and the corresponding calibration data for the devices in the calibration kit.

Option 910

This option adds an additional copy of the user's and service guide (this manual).

Equipment Required but Not Supplied

Gage sets are required for measuring the connector pin depth. Gages and various connector cleaning supplies are not supplied with this kit.

Connector cleaning supplies and various electrostatic discharge (ESD) protection devices are not supplied with the calibration kit but are required to ensure successful operation of the kit.

Refer to Table 6-2 on page 6-3 for ordering information.

Incoming Inspection

Verify that the shipment is complete by referring to Table 6-1.

Check for damage. The foam-lined storage case provides protection during shipping. Verify that this case and its contents are not damaged.

If the case or any device appears damaged, or if the shipment is incomplete, contact the nearest Agilent Technologies sales or service office. See page 5-4. Agilent will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company.

When you send the kit or device to Agilent, include a service tag (found near the end of this manual) with the following information:

- your company name and address
- the name of a technical contact person within your company, and the person's complete phone number
- the model number and serial number of the kit
- the part number and serial number of the device
- the type of service required
- a *detailed* description of the problem

Recording the Device Serial Numbers

In addition to the kit 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 Table 1-1. 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 85056D

Device	Serial Number
Calibration kit	_____
Male open	_____
Female open	_____
Male short	_____
Female short	_____
Male broadband load	_____
Female broadband load	_____
Male-to-male 2.4 mm adapter	_____
Male-to-female 2.4 mm adapter	_____
Female-to-female 2.4 mm adapter	_____

General Information

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.

Connector gages are 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
- cleaning
- proper gaging
- proper connection techniques

All of these techniques 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
Operating temperature ^a	+20 °C to +26 °C (+68 °F to +79 °F)
Error-corrected temperature range ^b	±1 °C of measurement calibration temperature
Storage temperature	-40 °C to +75 °C (-40 °F to +167 °F)
Altitude	
Operation	< 4,500 meters (~15,000 feet)
Storage	< 15,000 meters (~50,000 feet)
Relative humidity	Always non-condensing
Operation	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 are a heat source.

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 3-7 explains how to use gages to determine if the kit devices have maintained their mechanical integrity. Refer to Table 2-2 on page 2-4 for typical and observed pin depth limits.

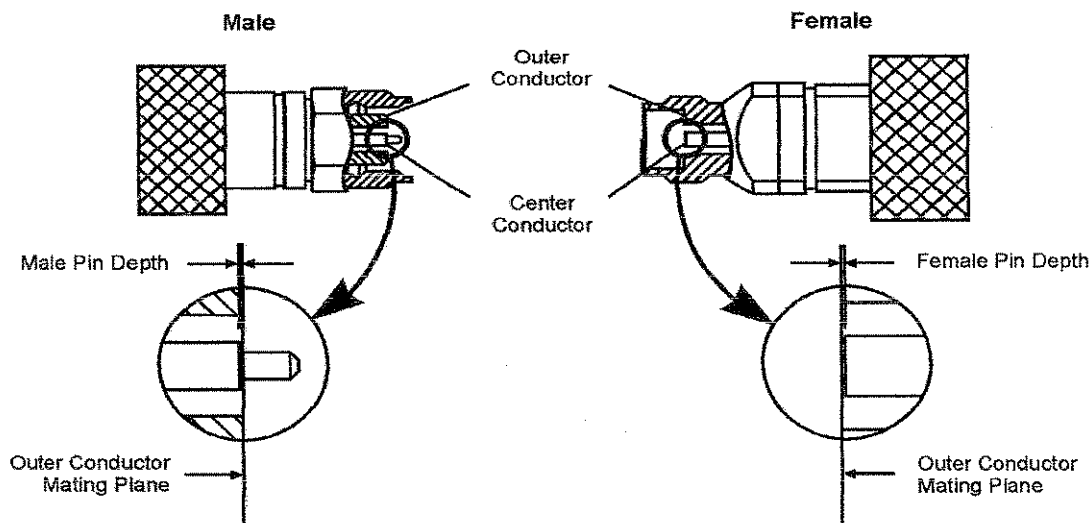
Pin Depth

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



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Mechanical Characteristics

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 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 -0.00010 to -0.00080 in	+0.0030 to -0.0030 mm +0.00012 to -0.00012 in	+0.0005 to -0.0234 mm +0.00002 to -0.00092 in
Adapters	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

- 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.

Electrical Specifications

The electrical specifications in Table 2-3 apply to the devices in your calibration kit when connected with an Agilent precision interface.

Table 2-3 Electrical Specifications for 85056D 2.4 mm Devices

Device	Specification	Frequency (GHz)
Broadband loads (male and female)	Return loss ≥ 42 dB ($\rho \leq 0.00794$)	dc to ≤ 4
	Return loss ≥ 34 dB ($\rho \leq 0.01995$)	> 4 to ≤ 20
	Return loss ≥ 30 dB ($\rho \leq 0.03162$)	> 20 to ≤ 26.5
	Return loss ≥ 26 dB ($\rho \leq 0.05019$)	> 26.5 to ≤ 50
Adapters	Return loss ≥ 32 dB ($\rho \leq 0.02512$)	dc to ≤ 4
	Return loss ≥ 30 dB ($\rho \leq 0.03162$)	> 4 to ≤ 26.5
	Return loss ≥ 25 dB ($\rho \leq 0.05623$)	> 26.5 to ≤ 40
	Return loss ≥ 20 dB ($\rho \leq 0.10000$)	> 40 to ≤ 50
Offset opens ^a (male and female)	$\pm 0.5^\circ$ deviation from nominal	dc to ≤ 2
	$\pm 1.25^\circ$ deviation from nominal	> 2 to ≤ 20
	$\pm 1.75^\circ$ deviation from nominal	> 20 to ≤ 40
	$\pm 2.25^\circ$ deviation from nominal	> 40 to ≤ 50
Offset shorts ^a (male and female)	$\pm 0.50^\circ$ deviation from nominal	dc to ≤ 2
	$\pm 1.25^\circ$ deviation from nominal	> 2 to ≤ 20
	$\pm 1.5^\circ$ deviation from nominal	> 20 to ≤ 40
	$\pm 2.0^\circ$ deviation from nominal	> 40 to ≤ 50

a. The specifications for the opens and shorts are given as allowed deviation from the nominal model as defined in the standard definitions (see "Nominal Standard Definitions" on page A-6).

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

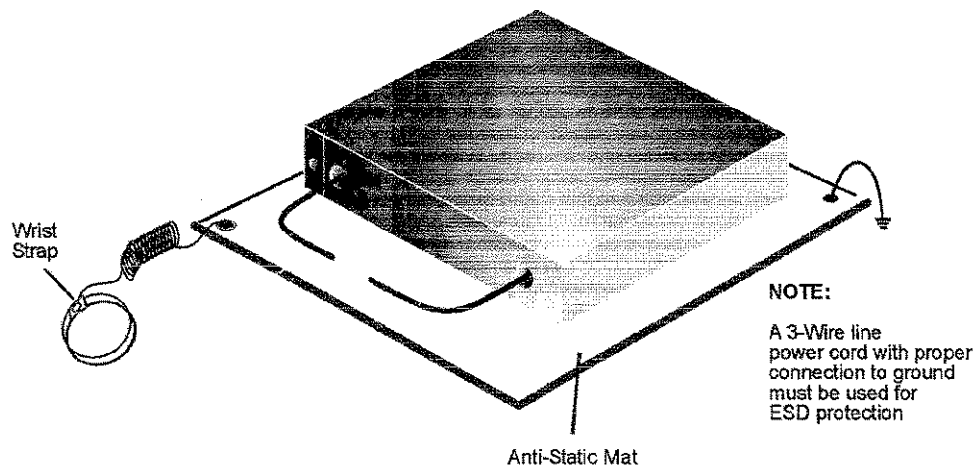
Protection against electrostatic discharge (ESD) is essential while connecting, inspecting, or cleaning connectors attached to a static-sensitive circuit (such as those found in test sets).

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 M Ω 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 Chapter 6, "Replaceable Parts," for information on ordering supplies for ESD protection.

Figure 3-1 ESD Protection Setup



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Inspecting Connectors

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 $\geq 10\times$ 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.

Inspect Female 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.

The female 2.4 mm connectors in this calibration kit are metrology-grade, precision slotless connectors (PSC). Precision slotless connectors are used to improve accuracy. 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.

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 female 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, this center conductor has an internal contact that flexes to accept the male pin.

Cleaning Connectors

Clean connectors are essential for ensuring the integrity of RF and microwave coaxial connections.

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 6-3 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.

Cleaning Connectors

- 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 "Inspecting Connectors" on page 3-3.

Gaging Connectors

The gages available from Agilent Technologies are intended for preventive maintenance and troubleshooting purposes only. See Table 6-2 on page 6-3 for part number information. They are effective in detecting excessive center conductor protrusion or recession, and conductor damage on DUTs, test accessories, and the calibration kit devices. Do not use the gages for precise pin depth measurements.

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 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 in Table 2-2 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 opens and shorts in Table 2-2.

The observed pin depth limits in Table 2-2 add these uncertainties to the typical factory pin depth values to provide practical limits that can be referenced when using the gages. See "Pin Depth" on page 2-3. Refer to "Kit Contents" on page 1-2 for more information on the design of the calibration devices in the kit.

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 to evaluate the *condition of device connectors*.

Gaging 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 Connectors

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. Refer to Table 6-2 on page 6-3 for gage part numbers.
2. Inspect and clean the gage, gage master, and device to be gaged. Refer to “Inspecting Connectors” and “Cleaning Connectors” earlier in this chapter.
3. Zero the connector gage (refer to Figure 3-2):
 - 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.
 - 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 3-11 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 3-2):
 - 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 3-11 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 \pm signs; *not* the red \pm 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.

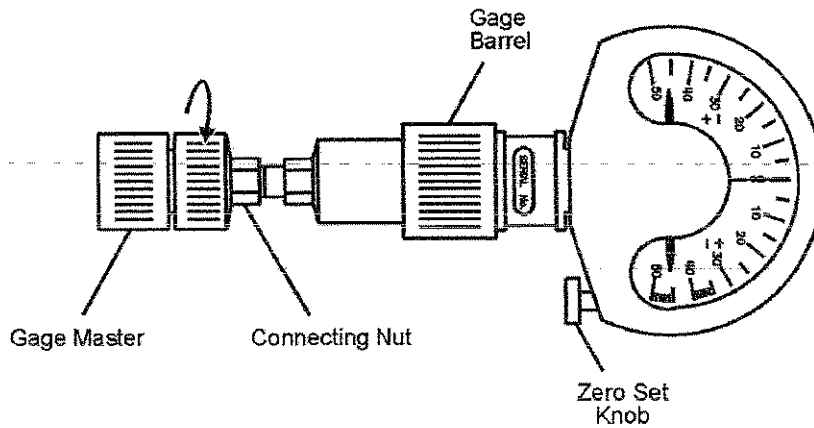
Figure 3-2 Gaging 2.4 mm Connectors

Note:

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

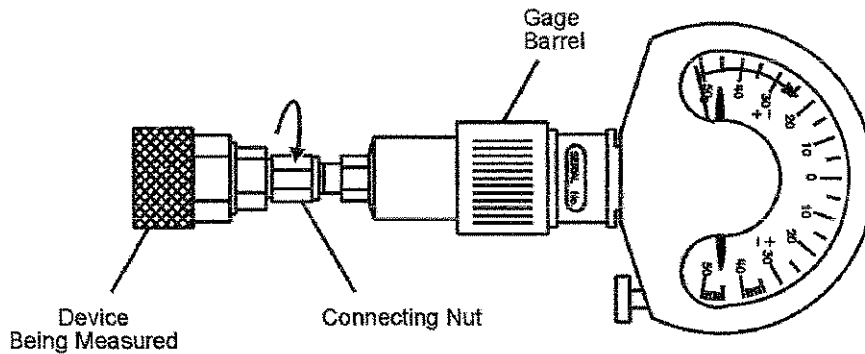
Zero the Connector Gage

- 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.



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Making 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. Refer to "Electrostatic Discharge" on page 3-2 for ESD precautions.
2. Visually inspect the connectors. Refer to "Inspecting Connectors" on page 3-3.
3. If necessary, clean the connectors. Refer to "Cleaning Connectors" on page 3-5.
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. Refer to "Gaging Connectors" on page 3-7.
5. Carefully align the connectors. The male connector center pin must slip concentrically into the contact finger of the female connector.
6. Push the connectors straight together and tighten the connector nut finger tight.

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.

Do *not* twist or screw the connectors together. As the center conductors mate, there is usually a 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 a torque wrench to make a final connection. Table 3-1 provides information about the torque wrench recommended for use with the calibration kit. A torque wrench is included in the calibration kit. Refer to Table 6-1 on page 6-2 for replacement part number and ordering information.

Table 3-1 Torque Wrench Information

Connector Type	Torque Setting	Torque Tolerance
2.4 mm	90 N-cm (8 in-lb)	±9.0 N-cm (±0.8 in-lb)

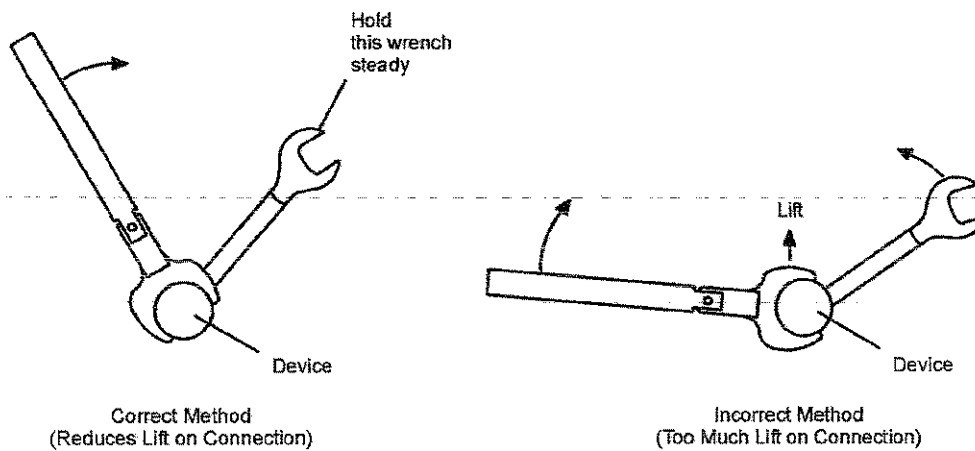
Use, Maintenance, and Care of the Devices
Making Connections

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.

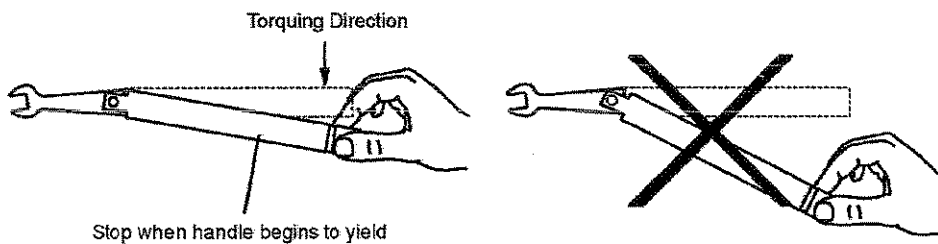
1. Position both wrenches within 90 degrees of each other before applying force. See Figure 3-3. Wrenches opposing each other (greater than 90 degrees apart) will cause a lifting action which can misalign and stress the connections of the devices involved. This is especially true when several devices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

Figure 3-3 Wrench Positions



2. Hold the torque wrench lightly, at the end of the handle only (beyond the groove). See Figure 3-4.

Figure 3-4 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. See Figure 3-4. Do not tighten the connection further.

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.

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

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

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* and a *U.S. MIL-STD 45662* calibration for the recertification of the kit. For more information, contact the nearest Agilent Technologies sales or service office. See Table 5-1 on page 5-4.

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

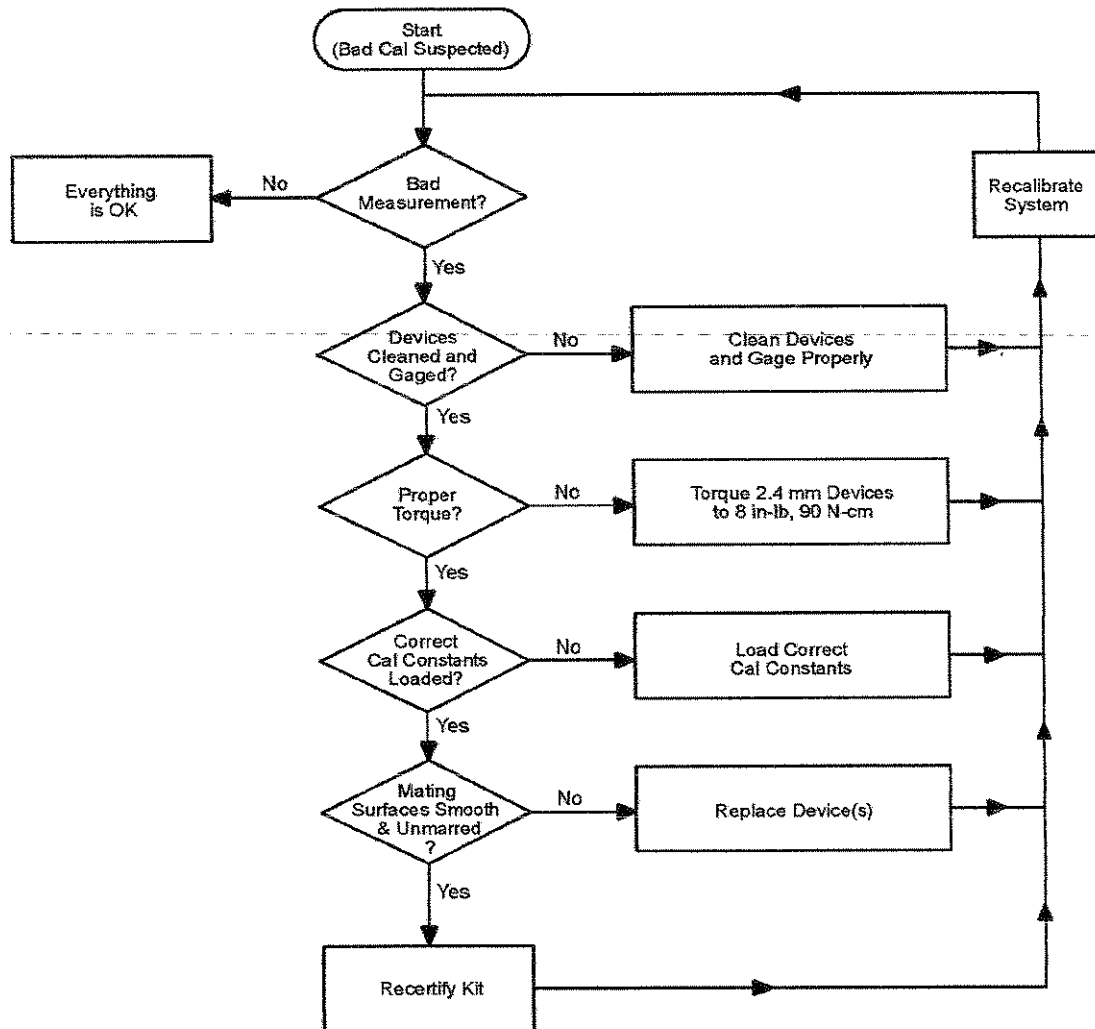
Contact the sales or service office nearest you for information on where to send your kit for recertification. Offices are listed on page 5-4. Refer to "Returning a Kit or Device to Agilent" on page 5-3 for details on sending your kit.

5 Troubleshooting

Troubleshooting Process

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



ph75a

Returning a Kit or Device to Agilent

If your kit or device requires service, contact the Agilent Technologies office nearest you for information on where to send it. See Table 5-1. 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 phone 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)

Table 5-1 Agilent Technologies Sales and Service Offices

UNITED STATES		
Instrument Support Center Agilent Technologies S.A. (800) 403-0801		
EUROPEAN FIELD OPERATIONS		
Headquarters Agilent Technologies S.A. 150, Route du Nant-d'Avril 1217 Meyrin 2/ Geneva Switzerland (41 22) 780.8111	France Agilent Technologies France 1 Avenue Du Canada Zone D'Activite De Courtaboeuf F-91947 Les Ulis Cedex France (33 1) 69 82 60 60	Germany Agilent Technologies GmbH Agilent Technologies Strasse 61352 Bad Homburg v.d.H Germany (49 6172) 16-0
Great Britain Agilent Technologies Ltd. Eskdale Road, Winnersh Triangle Wokingham, Berkshire RG41 5DZ England (44 734) 696622		
INTERCON FIELD OPERATIONS		
Headquarters Agilent Technologies 3495 Deer Creek Rd. Palo Alto, CA 94304-1316 USA (415) 857-5027	Australia Agilent Technologies Australia Ltd. 31-41 Joseph Street Blackburn, Victoria 3130 (61 3) 895-2895	Canada Agilent Technologies (Canada) Ltd. 17500 South Service Road Trans-Canada Highway Kirkland, Quebec H9J 2X8 Canada (514) 697-4232
Japan Agilent Technologies Japan, Ltd. Measurement Assistance Center 9-1, Takakura-Cho Hachioji-Shi, Tokyo 192-8510, Japan TEL (81) -426-56-7832 FAX (81) -426-56-7840	Singapore Agilent Technologies Singapore (Pte.) Ltd. 150 Beach Road #29-00 Gateway West Singapore 0718 (65) 291-9088	Taiwan Agilent Technologies Taiwan 8th Floor, H-P Building 337 Fu Hsing North Road Taipei, Taiwan (886 2) 712-0404
China China Agilent Technologies 38 Bei San Huan X1 Road Shuang Yu Shu Hai Dian District Beijing, China (86 1) 256-6888		

6 Replaceable Parts

Replaceable Parts

Table 6-1 lists the replacement part numbers for items included in the 85056D calibration kit and Figure 6-1 illustrates each of these items.

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 the nearest Agilent Technologies sales or service office. See Table 5-1 on page 5-4.

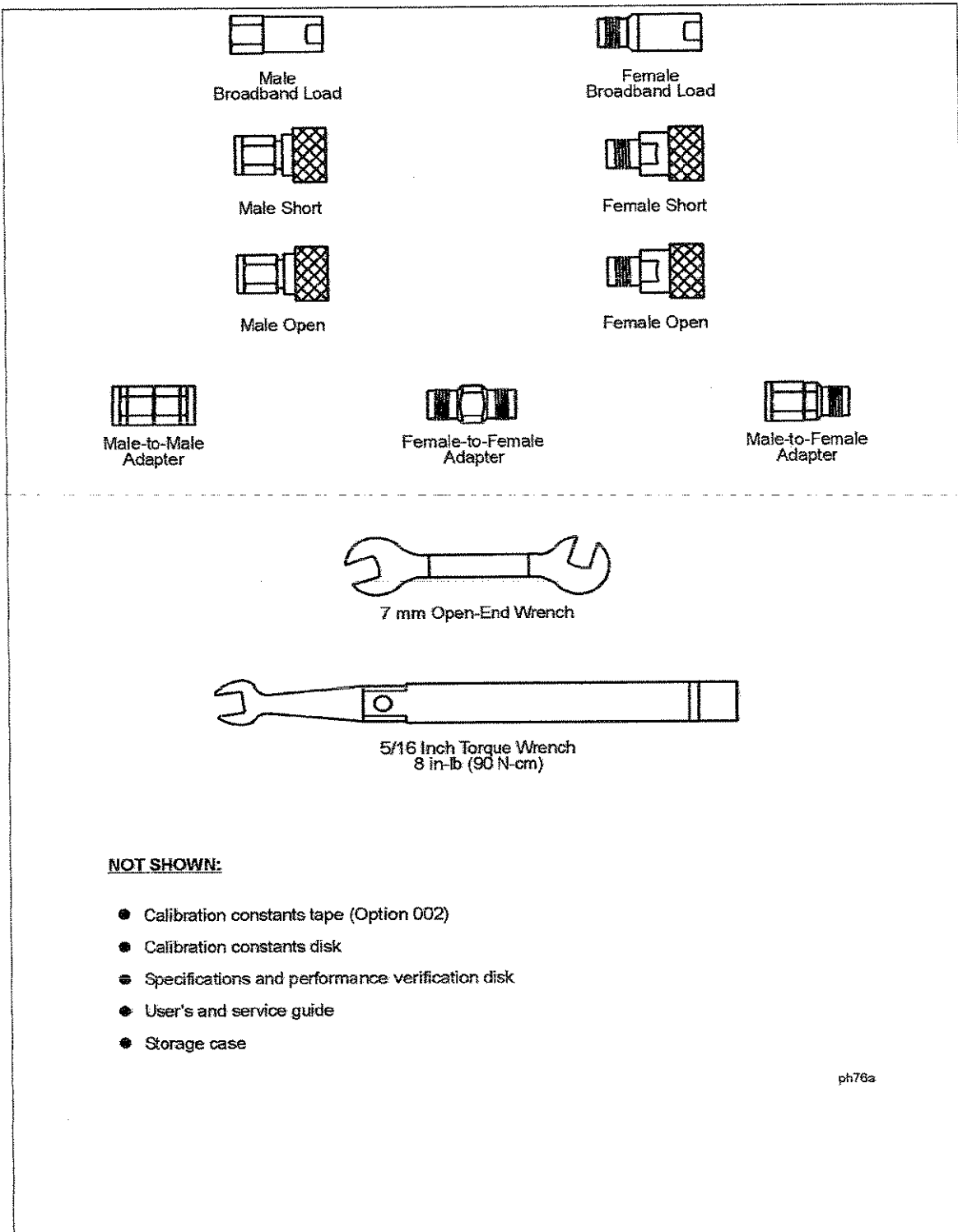
Table 6-1 Replaceable Parts for the 85056D Calibration Kit

Description	Qty per kit	Agilent Part Number
Calibration Devices (2.4 mm)		
Male broadband load	1	00901-60003
Female broadband load	1	00901-60004
Male offset open	1	85056-60022
Female offset open	1	85056-60023
Male offset short	1	85056-60020
Female offset short	1	85056-60021
Adapters (2.4 mm)		
Male to male	1	85056-60005
Male to female	1	85056-60006
Female to female	1	85056-60007
Calibration Kit Storage Case		
Box (including foam pads)	1	85056-60019
Box (without foam pads)	1	5180-7862
Foam pad (for lid)	1	5181-5544
Foam pad (for lower case)	1	85052-80026
Wrenches		
5/16 in, 90 N-cm (8 in-lb) torque wrench	1	8710-1765
7 mm open-end wrench	1	8710-1761
Miscellaneous Items		
Calibration constants disk	1	85056-10004
Calibration constants tape (Option 002 only)	1	85056-10002
Specifications and performance verification disk	1	08510-10033
User's and service guide	1	85056-90021

Table 6-2 Items Not Included in the Calibration Kit

Description	Qty	Agilent Part Number
Connector Gages (2.4 mm)		
Male gage set (includes gage master)	1	11752-60108
Female gage set (includes gage master)	1	11752-60107
Open-End Wrench		
5/16 in open-end wrench	1	8720-0015
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

Figure 6-1 Replaceable Parts for the 85056D Calibration Kit



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. Table A-1 and Table A-2 list the classes of the devices in the kit for various network analyzers. This information resides on the calibration constants disk included in the kit.

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

Disk File Name: CK_24MMA4		Calibration Kit Label: 2.4 mm A.4						
Tape File Number: * FILE 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							Isol'n Std
Reverse isolation	9							Isol'n Std
Frequency response	1	2	11					Response
TRL thru	14							Undefined
TRL reflect	1							Undefined
TRL line	15	16	17					Undefined
Adapter	13							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 the response and isolation calibration.

Table A-2 Standard Class Assignments for the 8719, 8720 and 8722 Family of Network Analyzers

Calibration Kit 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 <u> X </u> Line Z ₀								
Set ref: <u> X </u> Thru _____ Reflect								

Blank Form

The standard class assignments listed in Table A-1 and Table A-2 may be changed to meet your specific requirements. Table A-3 and Table A-4 are provided to record the modified standard class assignments.

Table A-3 Standard Class Assignments Blank Form for the 8510 Network Analyzer

Disk File Name: _____		Calibration Kit Label: _____						
Tape File Number: _____		_____						
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:								

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

Table A-4 Standard Class Assignments Blank Form for the 8719, 8720 and 8722 Family of Network Analyzers

Disk File Name: _____				Calibration Kit 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								
TRL line								
TRL Option								
Cal Z ₀ : _____ System Z ₀ _____ Line Z ₀								
Set ref: _____ Thru _____ Reflect								
Lowband frequency:								

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 Table A-5 and Table A-6 list typical calibration kit parameters used 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's user's guide for instructions on loading calibration constants.

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

Setting the System Impedance

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

Table A-5 Standard Definitions for the 8510 Network Analyzer

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 or Sliding ^f	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 in ps	Z_0 Ω	Loss in G Ω /s	Min	Max		
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													
6													
7													
8													
9	Load					Fxd	0	50	0	0	999	Coax	Broadband
10	Delay/ thru						0	50	0	0	999	Coax	Thru
11	Load					Fxd	0	50	0	0	4.001	Coax	Lowband
12	Delay/ thru						43.240	50	7.0	0	999	Coax	Adapter
13													
14													
15													
16													
17													
18													
19													
20													

- 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/tape values may be different.

Standard Definitions

Nominal Standard Definitions

Table A-6 Standard Definitions for the 8719, 8720 and 8722 Family of Network Analyzers

Standard ^b		Calibration Kit Label: 2.4 mm											
Number	Type	C0 × 10 ⁻¹⁵ F	C1 × 10 ⁻²⁷ F/Hz	C2 × 10 ⁻³⁶ F/Hz ²	C3 × 10 ⁻⁴⁵ F/Hz ³	Fixed or Sliding ^c	Offset			Frequency in GHz ^d		Coax or Waveguide	Standard Label
							Delay in ps	Z ₀ 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					Fxd	0	50	3.554	0	999	Coax	Broadband
4	Delay/ thru						0	50	3.554	0	999	Coax	Thru
5	Load					Fxd	0	50	3.554	0	4.001	Coax	Lowband
6													
7													

- a. Ensure system Z₀ 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 Form

The standard definitions listed in Table A-5 and Table A-6 may be changed to meet your specific requirements. Table A-7 and Table A-8 are provided to record the modified standard definitions.

Table A-7 Standard Definitions Blank Form for the 8510 Network Analyzer

System $Z_0^a =$ _____							Calibration Kit Label: _____						
Disk File Name: _____							Tape File Number: _____						
Number	Standard ^b Type	Frequency in GHz ^c			Fixed or sliding ^e	Termination Impedance Ω^d	Offset			Coax or Waveguide	Standard Label		
		$C0 \times 10^{-15}$ 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	Delay	$Z_0 \Omega$			Loss in G Ω /s	Min
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. Arbitrary impedance only, device terminating impedance.
- e. For waveguide, the lower frequency is the same as F_{CO} .

Standard Definitions

Nominal Standard Definitions

Table A-8 Standard Definitions Blank Form for the 8719, 8720 and 8722 Family of Network Analyzers

System $Z_0^a =$ _____													
Disk File Name: _____							Calibration Kit Label: _____						
Number	Type	Standard ^b				Fixed or Sliding ^c	Offset			Frequency in GHz ^d		Coax or Waveguide	Standard Label
		$C0 \times 10^{-15} \text{ F}$	$C1 \times 10^{-27} \text{ F/Hz}$	$C2 \times 10^{-36} \text{ F/Hz}^2$	$C3 \times 10^{-45} \text{ F/Hz}^3$		Delay in ps	$Z_0 \Omega$	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} .

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