

User's and Service Guide

Agilent Technologies 85032F Type-N 50 Ω Calibration Kit



Agilent Part Number: 85032-90021

Printed in USA

Print Date: December 2007

Supersedes: December 2006

© Copyright 2000, 2002, 2004-2007 Agilent Technologies, Inc. All rights reserved.

Documentation Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, AGILENT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. AGILENT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR ANY INFORMATION CONTAINED HEREIN. SHOULD AGILENT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT WILL CONTROL.

DFARS/Restricted Rights Notice

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as "Commercial computer software" as defined in DFAR 252.227-7014 (June 1995), or as a "commercial item" as defined in FAR 2.101(a) or as "Restricted computer software" as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies' standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14 (June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

Printing Copies of Documentation from the Web

To print copies of documentation from the Web, download the PDF file from the Agilent web site:

- Go to www.agilent.com.
- Enter the document's part number (located on the title page) in the **Search** box.
- Click **Search**.
- Click on the hyperlink for the document.
- Click the printer icon located in the tool bar.

Assistance

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

For any assistance, contact Agilent Technologies. Refer to “Contacting Agilent” on page 5-4.

Contents

1 General Information

Calibration Kit Overview	1-2
Kit Contents	1-2
Broadband Loads	1-2
Offset Opens and Shorts	1-2
Calibration Definitions	1-3
Installation of the Calibration Definitions	1-3
Options	1-3
Equipment Required but Not Supplied	1-3
Incoming Inspection	1-4
Recording the Device Serial Numbers	1-4
Clarifying the Terminology of a Connector Interface	1-4
Preventive Maintenance	1-5

2 Specifications

Environmental Requirements	2-2
Temperature—What to Watch Out For	2-2
Mechanical Characteristics	2-3
Pin Depth	2-3
Electrical Specifications	2-5
Certification	2-5

3 Use, Maintenance, and Care of the Devices

Electrostatic Discharge	3-2
Visual Inspection	3-3
Look for Obvious Defects and Damage First	3-3
What Causes Connector Wear?	3-3
Inspect the Mating Plane Surfaces	3-3
Inspect Female Connectors	3-4
Cleaning Connectors	3-5
Gaging Connectors	3-7
Connector Gage Accuracy	3-7
When to Gage Connectors	3-8
Reading the Connector Gage	3-8
Gaging Procedures	3-9
Gaging Type-N Connectors	3-9
Connections	3-11
How to Make a Connection	3-11
Preliminary Connection	3-11
Final Connection Using a Torque Wrench	3-12
How to Separate a Connection	3-13
Handling and Storage	3-14

4 Performance Verification

Introduction	4-2
How Agilent Verifies the Devices in This Kit	4-2
Recertification	4-3
How Often to Recertify	4-3
Where to Send a Kit for Recertification	4-3

Contents

5 Troubleshooting

Troubleshooting Process	5-2
Where to Look for More Information	5-3
Returning a Kit or Device to Agilent	5-3
Contacting Agilent.	5-4

6 Replaceable Parts

Introduction	6-2
------------------------	-----

A Standard Definitions

Class Assignments and Standard Definitions Values are Available on the Web.	A-2
---	-----

1 General Information

Calibration Kit Overview

The Agilent 85032F type-N 50 Ω calibration kit is used to calibrate Agilent network analyzer systems for measurements of components with type-N connectors up to 9 GHz. The standards in this calibration kit allow you to perform simple 1- or 2-port calibrations.

This manual describes the 85032F calibration kit and provides replacement part numbers, specifications, and procedures for using, maintaining and troubleshooting the kit.

NOTE This manual assumes you practice proper connector care. For information, refer to Chapter 3, “Use, Maintenance, and Care of the Devices.” Also refer to the “Connector Care – Quick Reference Card,” located in the back of this manual.

Kit Contents

The 85032F type-N calibration kit contains the following:

- offset opens and shorts, and broadband load terminations with both male and female connectors
- a disk that contains the calibration definitions of the devices in the kit for 872x and 875x VNA systems

Broadband Loads

The broadband loads are metrology-grade, 50 Ω terminations that have been optimized for performance up to 9 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 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.

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
- loaded from the provided disk
- entered from the front panel

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. You can download the most recent class assignments and standard definitions from Agilent's Calibration Kit Definitions Web page at www.na.tm.agilent.com/pna/caldefs/stddefs.html.

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

There are several optional adapters available for the 85032F. See Table 6-1 on page 6-3 for further information.

Equipment Required but Not Supplied

Connector gage sets, optional adapters, wrenches, and various connector cleaning supplies are *not* included with this calibration kit. These or similar items are recommended to ensure the successful operation of this calibration kit. Refer to Table 6-2 on page 6-4 for ordering information.

Incoming Inspection

Refer to Figure 6-1 on page 6-2 to verify a complete shipment.

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 Technologies. See “Contacting Agilent” on page 5-4. Agilent will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company. See “Returning a Kit or Device to Agilent” on page 5-3.

Recording the Device Serial Numbers

In addition to the kit serial number, the devices in this kit are individually serialized (serial numbers are labeled onto the body of each device). For your convenience, the following table is provided for you to record these serial numbers. Recording the serial numbers will prevent you from confusing the devices with similar devices.

Table 1-1 Kit and Device Serial Number Record

Device	Serial Number
Calibration kit	_____
Broadband load –m–	_____
Broadband load –f–	_____
Open –m–	_____
Open –f–	_____
Short –m–	_____
Short –f–	_____

Clarifying the Terminology of a Connector Interface

In this document and in the prompts of the PNA calibration wizard, the gender of cable connectors and adapters is referred to in terms of the center conductor. For example, a connector or device designated as 1.85 mm –f– has a 1.85 mm female center conductor.

8510-series, 872x, and 875x ONLY: In contrast, during a measurement calibration, the network analyzer softkey menus label a 1.85 mm 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) refers to the short that is to be connected to the female test

port. This will be a male short from the calibration kit.

Table 1-2 Clarifying the Sex of Connectors: Examples

Terminology	Meaning
Short –f–	Female short (female center conductor)
Short (f)	Male short (male center conductor) to be connected to female port

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

Preventive Maintenance

The best techniques for maintaining the integrity of the devices in this 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 2-3 on page 2-4), or from poor connection techniques, can also damage these devices.

General Information
Preventive Maintenance

2 Specifications

Environmental Requirements

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

Table 2-1 Environmental Requirements

Parameter	Limits
Temperature	
Operating ^a	+20 °C to +26 °C
Storage	-40 °C to +75 °C
Error-corrected range ^b	± 1 °C of measurement calibration temperature
Altitude	
Operating	< 4,500 meters (≈15,000 feet)
Storage	< 4,500 meters (≈15,000 feet)
Relative humidity	Type tested, 0% to 95% at 40 °C, non-condensing

- 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 this kit with special gaging processes and electrical testing. This ensures that the device connectors do not exhibit any center conductor protrusion or improper pin depth when the kit leaves the factory.

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

Table 2-2 Mechanical Characteristics

Dimension	Typical Value
Inside diameter of outer conductor	7.0000 ±0.0076 mm
Outside diameter of center conductor	3.0404 ±0.0051 mm

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

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 2-3 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 in type-N connectors.

NOTE The gages intended for measuring the type-N connectors compensate for the designed offset of 5.26 mm (0.207 inch). Therefore, protrusion and recession readings will be 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 2-3.

Figure 2-1 Connector Pin Depth

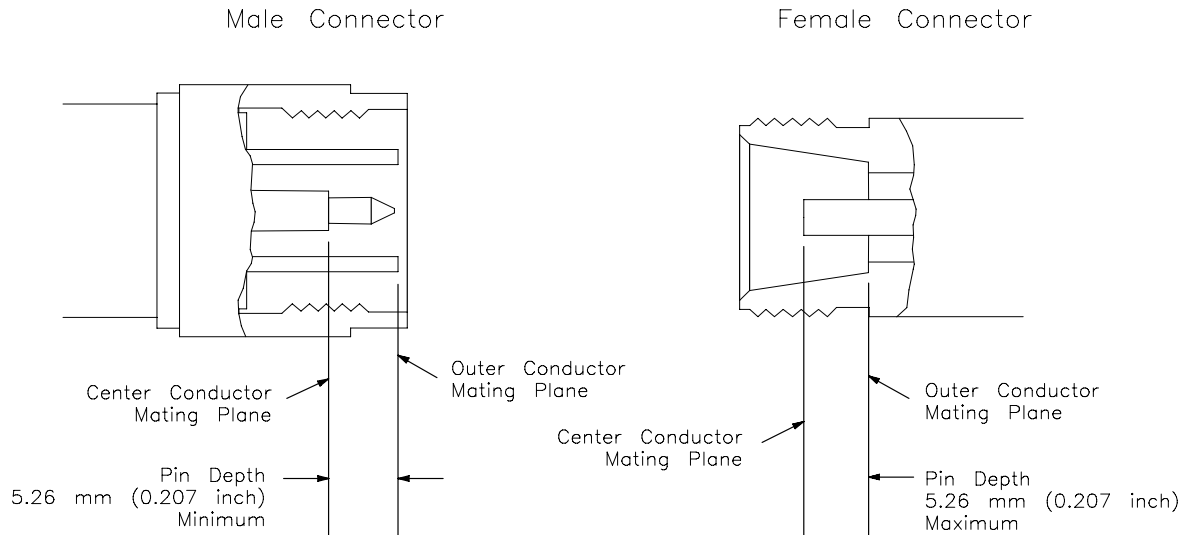


Table 2-3 Pin Depth Limits

Device	Typical Pin Depth	Measurement Uncertainty ^a	Observed Pin Depth Limits
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 -0.002 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 using the 85054-60049 gages kit (same as kit gages) according to recommended procedures.

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 2-3 to evaluate the condition of device connectors.

Electrical Specifications

The electrical specifications in Table 2-4 apply to the devices in your calibration kit when connected with an Agilent precision interface.

Table 2-4 Electrical Specifications

Device	Frequency (GHz)	Parameter	Specification
Broadband Loads (male and female)	DC to ≤ 2	Return Loss	≥ 48 dB ($\leq 0.00398\rho$)
	> 2 to ≤ 3	Return Loss	≥ 45 dB ($\leq 0.00562\rho$)
	> 3 to ≤ 6	Return Loss	≥ 40 dB ($\leq 0.010\rho$)
	> 6 to ≤ 9	Return Loss	≥ 38 dB ($\leq 0.0126\rho$)
Adapters ^a	DC to ≤ 9	Return Loss	≥ 34 dB ($\leq 0.01996\rho$)
Offset Opens ^b (male and female)	DC to ≤ 3	Deviation from Nominal	$\pm 0.65^\circ$
	> 3 to ≤ 9	Phase	$\pm 1.00^\circ$
Offset Shorts ^b (male and female)	DC to ≤ 3	Deviation from Nominal	$\pm 0.65^\circ$
	> 3 to ≤ 9	Phase	$\pm 1.00^\circ$

a. Specifications apply to Options 100, 200, and 300 only.

b. The specifications for the opens and shorts are given as allowed deviation from the nominal model as defined in the standard definitions. Refer to the Appendix, “Class Assignments and Standard Definitions Values are Available on the Web”.

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.

Specifications
Electrical Specifications

3 Use, Maintenance, and Care of the Devices

Electrostatic Discharge

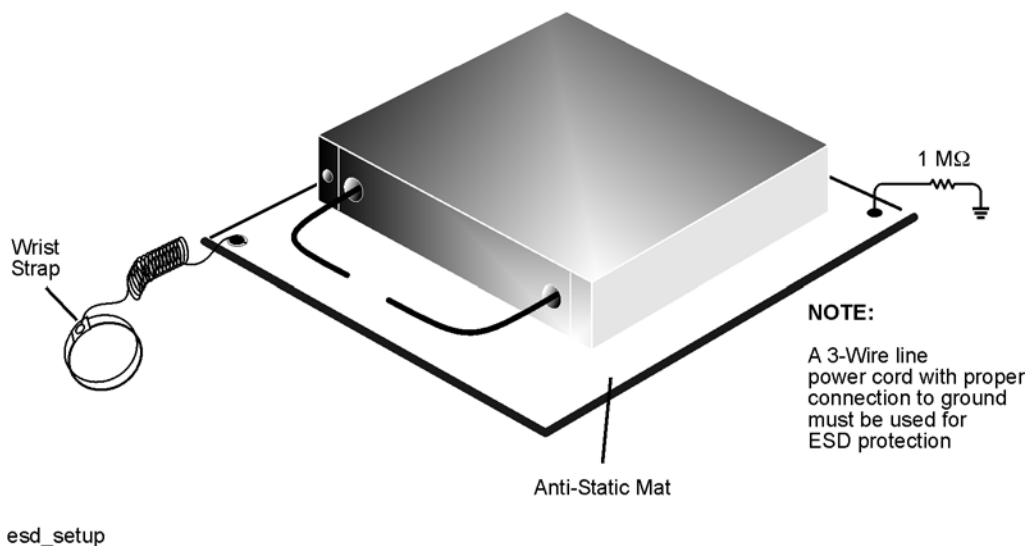
Protection against electrostatic discharge (ESD) is essential while connecting, inspecting, or cleaning connectors attached to a static-sensitive circuit (such as those found in test sets).

Static electricity can build up on your body and can easily damage sensitive internal circuit elements when discharged. Static discharges too small to be felt can cause permanent damage. Devices such as calibration components and devices under test (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* have a grounded antistatic mat in front of your test equipment.
- *always* wear a heel strap when working in an area with a conductive floor.
- *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 ordering ESD protection supplies.

Figure 3-1 ESD Protection Using Mat, Wrist Strap, and Grounded Power Cord



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.

Magnification is helpful when inspecting connectors, but it is not required and may actually be misleading. Defects and damage that cannot be seen without magnification generally have no effect on electrical or mechanical performance. Magnification is of great use in analyzing the nature and cause of damage and in cleaning connectors, but it is not required for inspection.

CAUTION Devices with damaged connectors should immediately be discarded or clearly marked and set aside for repair. A damaged device will in turn damage any good connector to which it is attached. Try to determine the cause of damage before connecting a new, undamaged connector in the same configuration.

In some cases, magnification is necessary to see damage on a connector. 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 the device gets, the faster it wears and degrades. The wear is greatly accelerated when connectors are not kept clean, or are not properly connected.

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.

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 connectors. Replace devices with worn connectors.

Inspect the Mating Plane Surfaces

Even contact between the connectors at all points on their mating plane surfaces is required for a good connection. See Figure 2-1 on page 2-4. Look especially for deep scratches or dents, and for dirt and metal particles on the connector mating plane surfaces.

Visual Inspection

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.

Inspect Female Connectors

When using 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 you are mating nonprecision to precision devices.
-------------	---

Cleaning Connectors

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

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

1. Use 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.

WARNING Keep Isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. Isopropyl alcohol 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 regulation.

Cleaning Connectors

2. Clean the Connector Threads

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 a part number for cleaning swabs.

- a. Apply a small amount of isopropyl alcohol to the 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 new swab.
- b. Clean the center and outer conductor mating plane surfaces. Refer to Figure 2-1 on page 2-4. 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 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.

4. Inspect Each Connector

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 6-2 on page 6-4 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.*

Gages are matched with gage masters at the factory. The paired master is then labeled (on the bottom) with an offset value to compensate for its inaccuracy with its gage. Always set the gage to the master offset value shown on the label and *not* to zero (unless that is the offset value indicated).

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 2-3 on page 2-4 assumes new gages and gage masters. Therefore, these systematic errors were not included in the uncertainty analysis. As the gages endure more use, the systematic errors can become more significant in the accuracy of the measurement.

The measurement uncertainties are primarily a function of the assembly materials and design, and the unique interaction each device type has with the gage. Therefore, these uncertainties can vary among the different devices. For example, note the difference between the uncertainties of the opens and shorts in Table 2-3 on page 2-4.

The *observed* pin depth limits in Table 2-3 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) contains measurement uncertainty and is not necessarily the true value. Always compare the measured value with the observed pin depth limits (which account for measurement uncertainties) 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:

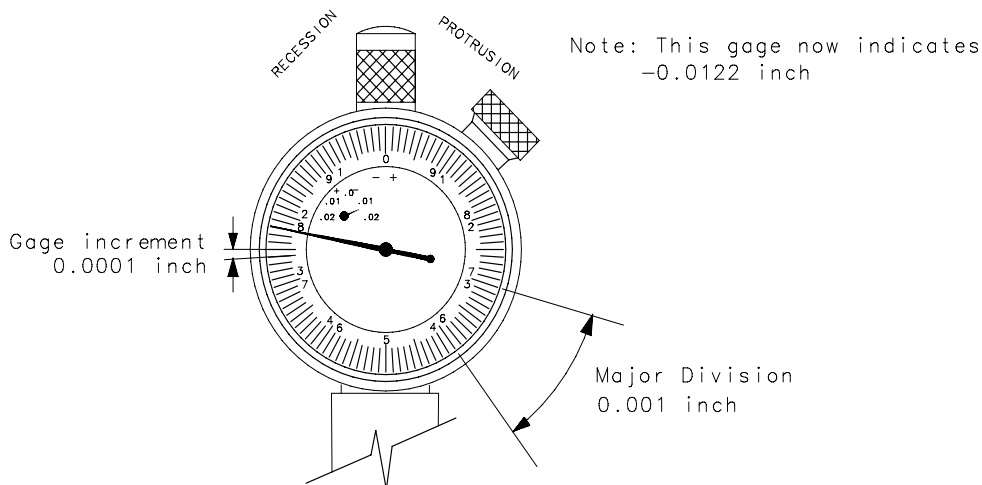
- Prior to using a device for the first time: record the pin depth measurement so that it can be compared with future readings. (It will serve as a good troubleshooting tool when you suspect damage may have occurred to the device.)
- If either visual inspection or electrical performance suggests that 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 suggests.

Reading the Connector Gage

The gage dial is divided up 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 determine the amount of *recession*, which is read as a negative value. If the center conductor protrudes, the indicator will move clockwise to measure the amount of *protrusion*, which is read as a positive value.

Figure 3-2 Reading the Connector Gage



wj57f

Gaging Procedures

Gaging 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 6-2 on page 6-4 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, connect the gage to the gage master by interconnecting the male and female connectors. Connect the nut finger tight. Do not overtighten.
 - b. Using an open-end wrench to keep the device body from rotating, use the torque wrench recommended for use with this kit to tighten the connecting nut to the specified torque. Refer to “Final Connection Using a Torque Wrench” 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, connect the gage to the device by interconnecting the male and female connectors. Connect the nut finger-tight. Do not overtighten.
 - b. Using an open-end wrench to keep the device body from rotating, use the torque wrench recommended for use with this kit to tighten the connecting nut to the specified torque. Refer to “Final Connection Using a Torque Wrench” 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.

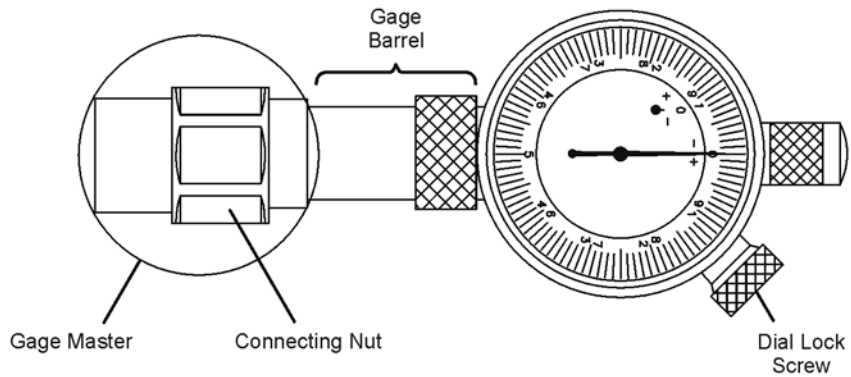
For maximum accuracy, measure the connector a minimum of three times and take an average of the readings. After each measurement, rotate the gage a quarter-turn to reduce measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.
 - e. Compare the average reading with the pin depth specifications listed in Table 2-3 on page 2-4.
 - f. Without turning either the gage or the device, remove the device from the gage.

Figure 3-3 Gaging Type-N Connectors

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

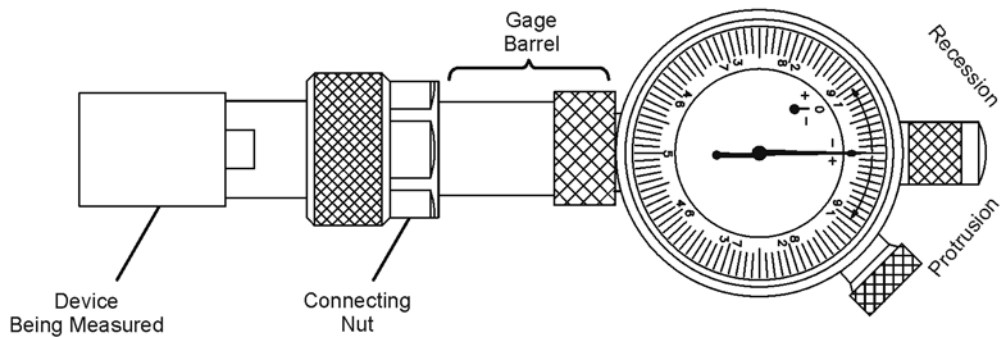
Zero the Connector Gage

- Connect the gage to the gage master.
- Torque the connecting nut.
- Loosen the dial lock screw.
- Adjust the gage to the correction value noted on the gage master.
- Tighten the dial lock screw.
- Remove the gage master.



Gage the Device Connector

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



wj55f

Connections

Good connections are essential for accurate measurements and require a skilled operator. *The most common cause of measurement error is poor connections.*

How to Make a Connection

Preliminary Connection

1. Ground yourself and all devices. Wear a grounded wrist strap and work on an antistatic mat.
2. Visually inspect the connectors. Refer to
3. If necessary, clean the connectors.
4. Use a connector gage to verify that all center conductors are within pin depth values in Table 2-3 on page 2-4.
5. Carefully align the connectors. The male connector center pin must slip concentrically into the contact finger of the female connector.
6. Push the connectors straight together. Do *not* twist or screw them together. As the center conductors mate, there is usually a slight resistance.

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.

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.

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

NOTE 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.

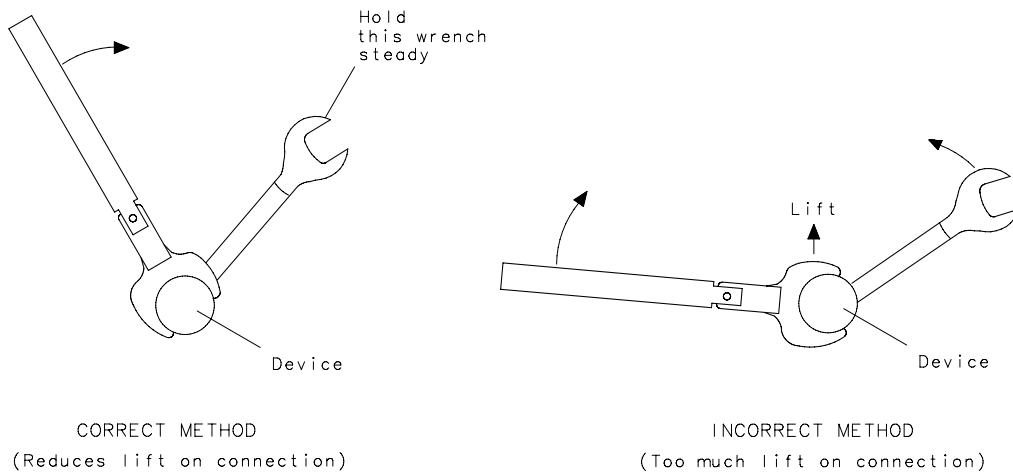
Use a torque wrench to make a final connection. Table 3-1 provides information on the torque wrench recommended for use with this kit. Refer to Chapter 6, "Replaceable Parts," for ordering information.

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)

1. Turn the connector nut. This may be possible to do by hand if one of the connectors is fixed (as on a test port). In all situations, the use of an open-end wrench to keep the body of the device from turning is recommended.
2. Position both wrenches within 90 degrees of each other before applying force. Wrenches opposing each other (greater than 90 degrees apart) will cause a lifting action that can misalign and stress the connections of the device involved. This is especially true when several devices are connected together. See Figure 3-4.

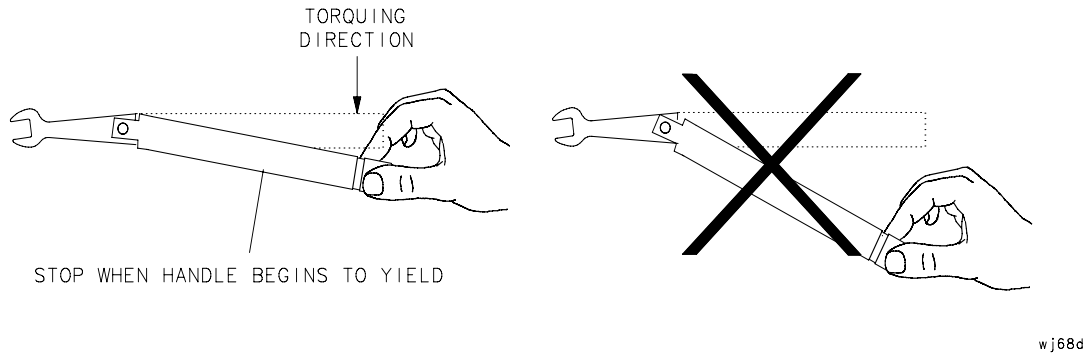
Figure 3-4 Wrench Positions



wj56f

3. 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



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

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

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.

5. 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.

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 the torque 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.

Handling and Storage

- Use the plastic end caps and store the calibration devices in the foam-lined storage case when not in use.
- Never store connectors loose in a box, in a desk, or in a 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 and calibration standards required to verify the specifications of the devices inside the kit have been specially manufactured and are 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 back 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/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 are traceable to NIST through Agilent Technologies.

Recertification

The following will be provided with a recertified kit:

- new calibration sticker affixed to the case
- certificate of calibration
- calibration report for each device in the kit listing measured values, specification, 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 “Contacting Agilent” on page 5-4.

How Often to Recertify

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

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

Where to Send a Kit for Recertification

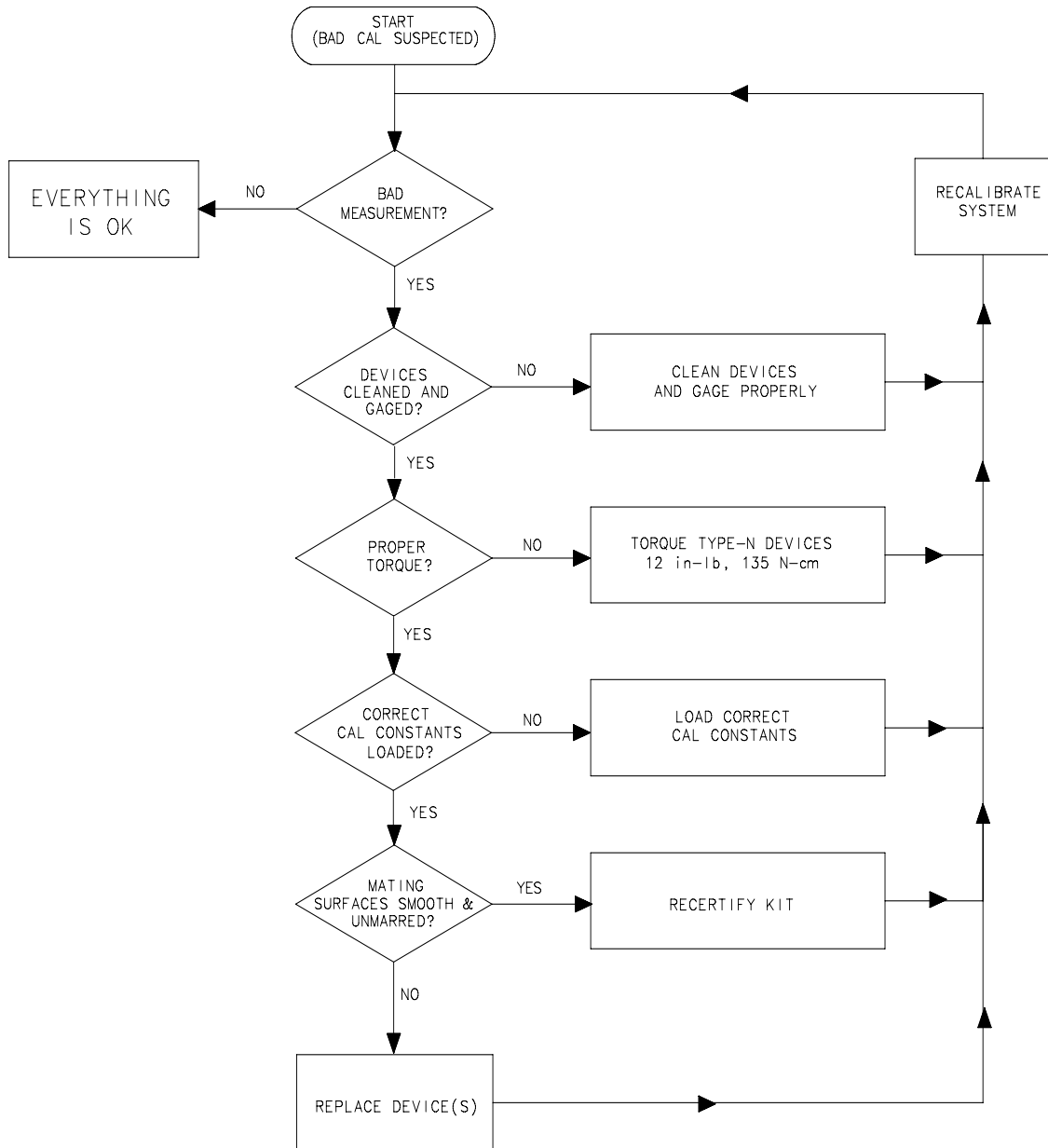
Contact Agilent for information on where to send your kit for recertification. See “Contacting Agilent” on page 5-4. Refer to “Returning a Kit or Device to Agilent” on page 5-3 for additional information.

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



wj53f

Where to Look for More Information

This manual contains limited information about network analyzer system operation. For detailed information on using a VNA, ENA or PNA series network analyzer, refer to the appropriate user guide or online Help.

- To view the ENA or PNA online Help, press the Help key on the front panel of the network analyzer.
- To view an online VNA user guide, use the following steps:
 1. Go to *www.agilent.com*.
 2. Enter your VNA model number (Ex: 8753ES) in the Search box and click **Search**.
 3. Under the heading **Manuals & Guides**, click on the title/hyperlink for the document PDF you want to view.

If you need additional information, see “Contacting Agilent” on page 5-4.

Returning a Kit or Device to Agilent

If your kit or device requires service, contact Agilent Technologies for information on where to send it. See “Contacting Agilent” on page 5-4. Include a service tag (found at 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 including the country code and area code
- 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)

Contacting Agilent

Assistance with test and measurements needs and information on finding a local Agilent office are available on the Web at:

www.agilent.com/find/assist

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

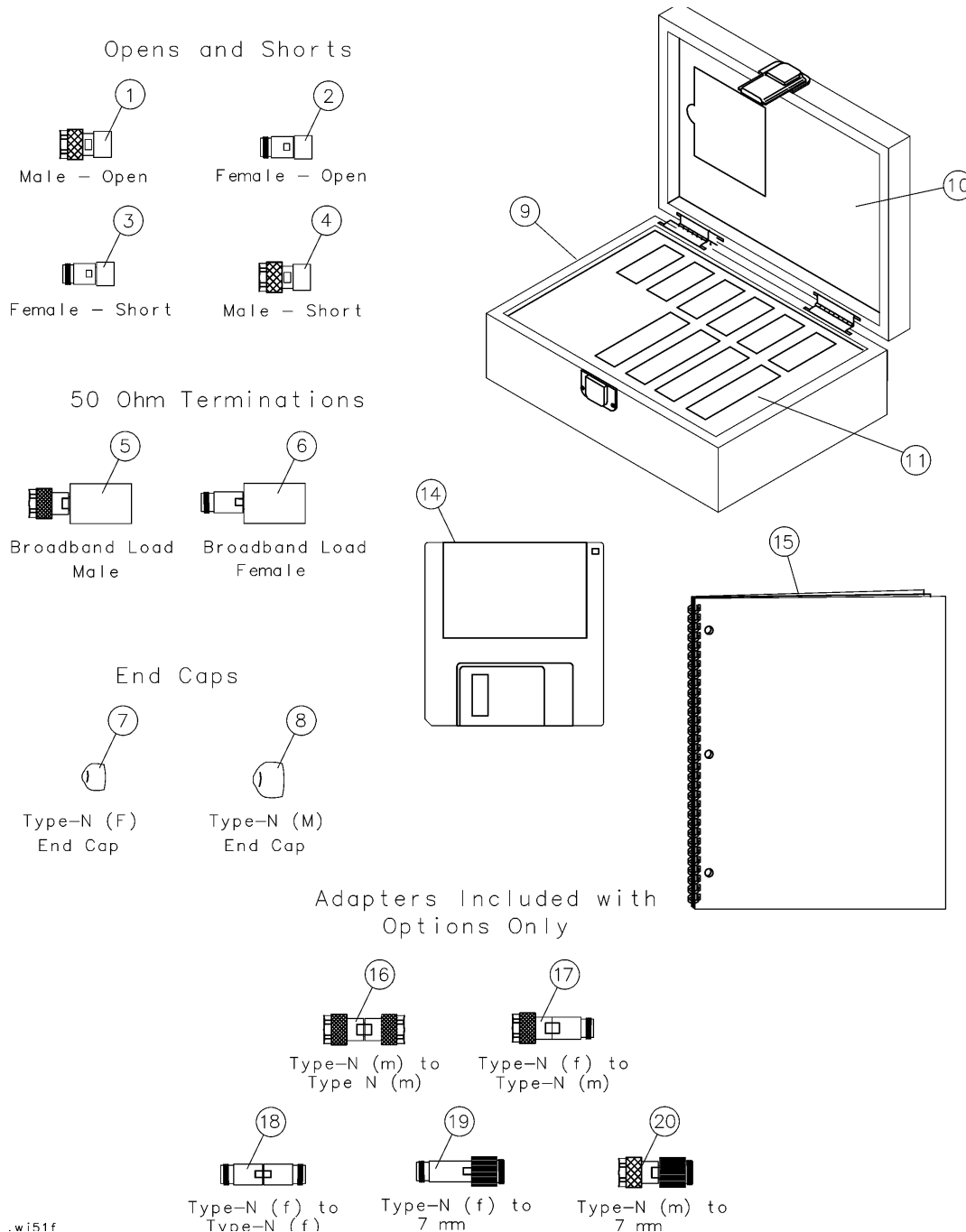
NOTE In any correspondence or telephone conversation, refer to the Agilent product by its model number and full serial number. With this information, the Agilent representative can determine whether your product is still within its warranty period.

6 Replaceable Parts

Introduction

Table 6-1 lists the replacement part numbers for the contents of the 85032F calibration kit. To order a listed part, note the description, the Agilent part number, and the quantity desired. Telephone or send your order to Agilent Technologies. See “Contacting Agilent” on page 5-4.

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



.wi51f

Table 6-1 Replaceable Parts^a

Item No.	Description	Qty	Agilent Part Number
Calibration Devices (Type-N 50 Ω)			
1	Offset open –m–	1	85032-60013
2	Offset open –f–	1	85032-60014
3	Offset short –f–	1	85032-60015
4	Offset short –m–	1	85032-60016
5	Broadband load –m–	1	85032-60017
6	Broadband load –f–	1	85032-60018
Protective End Caps for Connectors (Type-N 50 Ω)			
7	Protective end cap 0.625-ID, black	as required	1401-0225
8	Protective end cap 0.812-ID, black	as required	1401-0214
Calibration Kit Storage Case			
9	Box (without foam pads)	1	5180-8446
10	Box pads (top)	1	85032-80028
11	Box pads (bottom)	1	85032-80026
12	Disk holder (not shown in Figure 6-1)	1	5180-8491
Miscellaneous Items			
13	Connector care-quick reference card (not shown in Figure 6-1)	1	08510-90360
14	Calibration constants disk (875x and 872x series)	1	85032-10003
15	User's and service guide ^b	1	85032-90021
Optional Adapters^c (Type-N 50 Ω)			
16	Type-N –m– to type-N –m– (Option 200)	1	85032-60019
17	Type-N –f– to type-N –m– (Option 300)	1	85032-60020
18	Type-N –f– to type-N –f– (Option 100)	1	85032-60021
19	Type-N –f– to 7-mm adapter (Option 500)	2	85054-60001
20	Type-N –m– to 7-mm adapter (Option 500)	2	85054-60009

- a. Refer to “Clarifying the Terminology of a Connector Interface” on page 1-4.
b. Refer to “Printing Copies of Documentation from the Web” on page -iii.
c. The adapters are included when the applicable option is ordered.

Table 6-2 Items Not Included in Kit

Description	Agilent Part Number
Miscellaneous	
Type-N gage set	85054-60059
Adapter Kit (type-N 50 Ω to 3.5 mm)	11878A
Wrenches	
3/4 in, 135 N-cm (12 in-lb) torque wrench	8710-1766
1/2 in and 9/16 in open-end wrench	8710-1770
Connector Cleaning Supplies	
Anhydrous isopropyl alcohol (>92% pure) ^a	--
Cleaning swabs	9301-1243
ESD Devices	
Grounding wrist strap	9300-1367
5 ft grounding cord for wrist strap	9300-0980
2 x 4 ft conductive table mat and 15 ft. ground wire	9300-0797
ESD heel strap	9300-1308

a. Agilent can no longer safely ship isopropyl alcohol, so customers should purchase it locally.

A Standard Definitions

Class Assignments and Standard Definitions Values are Available on the Web

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. You can download the most recent class assignments and standard definitions from Agilent's Calibration Kit Definitions Web page at <http://na.tm.agilent.com/pna/caldefs/stddefs.html>.

For a detailed discussion of calibration kits, refer to the Agilent Application Note, "Specifying Calibration Standards and Kits for Agilent Vector Network Analyzers." This application note covers calibration standard definitions, calibration kit content and its structure requirements for Agilent vector network analyzers. It also provides some examples of how to set up a new calibration kit and how to modify an existing calibration kit definition file. To download a free copy, go to www.agilent.com and enter literature number 5989-4840EN in the Search window.

A

adapters, 6-2, 6-3
Agilent Technologies
 application note, A-2
 contacting, 5-4
altitude, specifications, 2-2
analyzers, compatible, 1-2

B

broadband loads, 1-2

C

calibration
 certificate of, 4-2
 constants, *See* calibration definitions
 definitions
 entering, 1-3
 permanently stored, 1-3
 report, 4-2
 temperature, 2-2
calibration kit
 Agilent Application Note, A-2
 modifying definition files, A-2
 overview, contents, 1-2
certificate of calibration, 2-5, 4-2
characteristics, mechanical, 2-3
class assignments
 downloading from Agilent Web site, A-2
cleaning connectors, 3-5
compressed air or nitrogen, 3-5
connections, 3-2, 3-11, 3-12, 3-13
connector
 accuracy, 3-7
 cleaning, 3-5
 damaged, 3-3
 gage
 handling, 3-9
 master, 3-9
 zeroing, 3-9
 gaging, 3-7, 3-8, 3-9
 gender, 1-4
 slotted, 3-4
 terminology, 1-4
 visual inspection, 3-3
 wear, 3-3
constants, calibration, *See* calibration definitions
contacting Agilent, 5-4

D

data, recertification, 4-2
defective connectors, 3-3
definitions
 calibration, 1-3

deviation from nominal phase, 2-5

device

 connecting, 3-11
 disconnecting, 3-13
 handling, 3-14
 maintenance, 1-5
 return, 5-3
 serial numbers, 1-4
 specifications, 2-5
 storage, 3-14
 temperature, 2-2
 visual inspection, 3-3
dimensions, 2-3
disconnections, 3-13
documentation warranty, -ii
downloading class assignments & std definitions from the Web, A-2

E

electrical characteristics
 effects of temperature, 2-2
electrical specifications, 2-5
electrostatic discharge, 3-2
environmental
 requirements, 2-2
 specifications, 2-2
equipment required, 1-3
ESD, 3-2

G

gage
 connector
 handling, 3-9
 master, 3-9
 zeroing, 3-9
 procedures, 3-9
gage master
 using, 3-9
gaging connectors, 3-7, 3-8
gender, connector, 1-4
general information, 1-2

H

handling, 3-14
humidity specifications, 2-2

I

incoming inspection, 1-4
information, troubleshooting, 5-3
inspection
 damage, 3-3
 defects, 3-3
 incoming, 1-4
 mating plane, 3-3
 slotted connectors, 3-4

visual, 3-3

K

kit overview, contents, 1-2

L

loads, broadband, 1-2

M

maintenance
 of devices, 1-5, 3-2
making connections, 3-11
mating plane surfaces
 clean, 3-6
 inspection, 3-3
mechanical characteristics, 2-3
modifying calibration kit
 definition files, A-2

N

nitrogen, 3-5

O

offsets, opens, shorts, 1-2
optional adapters, 6-3
options, 1-3
ordering parts, 6-2, 6-3
overview, of kit, 1-2

P

part numbers, 6-2
parts, replacing, 6-1
performance verification, 4-2
permanently stored calibration
 definitions, 1-3
pin depth, 2-3, 2-4
preventive maintenance, 1-5
procedure, gaging, 3-9

R

reading connector gage, 3-8
recertification, 4-2, 4-3
 interval, 4-3
 what's included, 4-3
 where it's done, 4-3
regulations
 environmental, 2-2
replaceable parts, 6-1, 6-2, 6-3
requirements
 environmental, 2-2
return, kit or device, 5-3

S

serial numbers, 1-4

Index

service, 5-2
slotted connectors, 3-4
specifications, 2-2
 altitude
 operating, 2-2
 storage, 2-2
 electrical, 2-5
 environmental, 2-2
 humidity
 operating, 2-2
 storage, 2-2
 temperature, 2-2
 verifying, 4-2
standard definitions
 downloading from Agilent Web
 site, A-2
static discharge, 3-2
storage, 3-14

T

temperature
 affect on electrical performance,
 2-2
 calibration, 2-2
 cautions about, 2-2
 changes in, 2-2
 device, 2-2
 error-corrected, 2-2
 measurement, 2-2
 specifications, 2-2
 operating, 2-2
 storage, 2-2
 verification and measurement,
 2-2
test data, 4-2
torque wrench, 3-12
traceability, 4-2
troubleshooting, 5-2

V

verification
 performance, 4-2
 temperature, 2-2
visual inspection, 3-3

W

warranty, documentation, -ii

Z

zeroing
 connector gage, 3-9