User's and Service Guide

Agilent Technologies 85032B/E
50Ω Type-N Calibration Kits

Agilent Technologies

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Documentation Warranty

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Assistance

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

For any assistance, contact Agilent Technologies. Refer to page 5-3.

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1 General Information

Calibration Kit Overview

The Agilent 85032B and 85032E type-N calibration kits are used to calibrate Agilent network analyzers up to 6 GHz for measurements of components with 50Ω type-N connectors.

Kit Contents

The 85032B calibration kit contains the following:

- one male and one female open termination
- one male and one female short termination
- one male and one female 50Ω load
- two type-N-male to 7-mm adapters (included with Option 100)
- two type-N-female to 7-mm adapters (included with Option 100)

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

The 85032E calibration kit contains the following:

- one male combination open/short termination
- one male 50Ω load

Refer to Table 6-2 and Figure 6-2 for a complete list of kit contents and their associated part numbers.

Broadband Loads

The broadband loads are instrument-grade, 50Ω 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.

Opens and Shorts

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

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

The female open has a separate-piece inner conductor that is made from a 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. Some of the opens and shorts have offsets. The lengths of these offsets 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.

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:

- resident within the analyzer
- 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 Agilent 85032B/E.

Option 100 (85032B only) Option 100 adds the four type-N to 7-mm adapters to the calibration kit.

Option 003 (85032B only) This option provides a limited calibration for the devices in the calibration kit to 3 GHz instead of 6 GHz. This calibration option can be requested *only* from an Agilent service center. It cannot be ordered from the factory.

Option UK6 This option adds a certificate of calibration and the corresponding calibration data for the devices in the calibration kit.

Equipment Required but Not Supplied

Gages, torque and open-end wrenches, and various connector cleaning supplies are *not* included in the calibration kit but are required to ensure successful operation of the calibration kit. Refer to Table 6-3 on page 6-5 for ordering information

Incoming Inspection

Verify that the shipment is complete by referring to Figure 6-1 or Figure 6-2.

Check for damage. The foam-lined storage case provides protection during shipping.

If the case or any device appears damaged, or if the shipment is incomplete, contact Agilent. 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 this kit are individually serialized (serial numbers are labeled onto the body of each device). Record these serial numbers in Table 1-1 for the 85032B and Table 1-2 for the 85032E. Recording the serial numbers will prevent confusing the devices in this kit with similar devices in other kits.

Table 1-1 Serial Number Record for 85032B

Device	Serial Number
Calibration kit	______________________
Male broadband load	______________________
Female broadband load	______________________
Male open	______________________
Female open	______________________
Male short	______________________
Female short	______________________
Type-N-male to 7-mm adapter	______________________
Type-N-male to 7-mm adapter	______________________
Type-N-female to 7-mm adapter	______________________
Type-N-female to 7-mm adapter	______________________

Table 1-2 Serial Number Record for 85032E

Device	Serial Number
Calibration kit	______________________
Male broadband load	______________________
Male combination open/short	______________________

Clarifying the Sex of a Connector

In this manual, the sex of 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 type-N 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 this kit include:

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

All of the above 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 connections, 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 specified 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 this kit with special gaging processes and electrical testing. This ensures that the device connectors do not exhibit any 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.)

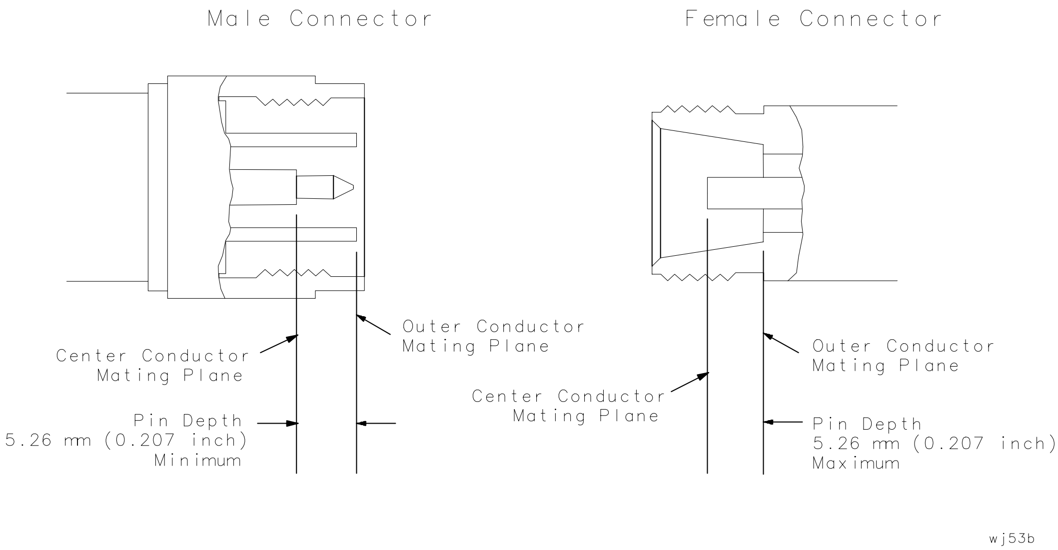
Pin Depth

Pin depth is the distance the center conductor mating plane differs from being flush with the outer conductor mating plane. Refer to Figure 2-1. Some coaxial connectors, such as 2.4 mm and 3.5 mm, are designed to have these planes nearly flush. Type-N connectors, however, are designed with a pin depth offset of approximately 5.26 mm (0.207 inch), not permitting these planes to be flush. The male center conductors are recessed by the offset value while the female center conductors compensate by protruding the same amount. This offset necessitates the redefining of pin depth with regard to protrusion and recession.

Protrusion refers to a male type-N connector center conductor having a pin depth value less than 5.26 mm (0.207 inch), or a female type-N connector center conductor having a pin depth value greater than 5.26 mm (0.207 inch).

Recession refers to a male type-N connector center conductor having a pin depth value greater than 5.26 mm (0.207 in), or a female type-N connector center conductor having a pin depth value less than 5.26 mm (0.207 inch).

Figure 2-1 Connector Pin Depth



NOTE The gages for measuring type-N connectors compensate for the designed offset of 5.26 mm (0.207 inch), therefore, protrusion and recession readings are in relation to a *zero* reference plane (as if the inner and outer conductor planes were intended to be flush). Gage readings can be directly compared with the *observed* values listed in Table 2-2.

The pin depth value of each calibration device in this 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 this 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 an illustration of pin depth in type-N connectors.

Table 2-2 Pin Depth Limit

Device	Typical Pin Depth	Measurement Uncertainty[a]	Observed Pin Depth Limits[b]
Opens	0 to –0.0127 mm 0 to –0.0005 in	+0.0038 to –0.0038 mm +0.00015 to –0.00015 in	+0.0038 to –0.0165 mm +0.00015 to –0.00065 in
Shorts	0 to –0.0127 mm 0 to –0.0005 in	+0.0038 to –0.0038 mm +0.00015 to –0.00015 in	+0.0038 to –0.0165 mm +0.00015 to –0.00065 in
Fixed Loads	0 to –0.0508 mm 0 to –0.0020 in	+0.0038 to –0.0038 mm +0.00015 to –0.00015 in	+0.0038 to –0.0546 mm +0.00015 to –0.00215 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 50Ω Type-N Devices

Device	Specification	Frequency (GHz)
Loads	Return loss ≥ 49 dB (ρ ≤ 0.00355)	DC to ≤ 2
	Return loss ≥ 46 dB (ρ ≤ 0.00501)	> 2 to ≤ 3
	Return loss ≥ 40 dB (ρ ≤ 0.01000)	> 3 to ≤ 6
Female open[a]	±0.501 ° ±0.484 °/GHz deviation from nominal	DC to ≤ 6
Female short[a]	±0.490 ° ±0.385 °/GHz deviation from nominal	DC to ≤ 6
Male open[a]	±0.501 ° ±0.234 °/GHz deviation from nominal	DC to ≤ 6
Male short[a]	±0.441 ° ±0.444 °/GHz deviation from nominal	DC to ≤ 6
Adapters (type-N to 7-mm)	Return loss ≥ 30 dB (ρ ≤ 0.03162)	DC 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 on page A-5.

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 This Kit" on page 4-2 for more information.

Supplemental Electrical Characteristics

Supplemental electrical characteristics are values which are typically met by a majority of the calibration kit devices tested. These supplemental characteristics are intended to provide information in calibration kit applications by giving typical, but non-warranted, performance parameters. Table 2-4 lists the typical electrical characteristics of the 50Ω loads and adapters in the 85032B/E calibration kit.

Table 2-4 Supplemental Electrical Characteristics

Device	Specification	Frequency (GHz)
Loads	Return loss ≥ 23 dB (ρ ≤ 0.07079)	> 6 to ≤ 18
Adapters (type-N to 7-mm)	Return loss ≥ 34 dB (ρ ≤ 0.01995)	DC to ≤ 8
	Return loss ≥ 28 dB (ρ ≤ 0.03981)	> 8 to ≤ 18

3 Use, Maintenance, and Care of the Devices

Electrostatic Discharge

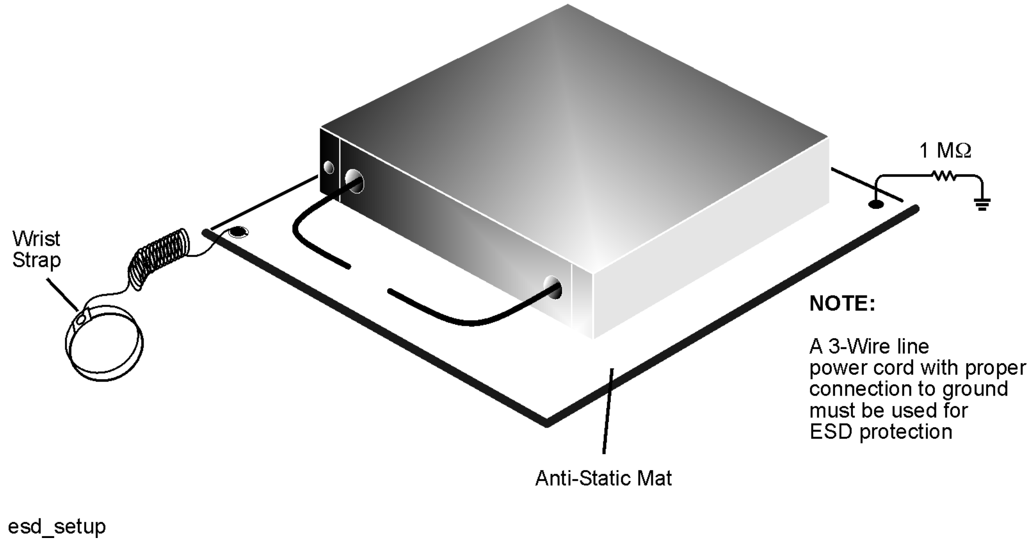
Protection against ESD (electrostatic discharge) is essential while connecting, inspecting, or cleaning connectors attached to a static-sensitive circuit (such as those found in test sets).

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 MΩ 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 on a connector; a magnifying device with a magnification of ≥10× 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 negatively affect electrical performance and must be replaced.

NOTE Inspection 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.

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 6-3 on page 6-5 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 6-3 on page 6-5 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 this 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 on page 2-4 to evaluate the condition of device connectors.

When to Gage Connectors

Gage a connector at the following times:

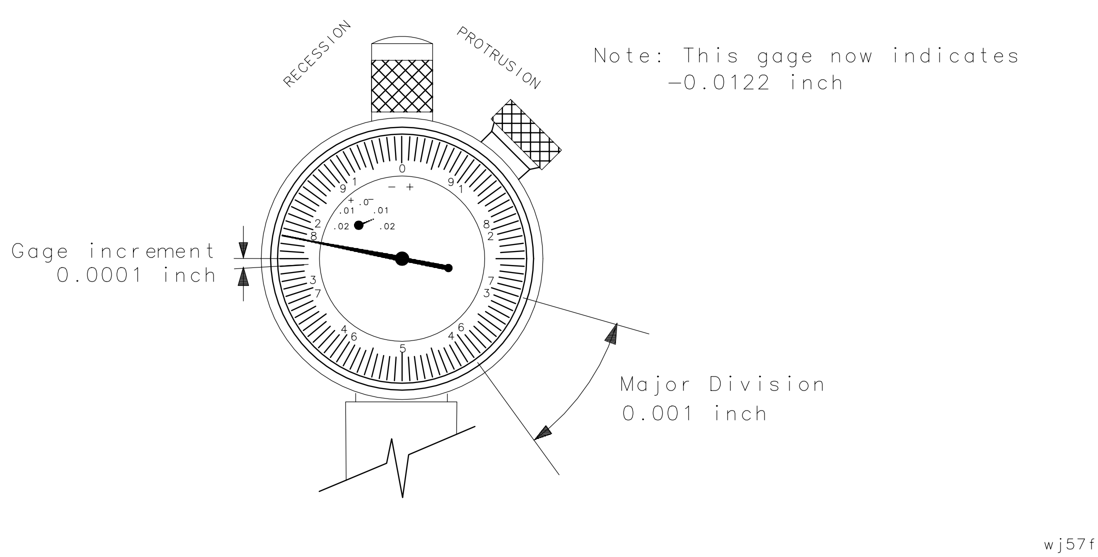
- Prior to using a device for the first time: record the pin depth measurement so that it can be compared with future readings. (It will serve as a good troubleshooting tool when you suspect damage may have occurred to the device.)
- If either visual inspection or electrical performance suggests that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

Reading the Connector Gage

The gage dial is divided into increments of 0.0001 inch and major divisions of 0.001 inch (see Figure 3-2). For each revolution of the large dial, the smaller dial indicates a change of 0.01 inch. Use the small dial as the indicator of multiples of 0.01 inch. In most connector measuring applications, this value will be zero.

When making a measurement, the gage dial indicator will travel in one of two directions. If the center conductor is recessed from the *zero* reference plane, the indicator will move counterclockwise to indicate the amount of **recession**, which is read as a negative value. If the center conductor protrudes, the indicator will move clockwise to indicate the amount of **protrusion**, which is read as a positive value. Refer to "Pin Depth" on page 2-3 for definitions of protrusion and recession.

Figure 3-2 Reading the Connector Gage



Gaging Procedures

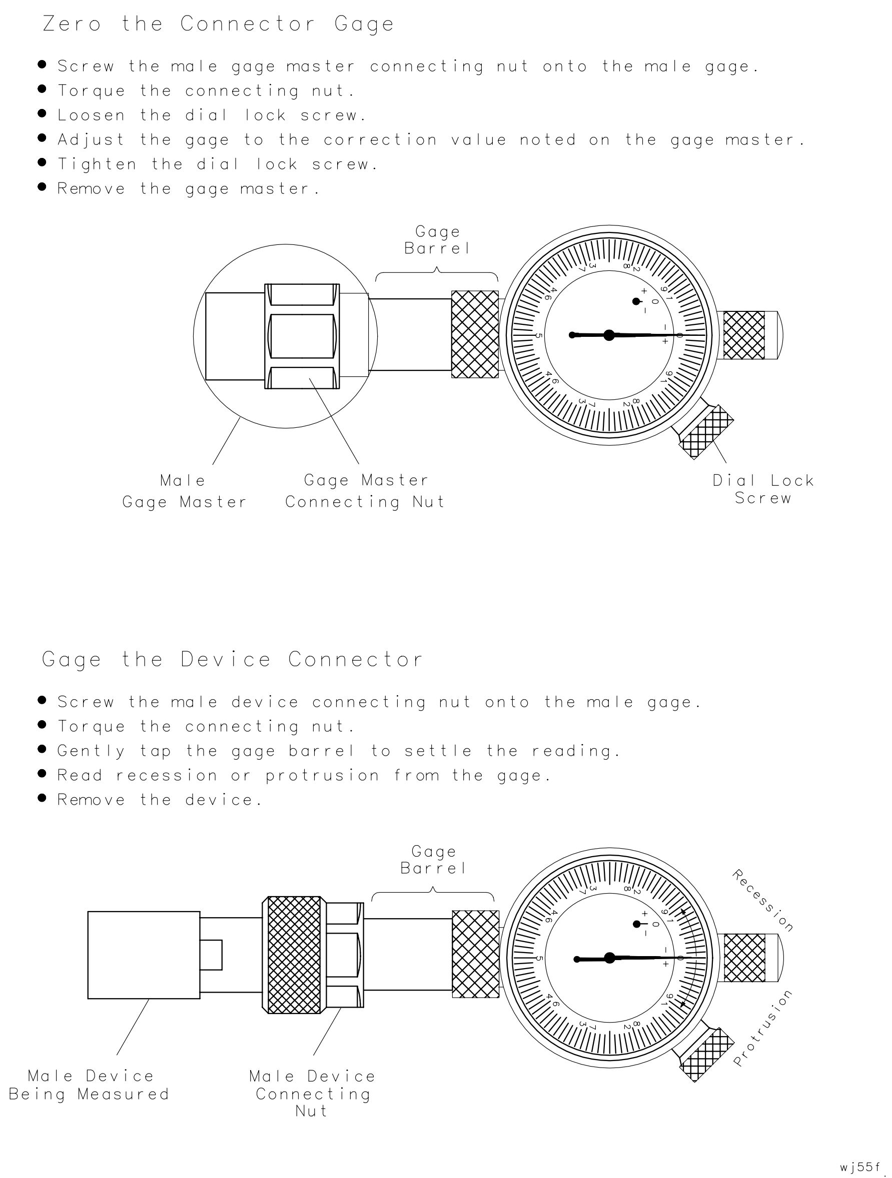
Gaging Male Type-N Connectors

NOTE Always hold a connector gage by the gage barrel, below the dial indicator. This gives the best stability, and improves measurement accuracy.

1. Select the proper gage for your connector. (Refer to Table 6-3 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 gage master, screw the 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 this kit to tighten the connecting nut to 135 N-cm (12 in-lb). Refer to "Connections" on page 3-12 for more information.
   c. Loosen the dial lock screw on the gage and rotate the gage dial so that the pointer corresponds to the correction value noted on the gage master. Do not adjust the gage dial to zero, unless the correction value on the gage master is zero.
   d. Tighten the dial lock screw and remove the gage master.
   e. Attach and torque the gage master to the gage once again to verify that the setting is repeatable. 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 connecting nut of the device being measured onto the gage, just until you meet resistance. Connect the nut finger-tight. Do not overtighten.
   b. Use the torque wrench recommended for use with this kit to tighten the connecting nut to 135 N-cm (12 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. If the needle has moved clockwise, the center conductor is *protruding* by an amount indicated by the *black* numbers. If the needle has moved counterclockwise, the center conductor is *recessed* by an amount indicated by the *red* numbers.

      For maximum accuracy, measure the connector a minimum of three times and take an average of the readings. After each measurement, rotate the gage a quarter-turn to reduce measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.
   e. Compare the average reading with the observed pin depth limits in Table 2-2 on page 2-4.

Figure 3-3 Gaging Male Type-N Connectors



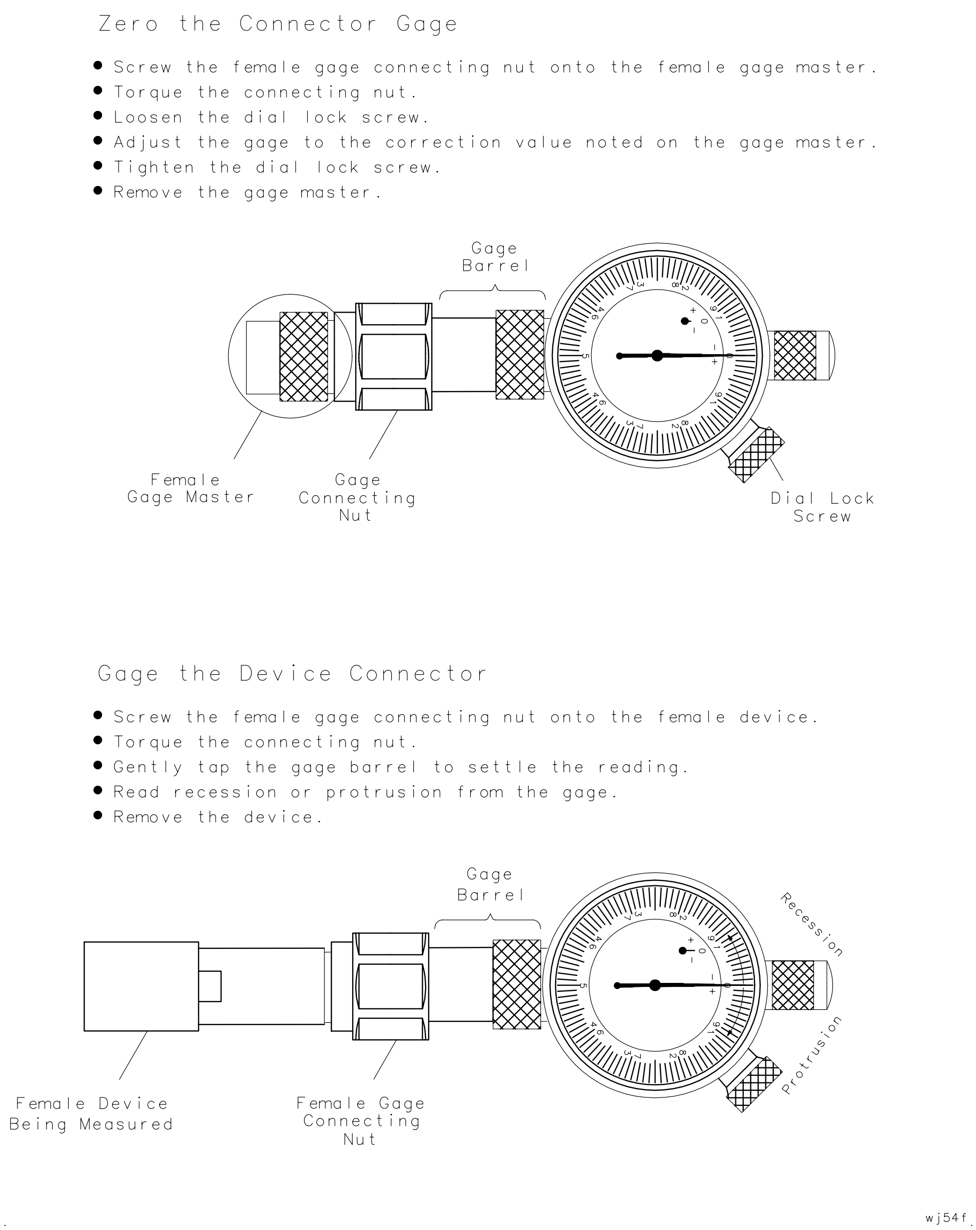
Gaging Female Type-N Connectors

NOTE Always hold a connector gage by the gage barrel, below the dial indicator. This gives the best stability, and improves measurement accuracy.

1. Select the proper gage for your connector. (Refer to Table 6-3 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 3-4):
   a. While holding the gage by the barrel, and without turning the gage or the gage master, screw the 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 this kit to tighten the connecting nut to 135 N-cm (12 in-lb). Refer to "Connections" on page 3-12 for more information.
   c. Loosen the dial lock screw on the gage and rotate the gage dial so that the pointer corresponds to the correction value noted on the gage master. Do not adjust the gage dial to zero, unless the correction value on the gage master is zero.
   d. Tighten the dial lock screw and remove the gage master.
   e. Attach and torque the gage master to the gage once again to verify that the setting is repeatable. Remove the gage master.
4. Gage the device connector (refer to Figure 3-4):
   a. While holding the gage by the barrel, and without turning the gage or the device, screw the gage connecting nut onto the 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 this kit to tighten the connecting nut to 135 N-cm (12 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. If the needle has moved clockwise, the center conductor is *protruding* by an amount indicated by the *black* numbers. If the needle has moved counterclockwise, the center conductor is *recessed* by an amount indicated by the *red* numbers.

      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 3-4 Gaging Female Type-N Connectors



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 this calibration kit. A torque wrench is *not* included in the calibration kit. Refer to Chapter 6 for part number and ordering information.

Table 3-1 Torque Wrench Information

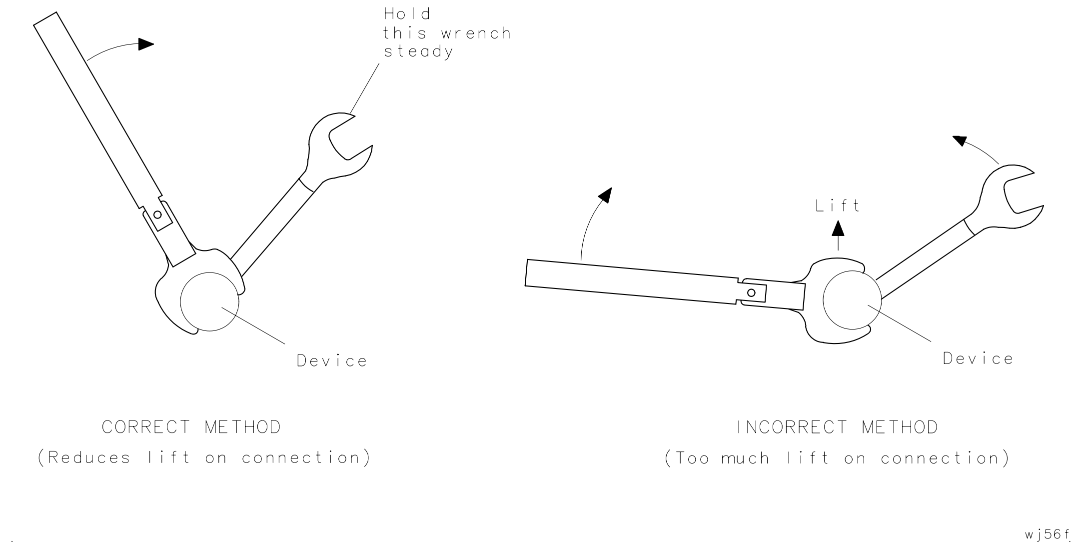
Connector Type	Torque Setting	Torque Tolerance
Type-N	135 N-cm (12 in-lb)	±13.5 N-cm (±1.2 in-lb)

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.

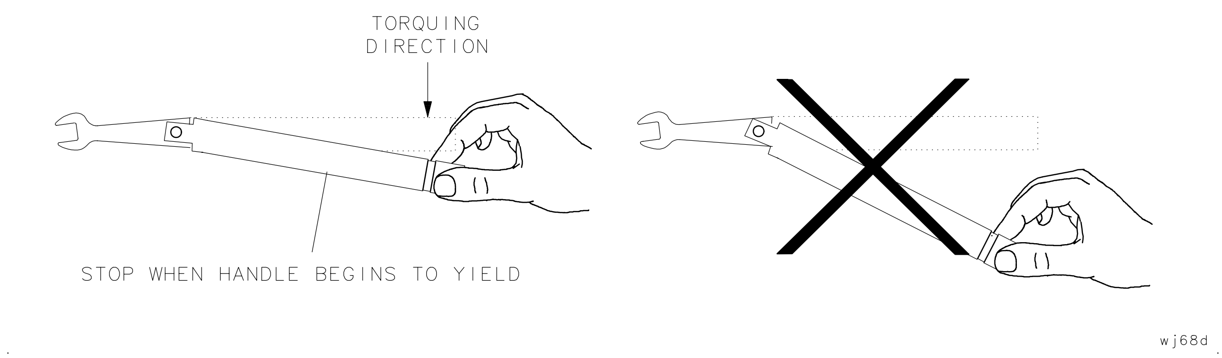
3. Position both wrenches within 90 degrees of each other before applying force. See Figure 3-5. Wrenches opposing each other (greater than 90 degrees apart) will cause a lifting action which can misalign and stress the connections of the devices involved. This is especially true when several devices are connected together.

Figure 3-5 Wrench Positions



4. Hold the torque wrench lightly, at the end of the handle only (beyond the groove). See Figure 3-6.

Figure 3-6 Using the Torque Wrench



5. Apply downward force perpendicular to the wrench handle. See Figure 3-6. 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 3-6. 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.

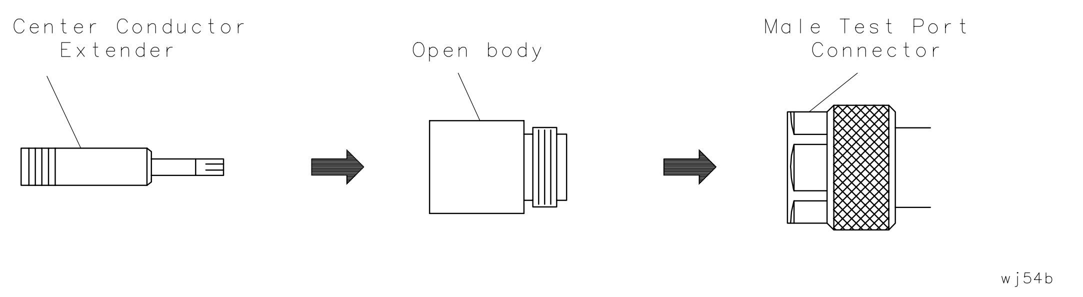
Do not pivot the wrench handle on your thumb or other fingers, otherwise you apply an unknown amount of torque to the connection when the wrench reaches its break point.

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.

Connecting and Disconnecting the Two-Piece Female Open (85032B)

The female open standard in the 85032B calibration kit is composed of two parts: the open body (outer conductor) and the center conductor extender. Refer to Figure 3-7.

Figure 3-7 Connecting the Two-Piece Female Open



To connect the female open:

1. Connect the open body to the male test port.
2. Insert the center conductor extender into the hole at the end of the body and push gently until the center conductors mate.

To disconnect the female open:

1. Remove the center conductor extender by pulling gently outwards without twisting, rocking, or bending the extender or the body.
2. Disconnect the body from the test port.

How to Separate a Connection

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

CAUTION Turn the connector nut, *not* the device body. Major 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, 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 This 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 this 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 this kit. For more information, contact Agilent Technologies. See Table 5-1 on page 5-3.

Limited Recertification (Option 003)

The 50Ω loads in the calibration kit are specified for use up to 6 GHz. For many applications, the performance above 3 GHz is not utilized.

For a standard recertification, the devices in the calibration kit are tested and calibrated up to 6 GHz. However, a limited recertification can be requested. For this limited recertification, the devices are tested and calibrated up to 3 GHz.

To request a limited recertification, make sure the following is clearly written on the order: *Limited Calibration DC–3 GHz (Option 003).*

All loads that receive a limited calibration are supplied with a limited calibration label applied to the device.

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. See Table 5-1 on page 5-3.

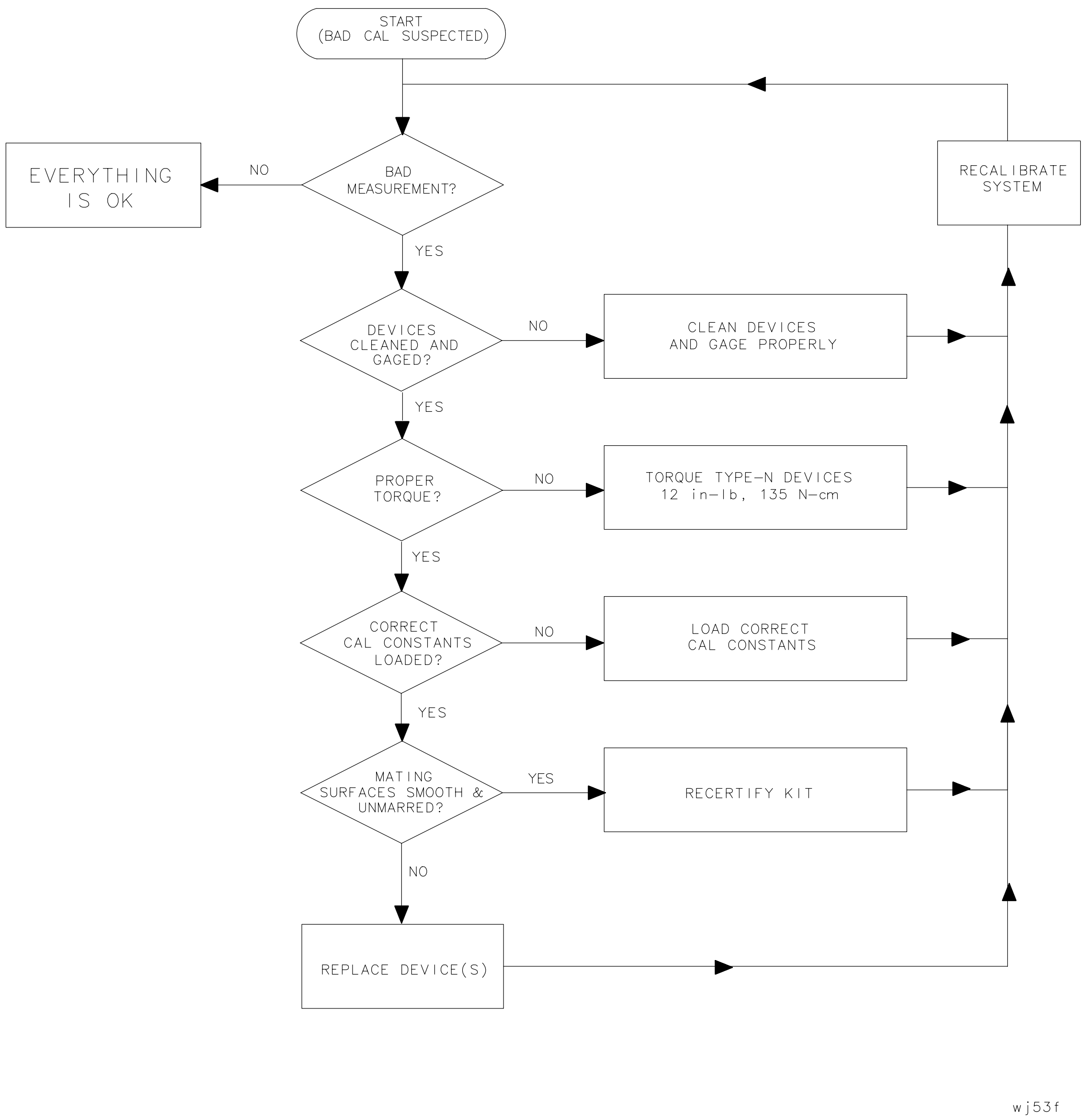
When you return the kit, complete and attach a service tag. Refer to “Returning a Kit or Device to Agilent” on page 5-3 for details.

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



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 Contacting Agilent

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

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

6 Replaceable Parts

Introduction

Table 6-1 lists the replacement part numbers for items included in the 85032B calibration kit and Figure 6-1 illustrates each of these items.

Table 6-2 lists the replacement part numbers for items included in the 85032E calibration kit and Figure 6-2 illustrates each of these items.

Table 6-3 lists the replacement part numbers for items recommended or required for successful operation but not included in the calibration kit.

To order a listed part, note the description, the part number, and the quantity desired. Telephone or send your order to Agilent Technologies. See Table 5-1 on page 5-3.

Table 6-1 Replaceable Parts for the 85032B Calibration Kit

Item No.	Description	Qty Per Kit	Agilent Part Number
Calibration Devices (50Ω Type-N)			
1	Male broadband load	1	00909-60009
2	Female broadband load	1	00909-60010
3	Male short	1	85032-60008
4	Female short	1	85032-60009
5	Male open	1	85032-60007
6	Female open[a]	1	85032-60012
Adapters (included with Option 100)[b]			
7	Type-N-male to 7-mm	2	85054-60009
8	Type-N-female to 7-mm	2	85054-60001
Calibration Kit Storage Case			
9	Box assembly (includes case and foam pad set)	1	85032-60010
10	Case (without foam pad set)[c]	1	85032-80002
11	Foam pad set[c]	1	85032-80003
Protective End Caps for Connectors			
12	Female end cap for type-N	as required	1401-0225
13	Male end cap for type-N and 7 mm	as required	1401-0214
Miscellaneous Items			
15	User's and service guide	1	85032-90020

a. Includes center conductor extender.
b. Refer to "Options" on page 1-3 for description of available options.
c. Included in box assembly.

Figure 6-1 Replaceable Parts for the 85032B Calibration Kit

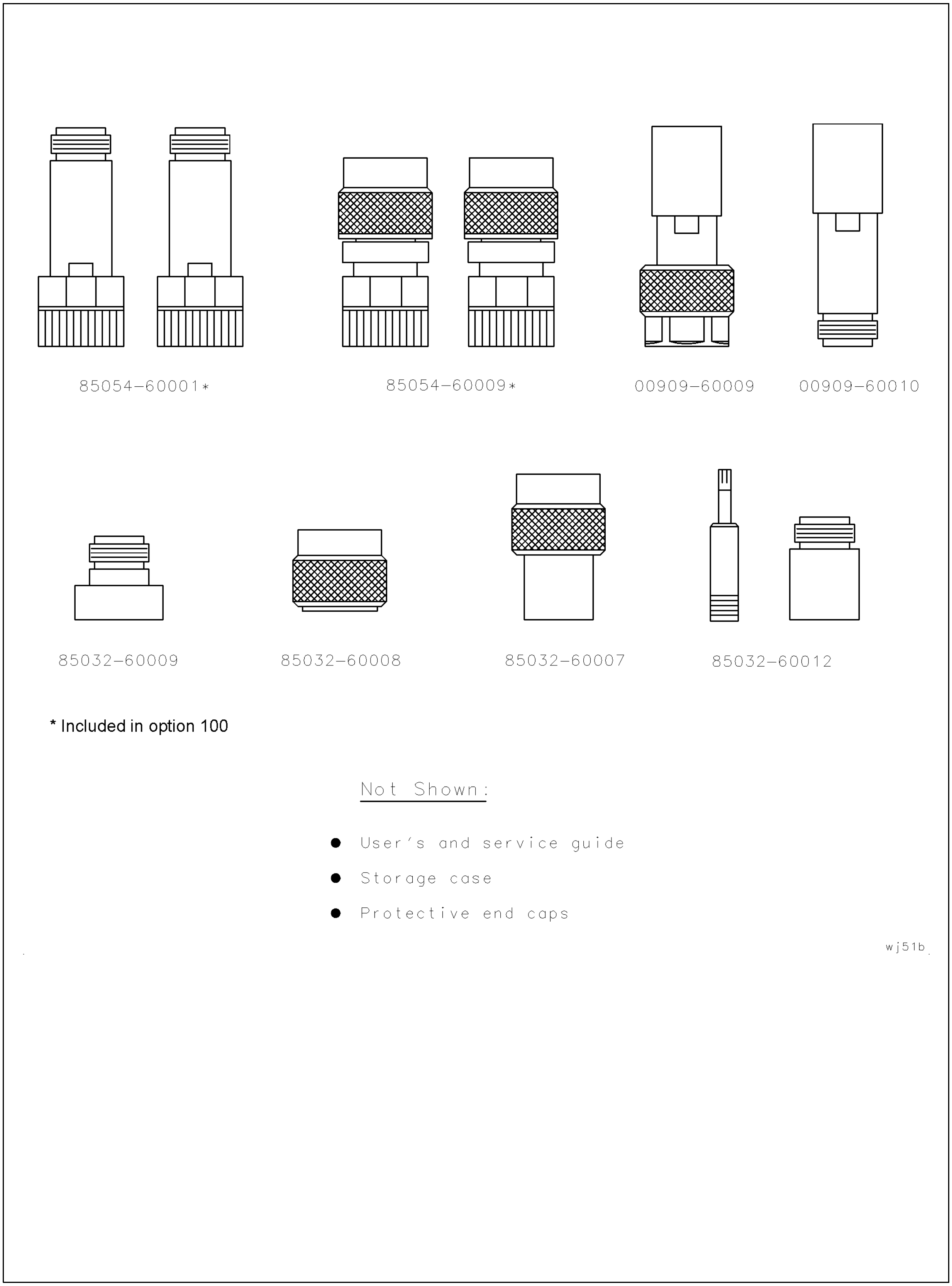


Table 6-2 Replaceable Parts for the 85032E Calibration Kit

Item No.	Description	Qty Per Kit	Agilent Part Number
Calibration Devices (50Ω Type-N)			
1	Male broadband load	1	00909-60009
2	Male combination open/short	1	85032-60011
Calibration Kit Storage Case			
3	Case (without foam pad set)	1	9211-1582
4	Foam pad set	1	85023-80005
5	Kit identification label	1	85032-80014
Protective End Caps for Connectors			
6	Male end cap for type-N and 7 mm	as required	1401-0214
Miscellaneous Items			
7	User's and service guide	1	85032-90020

Figure 6-2 Replaceable Parts for the 85032E Calibration Kit

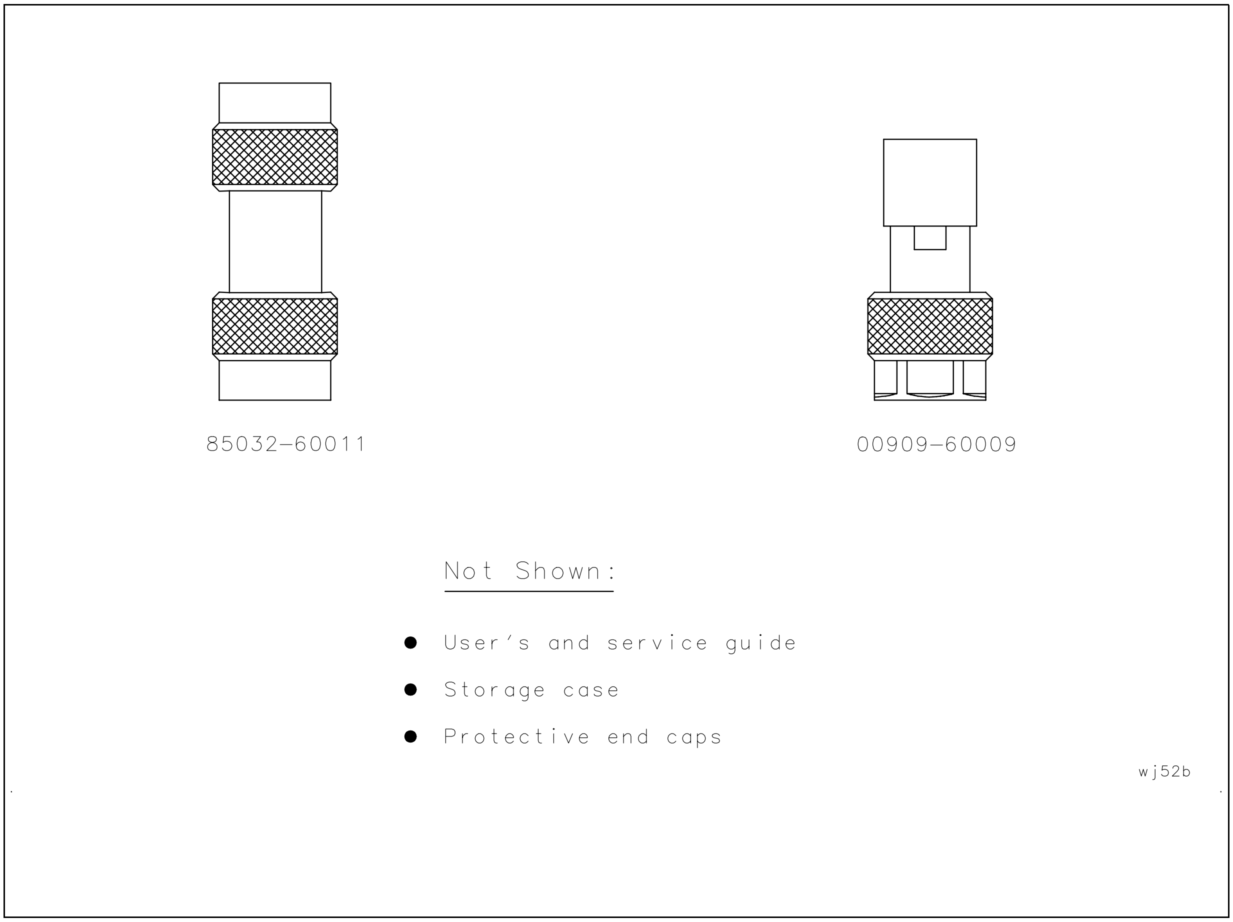


Table 6-3 Replaceable Parts—Items Not Included in the Calibration Kit

Item No.	Description	Qty	Agilent Part Number
Connector Gages[a] (Type-N)			
1	Gage set (includes items listed below)	1	85054-60049
2	Female gage	1	85054-60050
3	Female gage master	1	85054-60052
4	Male gage	1	85054-60051
5	Male gage master	1	85054-60053
6	Centering bead (2 supplied with gage set)	1	85054-80028
Wrenches			
7	3/4 in, 135 N-cm (12 in-lb) torque wrench	1	8710-1766
8	1/2 in and 9/16 in open-end wrench	1	8710-1770
9	3/4 in open-end wrench	1	8720-0011
ESD Protective Devices			
10	Grounding wrist strap	1	9300-1367
11	5 ft grounding cord for wrist strap	1	9300-0980
12	2 ft by 4 ft conductive table mat with 15 ft grounding wire	1	9300-0797
13	ESD heel strap	1	9300-1308
Connector Cleaning Supplies			
14	Isopropyl alcohol	30 ml	8500-5344
15	Foam tipped cleaning swabs	100	9301-1243

a. To ensure you choose the correct gage, refer to, “Clarifying the Sex of a Connector” on page 1-6.

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 this calibration kit.

Table A-1 Standard Class Assignments

Calibration Kit Label: N 50Ω

Class	A	B	C	D	E	F	G	Standard Class Label
S_{11}A	2	8						Opens
S_{11}B	1	7						Shorts
S_{11}C	3							Load
S_{22}A	2	8						Opens
S_{22}B	1	7						Shorts
S_{22}C	3							Load
Forward Transmission	4							Thru
Reverse Transmission	4							Thru
Forward Match	4							Thru
Reverse Match	4							Thru
Response	1	7	2	8	4			Response
Response and Isolation	1	7	2	8	4			Response & Isolation

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

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 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-3 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-3 Standard Definitions

System Z_0[a] = 50 Ω   Calibration Kit Label: N 50Ω

Standard[b] Number	Standard[b] 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 Delay (ps)	Offset Z_0 Ω	Offset Loss (Ω/s)	Freq (GHz) Min	Freq (GHz) Max	Coax or Waveguide	Standard Label[d]
1	Short						0.093	49.992	700M	0	999	Coax	Short (m)
2	Open	119.09	−36.955	26.258	5.5136		0	50	700M	0	999	Coax	Open (m)
3	Load					Fixed	0	50	700M	0	999	Coax	Broad-band
4	Delay/Thru						0	50	700M	0	999	Coax	Thru
5													
6													
7	Short						17.817	50.209	2.1002G	0	999	Coax	Short (f)
8	Open	62.140	−143.07	82.920	0.7600		17.411	50	700M	0	999	Coax	Open (f)

a. Ensure system impedance (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. Standard labels that specify sex, (m) or (f), refer to the sex of the analyzer's test port connector.

Blank Form

The standard definitions listed in Table A-3 may be changed to meet your specific requirements. Table A-4 is provided to record the modified standard definitions.

Table A-4 Standard Definitions Blank Form

System Z_0[a] = _______________ **Calibration Kit Label: ______________________**

Standard[b]							Offset			Freq (GHz)			
Number	Type	$C0 \times 10^{-15}$ 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]	Delay (ps)	Z_0 Ω	Loss (GΩ/s)	Min	Max	Coax or Waveguide	Standard Label[d]
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. Standard labels that specify sex, (m) or (f), refer to the sex of the analyzer's test port connector.

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