

User's and Service Guide

Agilent Technologies 85033D 3.5 mm Calibration Kit



Agilent Technologies

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1 General Information

Calibration Kit Overview

The Agilent 85033D 3.5 mm calibration kit is used to calibrate Agilent network analyzers up to 6 GHz for measurements of components with 3.5 mm connectors.

Kit Contents

The 85033D calibration kit includes the following items:

- offset opens and shorts, and broadband load terminations
- disk that contains the nominal calibration definitions of the devices in the calibration kit
- two open-short-load (OSL) holders
- 2.5 mm hex key for use with the (OSL) holder

Refer to [Figure 6-1](#) and [Table 6-1](#) for a complete list of kit contents and their associated part numbers.

Broadband Loads

The broadband loads are metrology-grade terminations that have been optimized for performance up to 6 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. The adapters utilize a dual-beaded connector structure to ensure stable, repeatable connections. The beads are designed to minimize return loss and are separated far enough so that interaction between the beads is minimized.

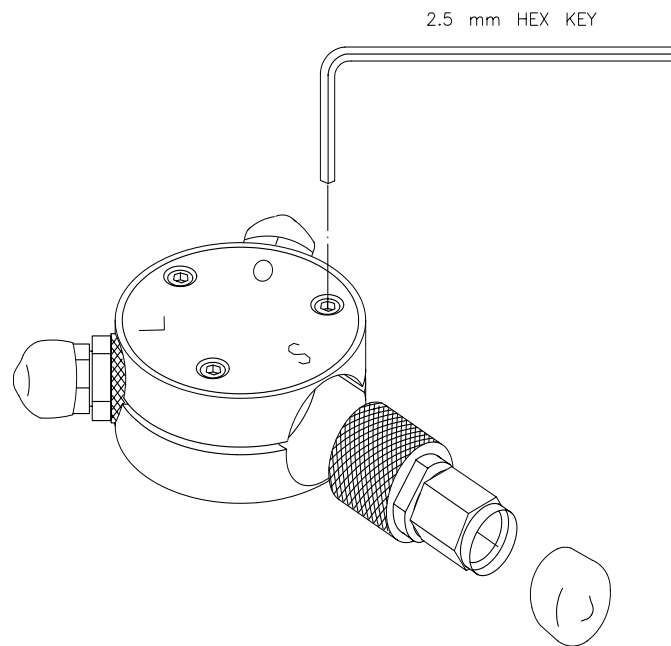
The adapters are designed so that their nominal electrical lengths are the same, which allows them to be used in calibration procedures for non-insertable devices.

Open-Short-Load Holders

The open-short-load (OSL) holders are included for your convenience. The OSL holders allow you to keep all of the calibration devices in two handy assemblies. Load each OSL holder with calibration devices of the same connector sex so that you can perform a calibration with just one assembly.

Use the 2.5-mm hex key included with the kit to secure the calibration devices in the holders. See [Figure 1-1](#).

Figure 1-1 Open-Short-Load Holder



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Calibration Definitions

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

The calibration definitions can be:

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

Installation of the Calibration Definitions

The calibration definitions for the kit may be permanently installed in the internal memory or hard disk of the network analyzer.

If the calibration definitions for the kit are not permanently installed in the network analyzer, they must be manually entered. Refer to your network analyzer user's guide for instructions.

Options

The following options are available for the 85033D:

Option 100

This option adds four 7-mm to 3.5-mm adapters.

Option 200

This option adds four type-N adapters:

- Type-N-male to 3.5-mm-male
- Type-N-male to 3.5-mm-female
- Type-N-female to 3.5-mm-male
- Type-N-female to 3.5-mm-female

Equipment Required but Not Supplied

Gages, torque and open-end wrenches, ESD protective devices, and various connector cleaning supplies are not supplied with the calibration kit but are required to ensure successful operation of the kit. Refer to [Table 6-2 on page 6-4](#) 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 Agilent Technologies. See [Table 5-1 on page 5-3](#). 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 the 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 85033D

Device	Serial Number
Calibration kit	_____
Male broadband load	_____
Female broadband load	_____
Male open	_____
Female open	_____
Male short	_____
Female short	_____

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.

Conversely, 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 are described in [Chapter 3](#) , “[Use, Maintenance, and Care of the Devices.](#)” 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	+15 °C to +35 °C (+59 °F to +95 °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 95%

- 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 3-6 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.)

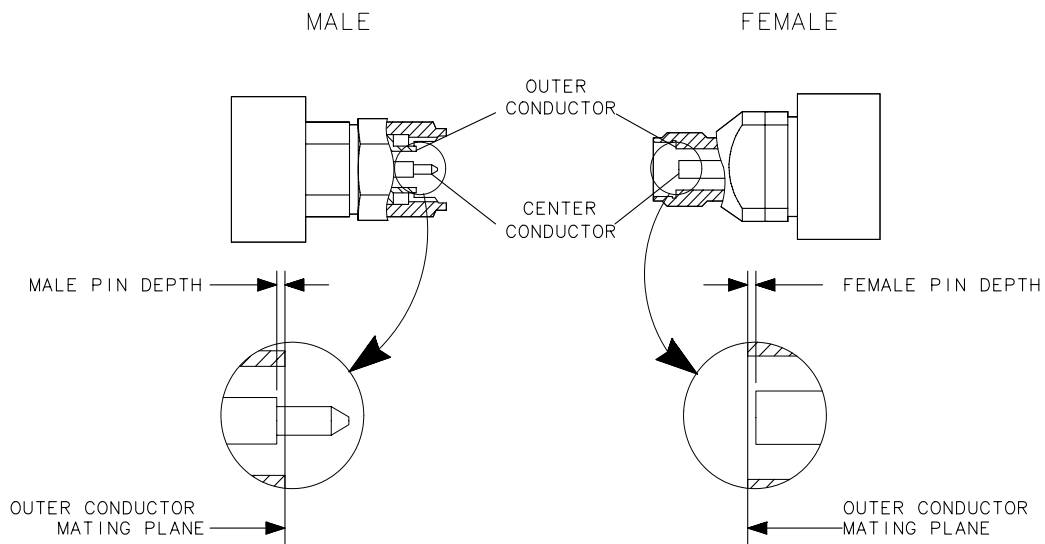
Pin Depth

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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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 -0.0005 in	+0.0064 to -0.0064 mm +0.00025 to -0.00025 in.	+0.0064 to -0.0191 mm +0.00025 to -0.00075 in
Shorts	0 to -0.0127 mm 0 to -0.0005 in	+0.0041 to -0.0041 mm +0.00016 to -0.00016 in	+0.0041 to -0.0168 mm +0.00016 to -0.00066 in
Fixed Loads	-0.0025 to -0.0254 mm -0.0001 to -0.001 in	+0.0041 to -0.0041 mm +0.00016 to -0.00016 in	+0.0016 to -0.02953 mm +0.00006 to -0.00116 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 85033D 3.5 mm Devices

Device	Specification	Frequency (GHz)
Broadband loads (male and female)	Return loss ≥ 46 dB ($\rho \leq 0.005$)	DC to ≤ 1.3
	Return loss ≥ 44 dB ($\rho \leq 0.006$)	>1.3 to ≤ 3
	Return loss ≥ 38 dB ($\rho \leq 0.013$)	>3 to ≤ 6
Offset opens ^a (male and female)	$\pm 0.65^\circ$ deviation from nominal	DC to ≤ 1.3
	$\pm 0.65^\circ$ deviation from nominal	>1.3 to ≤ 3
	$\pm 0.85^\circ$ deviation from nominal	> 3 to ≤ 6
Offset shorts ^a (male and female)	$\pm 0.48^\circ$ deviation from nominal	DC to ≤ 1.3
	$\pm 0.50^\circ$ deviation from nominal	> 1.3 to ≤ 3
	$\pm 0.55^\circ$ deviation from nominal	> 3 to ≤ 6

a. The specifications for the opens and shorts are given as allowed deviation from the nominal model as defined in the standard definitions (see [Table A-3](#) and [Table A-4](#) in Appendix A).

Supplemental Electrical Characteristics for Adapters

Supplemental electrical characteristics are provided as additional information that may be helpful in applying the devices. These characteristics are typical of most devices but are not warranted. [Table 2-4](#) lists the typical characteristics for the adapters in Options 100 and 200.

Table 2-4 Supplemental Electrical Characteristics for Adapters

Adapter	Typical Return Loss	Frequency (GHz)
7-mm to 3.5-mm ^a	Return loss ≥ 34 dB ($\rho \leq 0.020$)	DC to ≤ 6
Type-N-male to 3.5-mm-male ^b	Return loss ≥ 28 dB ($\rho \leq 0.040$)	DC to ≤ 6
Type-N-male to 3.5-mm-female ^b	Return loss ≥ 28 dB ($\rho \leq 0.040$)	DC to ≤ 6
Type-N-female to 3.5-mm-female ^b	Return loss ≥ 28 dB ($\rho \leq 0.040$)	DC to ≤ 6
Type-N-female to 3.5-mm-male ^b	Return loss ≥ 24 dB ($\rho \leq 0.060$)	DC to ≤ 6

a. See “Option 100” on page 1-4.

b. See “Option 200” on page 1-4.

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

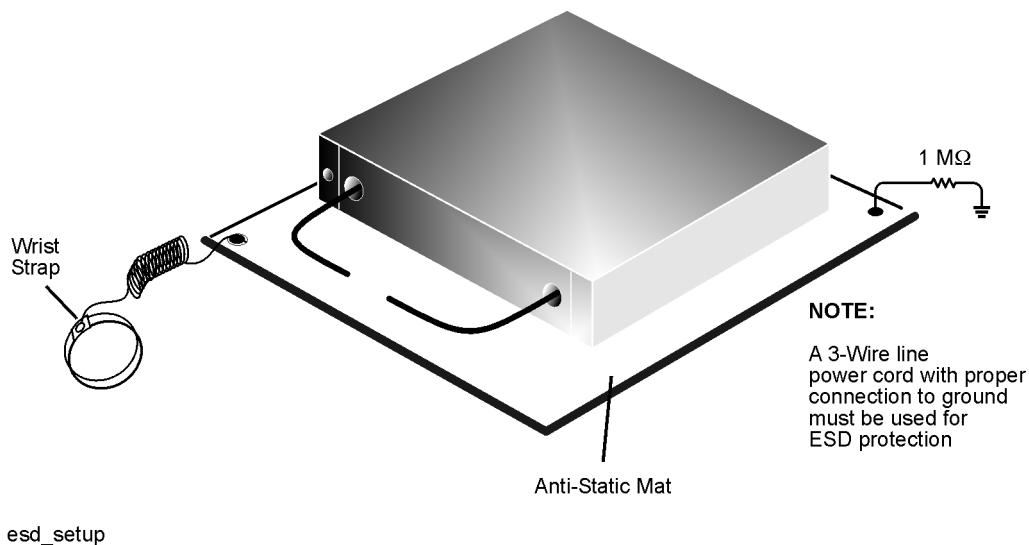
Protection against ESD (electrostatic discharge) is essential while connecting, inspecting, or cleaning connectors attached to a static-sensitive circuit (such as those found in test sets).

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 (DUTs), 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, conductive table mat while making connections.
- *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.
- *always* ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port or cable connector briefly.
- *always* ground the center conductor of a test cable before making a connection to the analyzer test port or other static-sensitive device. This can be done as follows:
 1. Connect a short (from your calibration kit) to one end of the cable to short the center conductor to the outer conductor.
 2. While wearing a grounded wrist strap, grasp the outer shell of the cable connector.
 3. Connect the other end of the cable to the test port.
 4. Remove the short from the cable.

Refer to [Chapter 6](#) , “[Replaceable Parts](#),” for part numbers and instructions for ordering ESD protection devices.

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 $\geq 10\times$ 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 connected incorrectly.

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

Pay special attention to the contact fingers in the female center conductor. 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.

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” on page 3-2](#) 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. Reinspect

Inspect the connector again to make sure that no particles or residue are present.

Gaging Connectors

The gages available from Agilent Technologies are intended for preventive maintenance and troubleshooting purposes only. (See [Table 6-1 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, however, 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 (see [Table 2-2 on page 2-4](#)) 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 on page 2-4](#) 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.

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 Male 3.5 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.)

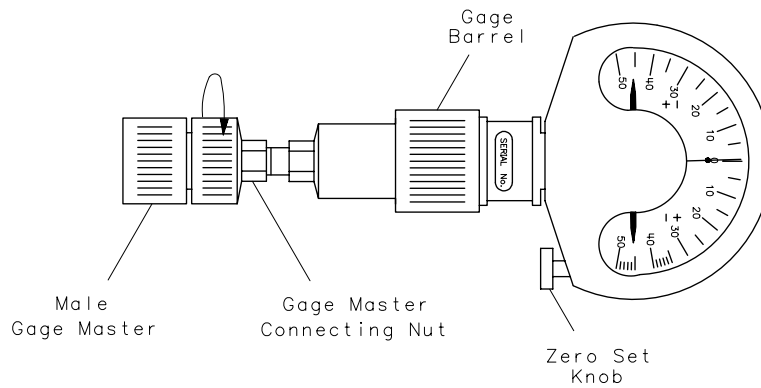
1. Select the proper gage for your connector. Refer to [Table 6-2](#) for gage part numbers.
2. Inspect and clean the gage, gage master, and device to be gaged. Refer to [“Visual Inspection”](#) and [“Cleaning Connectors”](#) earlier in this chapter.
3. Zero the connector gage (refer to [Figure 3-2](#)):
 - a. While holding the gage by the barrel, and without turning the gage or the device, screw the male gage master connecting nut onto the male gage, just until you meet resistance. Connect the nut finger tight. Do not overtighten.
 - b. Use the torque wrench recommended for use with the kit to tighten the connecting nut to 90 N-cm (8 in-lb). Refer to [“Connections” on page 3-12](#) for more 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 zero.
 - 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, screw the connecting nut of the male device being measured onto the male gage, just until you meet resistance. Connect the nut finger-tight. Do not overtighten.
 - b. Use the torque wrench recommended for use with the kit to tighten the connecting nut to 90 N-cm (8 in-lb). Refer to [“Connections” on page 3-12](#) for more 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 Male 3.5 mm Connectors

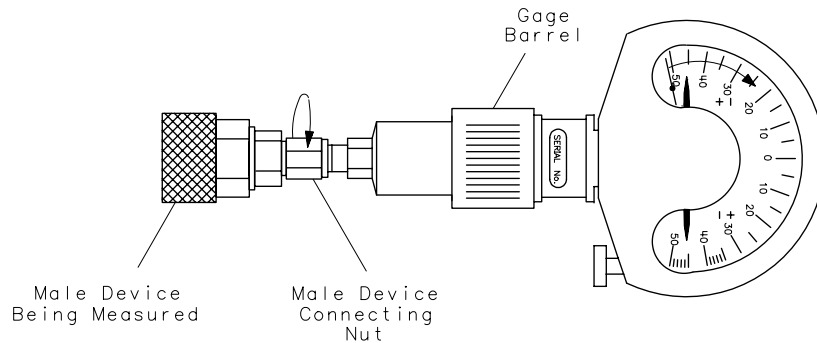
Zero the Connector Gage

- Screw the male gage master connecting nut onto the male gage.
- 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

- Screw the male device connecting nut onto the male gage.
- Torque the connecting nut.
- Gently tap the gage barrel to settle the reading.
- Read recession or protrusion from the gage.
- Remove the device.



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Gaging Female 3.5 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.)

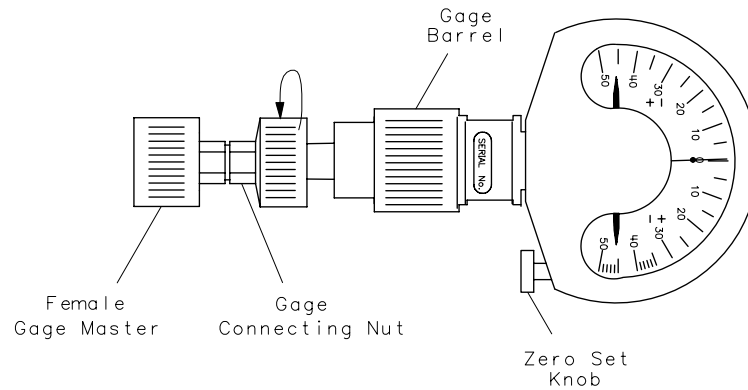
1. Select the proper gage for your connector. Refer to [Table 6-2](#) for gage part numbers.
2. Inspect and clean the gage, gage master, and device to be gaged. Refer to “[Visual Inspection](#)” and “[Cleaning Connectors](#)” earlier in this chapter.
3. Zero the connector gage (refer to [Figure 3-3](#)):
 - a. While holding the gage by the barrel, and without turning the gage or the device, screw the female gage connecting nut onto the female gage master, just until you meet resistance. Connect the nut finger-tight. Do not overtighten.
 - b. Use the torque wrench recommended for use with the kit to tighten the connecting nut to 90 N-cm (8 in-lb). Refer to “[Connections](#)” on [page 3-12](#) for more 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 zero.
 - 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, screw the female gage connecting nut onto the female device being measured, just until you meet resistance. Connect the nut finger-tight. Do not overtighten.
 - b. Use the torque wrench recommended for use with the kit to tighten the connecting nut to 90 N-cm (8 in-lb). Refer to “[Connections](#)” on [page 3-12](#) for more 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. Use different orientations of the gage within the connector. 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 Female 3.5 mm Connectors

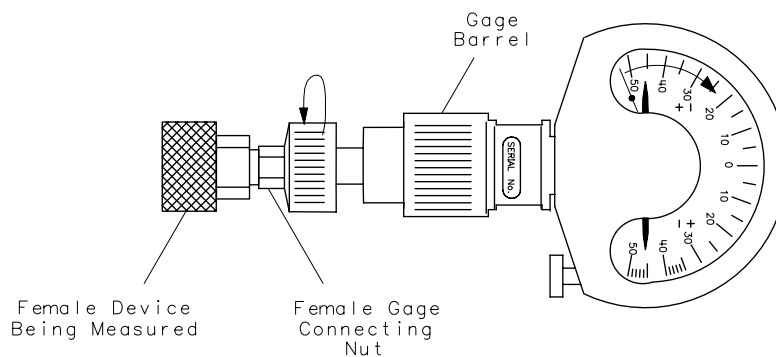
Zero the Connector Gage

- Screw the female gage connecting nut onto the female 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

- Screw the female gage connecting nut onto the female device.
- Torque the connecting nut.
- Gently tap the gage barrel to settle the reading.
- Read recession or protrusion from the gage.
- Remove the device.



wj616d

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 [“Visual Inspection” on page 3-3](#).
3. If necessary, clean the connectors. Refer to [“Cleaning Connectors” on page 3-4](#).
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 3-6](#).
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.

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

1. 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 not included in the calibration kit. Refer to [Chapter 6 , “Replaceable Parts,”](#) for part number and ordering information.

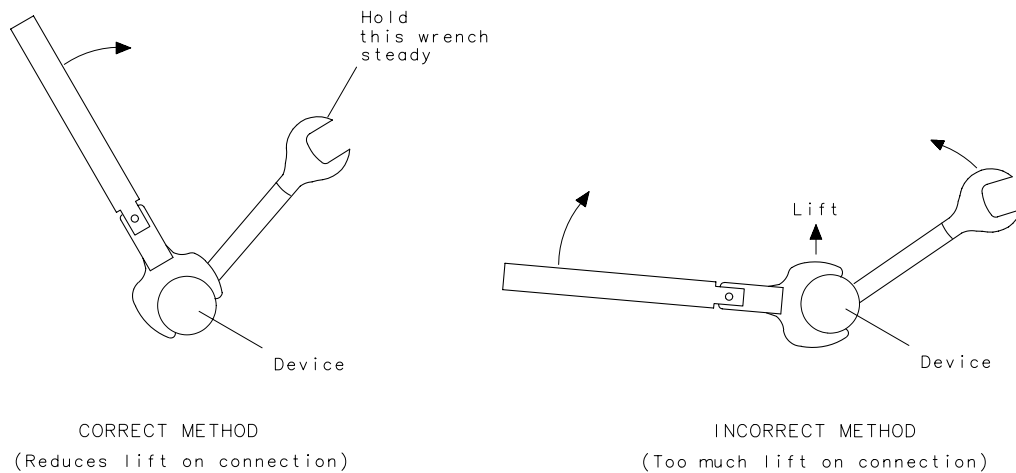
Table 3-1 Torque Wrench Information

Connector Type	Torque Setting	Torque Tolerance
3.5 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.

2. 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). In all situations, however, it is recommended that you use an open-end wrench to keep the body of the device from turning. Refer to [Chapter 6](#) for part number and ordering information.
3. 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.

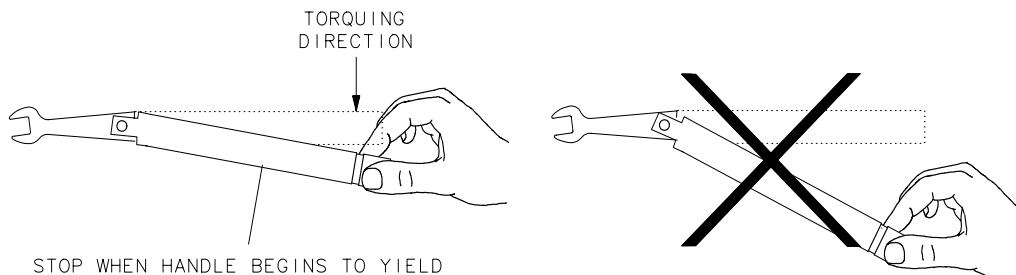
Figure 3-4 Wrench Positions



wj56f

4. Hold the torque wrench lightly, at the end of the handle only (beyond the groove). See [Figure 3-5](#).

Figure 3-5 Using the Torque Wrench



wj68d

5. Apply force downward on 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.

6. Tighten the connection just to the torque wrench break point. The wrench handle gives way at its internal pivot point. See [Figure 3-5](#). 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.

Do not pivot the wrench handle on your thumb or other fingers, otherwise you apply an unknown amount of torque to the connection when the wrench reaches its break point.

Do not twist the head of the wrench relative to the outer conductor mating plane. If you do, you apply more than the recommended 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 connector nut.
3. Complete the separation by hand, turning only the connector 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

Introduction

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 NIST (National Institute of Standards and Technology). 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. See [Table 5-1 on page 5-3](#).

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. Refer to contact information in [Table 5-1 on page 5-3](#).

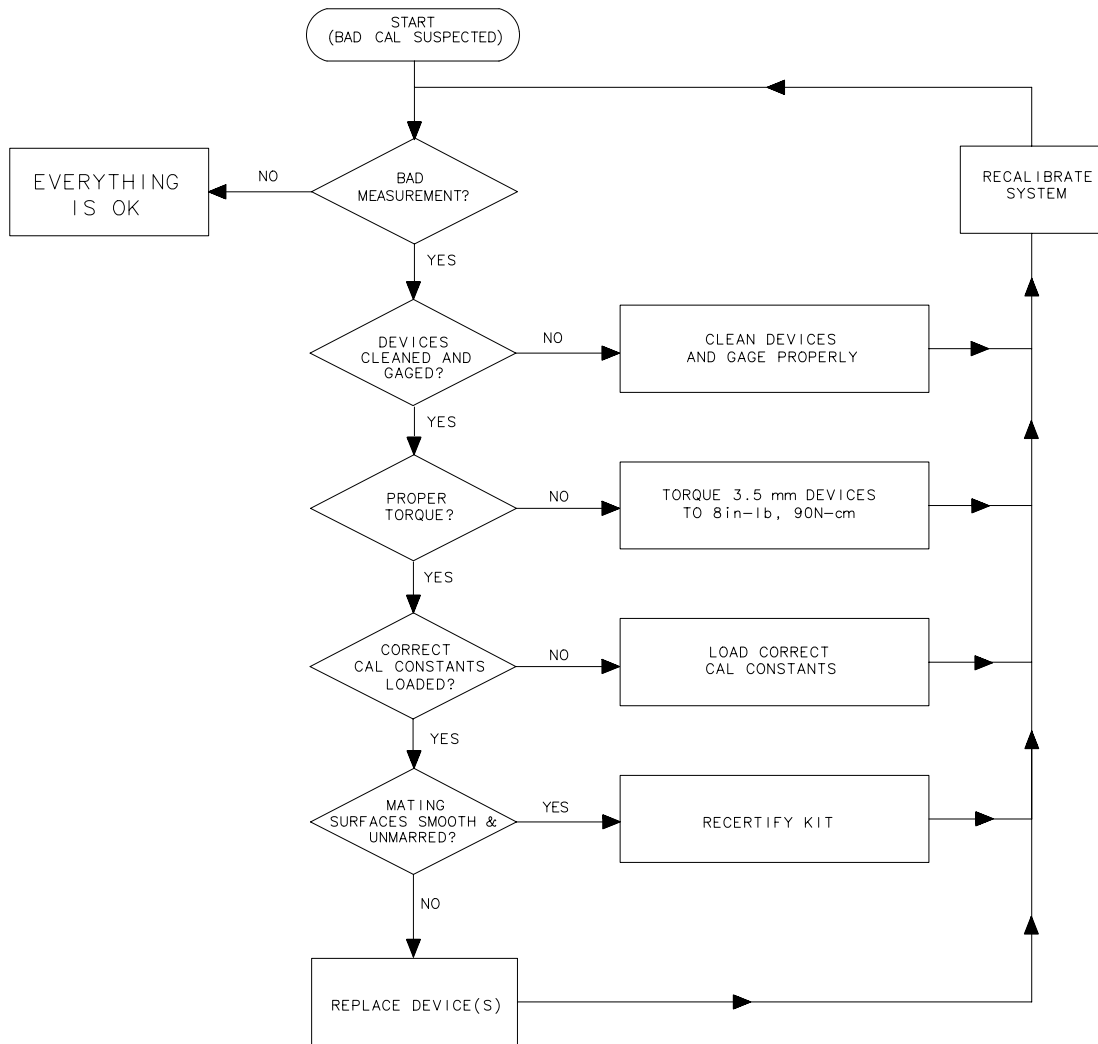
When you return the kit, complete and attach a service tag. Refer to [“Returning a Kit or Device to Agilent” on page 5-3](#) for details.

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



wj69d

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 [Figure 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 Contacting Agilent

Online assistance: www.agilent.com/find/assist

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

6 Replaceable Parts

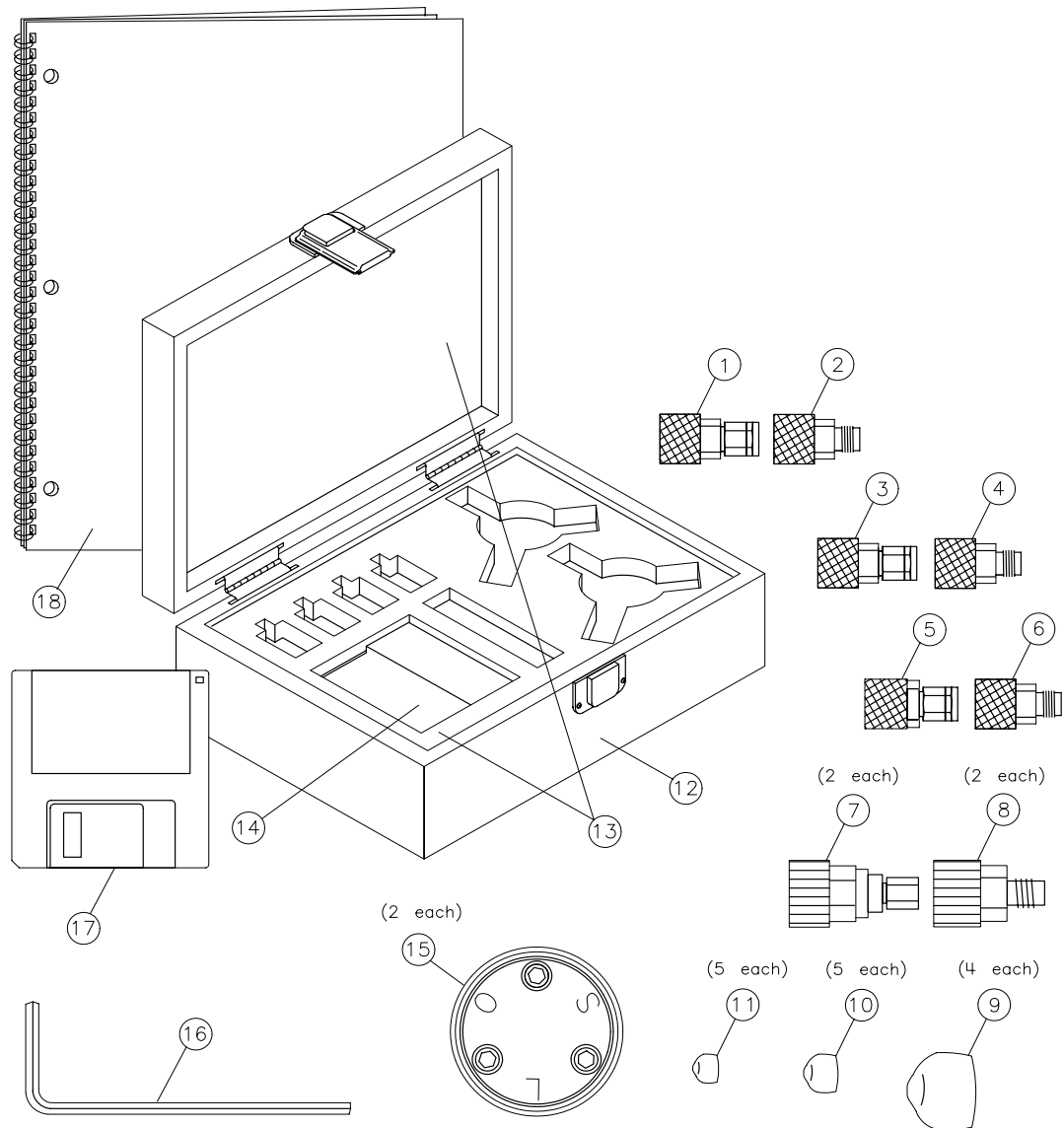
Introduction

Table 6-1 lists the replacement part numbers for items included in the 85033D 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 Agilent Technologies. For contact information, see Table 5-1 on page 5-3.

Figure 6-1 Replaceable Parts for the 85033D Calibration Kit



wj614d

Table 6-1 Replaceable Parts for the 85033D Calibration Kit

Item No.	Description	Qty per kit	Agilent Part Number
Calibration Devices (3.5 mm)^a			
1	Male broadband load	1	85033-60009
2	Female broadband load	1	85033-60010
3	Male offset open	1	85033-60011
4	Female offset open	1	85033-60012
5	Male offset short	1	85033-60013
6	Female offset short	1	85033-60014
Adapters (included with Option 100)^a			
7	7-mm to 3.5-mm-male	2	1250-1746
8	7-mm to 3.5-mm-female	2	1250-1747
Adapters (Option 200 only)^a			
	Type-N-male to 3.5-mm-male	1	1250-1743
	Type-N-male to 3.5-mm-female	1	1250-1744
	Type-N-female to 3.5-mm-male	1	1250-1750
	Type-N-female to 3.5-mm-female	1	1250-1745
Protective End Caps for Connectors^a			
9	For 7-mm connectors	as required	1401-0214
10	For 3.5-mm-male connectors	as required	1401-0208
11	For 3.5-mm-female connectors	as required	1401-0202
Calibration Kit Storage Case			
12	Box (without foam pads)	1	85033-80015
13	Box pads, top and bottom	1	85033-80016
14	Disk holder	1	5180-8491
Miscellaneous Items			
15	Open-short-load holder	2	85033-40001
16	2.5 mm hex key	1	8710-1181
17	Calibration definitions disk	1	85033-10010
18	User's and Service guide	1	85033-90027

a. See "Clarifying the Sex of a Connector" on page 1-5.

Table 6-2 Replaceable Parts—Items Not Included in the Calibration Kit

Item No.	Description	Qty	Agilent Part Number
Connector Gages (3.5 mm)^a			
1	Gage Set (for male connectors)	1	85052-60043
2	Gage Set (for female connectors)	1	85052-60042
Wrenches			
3	5/16 in 90 N-cm (8 in-lb) torque wrench	1	8710-1765
4	5/16 in open-end wrench	1	8720-0015
Slotless Connector Repair Kit			
5	3.5 mm slotless connector contact repair kit	1	85052-60049
ESD Protective Devices			
6	Grounding wrist strap	1	9300-1367
7	5 ft grounding cord for wrist strap	1	9300-0980
8	2 ft by 4 ft conductive table mat with 15 ft grounding wire	1	9300-0797
9	ESD heel strap	1	9300-1308
Connector Cleaning Supplies			
10	Isopropyl alcohol	30 ml	8500-5344
11	Foam-tipped cleaning swabs	100	9301-1243

a. See [“Clarifying the Sex of a Connector” on page 1-5.](#)

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](#) lists the classes of the devices in the calibration kit. This information resides on the calibration definitions disk included in the kit.

Table A-1 Standard Class Assignments

Disk File Name for 8752A/B: A5235D		Calibration Kit Label: 3.5 mmD						
Disk File Name for 8753B/C: C5335D								
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							Loads
S ₂₂ A	2							Open
S ₂₂ B	1							Short
S ₂₂ C	3							Loads
Forward transmission	4							Thru
Reverse transmission	4							Thru
Forward match	4							Thru
Reverse match	4							Thru
Response	1	2	4					Response
Response and isolation	1	2	4					Response

Blank Form

The standard class assignments listed in [Table A-1](#) may be changed to meet your specific requirements. [Table A-2](#) is provided to record the modified standard class assignments.

Table A-2 Standard Class Assignments Blank Form

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 and isolation								

Nominal Standard Definitions

Standard definitions provide the definitions needed to mathematically model the electrical characteristics (delay, attenuation, and impedance) of each calibration standard. The nominal values of these definitions 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-3](#) and [Table A-4](#) 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 definitions.

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-3 Standard Definitions for 8753 and 872x Series Network Analyzers

Standard ^b							Offset			Frequency in GHz			
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	Delay in ps	Z ₀ Ω	Loss in GΩ/s	Min	Max	Coax or Waveguide	Standard Label
										System Z ₀ ^a = 50 Ω Disk File Name for 8752A/B: A5235D			
1	Short	0	0	0	0		31.798	50	2.1991	0	999	Coax	Short
2	Open	49.43	-310.13	23.17	-0.16		29.243	50	2.2	0	999	Coax	Open
3	Load					Fixed	0	50	2.2	0	999	Coax	Broad-band
4	Delay/thru						0	50	2.2	0	999	Coax	Thru
5													
6													
7													
8													

- 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.

Table A-4 Standard Definitions for 8510 and PNA Series Network Analyzers

System $Z_0^a = 50 \Omega$														Calibration Kit Label: 3.5 mmD	
Standard ^b		$C0 \times 10^{-15} \text{ F}$	$C1 \times 10^{-27} \text{ F/Hz}$	$C2 \times 10^{-36} \text{ F/Hz}^2$	$C3 \times 10^{-45} \text{ F/Hz}^3$	Fixed or Sliding ^c	Offset			Frequency in GHz		Coax or Waveguide	Standard Label		
Number	Type	$L0 \times 10^{-12} \text{ H}$	$L1 \times 10^{-24} \text{ H/Hz}$	$L2 \times 10^{-33} \text{ H/Hz}^2$	$L3 \times 10^{-42} \text{ H/Hz}^3$		Delay in ps	$Z_0 \Omega$	Loss in GΩ/s	Min	Max				
1	Short ^d	2.0765	-108.54	2.1705	-0.01		31.808	50	2.36	0	999	Coax	Short		
2	Open	49.43	-310.13	23.17	-0.16		29.243	50	2.2	0	999	Coax	Open		
3	Load					Fixed	0	50	2.2	0	999	Coax	Broad-band		
4	Delay/thru						0	50	2.2	0	999	Coax	Thru		
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. L terms apply to PNA and ENA series network analyzers.

Blank Forms

The standard definitions listed in [Table A-3](#) and [Table A-4](#) may be changed to meet your specific requirements. [Table A-5](#) and [Table A-6](#) are provided to record the modified standard definitions.

Table A-5 Standard Definitions Blank Form for 8753 and 872x Series Network Analyzers

System Z_0 ^a = _____		Calibration Kit Label: 											
Disk File Name: _____		Disk File Name: _____											
Standard ^b		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		Coax or Waveguide	Standard Label
Number	Type						Delay in ps	Z_0 Ω	Loss in GΩ/s	Min	Max		
1	Short												
2	Open												
3	Load												
4	Delay/ thru												
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.

Table A-6 Standard Definitions Blank Form for 8510 and PNA Series Network Analyzers

System $Z_0^a =$ _____							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 or Sliding ^c	Offset			Frequency in GHz		Coax or Waveguide	Standard Label
Number	Type	$L0 \times 10^{-12}$ F	$L1 \times 10^{-24}$ F/Hz	$L2 \times 10^{-33}$ F/Hz ²	$L3 \times 10^{-42}$ SE/Hz ³		Delay in ps	$Z_0 \Omega$	Loss in GΩ/s	Min	Max		
1	Short ^d												
2	Open												
3	Load												
4	Delay/ thru												
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. L terms apply to PNA and ENA series network analyzers.

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