Operating and Service Manual

HP 85033D 3.5 mm Calibration Kit

SERIAL NUMBERS

This manual applies directly to HP 85033D calibration kits with serial number prefix 3423A. The calibration devices in this kit are individually serialized. Record the device serial numbers in the table provided in this manual. (See "Device Serial Numbers" in Chapter 1.)

HP Part No. 85033-90027
Printed in USA May 1998 Supersedes June 1994

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST, formerly NBS), to the extent allowed by the institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

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

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

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

LIMITATION OF WARRANTY

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

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

EXCLUSIVE REMEDIES

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

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard Products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided in Table 6-1.

Contents

Figures

Tables

1

General Information

Calibration Kit Overview

The HP 85033D 3.5 mm calibration kit is used to calibrate the following HP network analyzers for measurements of components with 3.5 mm connectors up to 6 GHz. Where "pre-installed" is noted, the calibration constants for this kit are permanently stored in the analyzer's firmware. "User-defined" means the calibration constants must be loaded into the analyzer from a disk supplied with the calibration kit or entered from the analyzer's front panel.

This calibration kit applies to the following HP network analyzers:

- HP 8711C pre-installed
- HP 8712C pre-installed
- HP 8713C pre-installed
- HP 8714C pre-installed
- HP 8752C pre-installed
- HP 8753D/E pre-installed
- HP 8752A/B user-defined
- HP 8753A/B/C user-defined

The calibration kit consists of the following:

- offset opens and shorts, and broadband load terminations
- four 7 mm to 3.5 mm adapters for converting 7 mm test port connectors to 3.5 mm
- a disk that contains the nominal calibration constants of the devices in the calibration kit for installing into the HP 8752A/B and HP 8753B/C
- two open-short-load (OSL) holders
- a 2.5 mm hex key for use with the OSL holder

This manual provides information for the following topics:

- specifications
- user-related procedures and information
- maintenance and care of the devices
- how to verify performance
- troubleshooting information
- replacement part numbers

Equipment Required but Not Supplied

Gages, a torque wrench, and various connector cleaning supplies are *not* included with this calibration kit. Gage sets are required for measuring the connector pin depth, and a torque wrench is necessary to achieve proper connections. (Refer to Chapter 7 for ordering information.)

Serial Numbers

A serial number label is attached to this calibration kit. A typical kit serial number label is shown in Figure 1-1. The first four digits followed by a letter comprise the serial number prefix; the last five digits are the suffix, unique to each calibration kit.

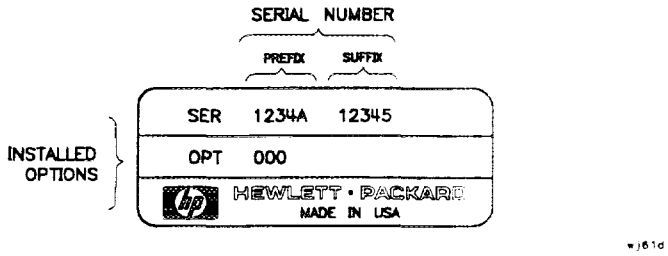


Figure 1-1. Typical Kit Serial Number Label

Calibration kits documented in this manual

This manual applies to any HP 85033D calibration kit whose serial prefix is listed on the title page.

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. This can help you avoid confusing the devices in this kit with similar devices from other kits. Kit integrity is an important part of compliance with the U.S. MIL-STD 45662A, should you need to comply with this standard. The adapters are for measurement convenience only and are not regarded as devices requiring a traceable path in order to comply with MIL-STD 45662A.

Table 1-1. Kit and Device Serial Number Record

Device	Serial Number
Calibration Kit	_____
Male Broadband Load	_____
Female Broadband Load	_____
Male Open	_____
Female Open	_____
Male Short	_____
Female Short	_____

Options

There are three options available for the HP 85033D:

Option 001 deletes the four 7 mm to 3.5 mm adapters of the standard kit.

Option 910 provides an extra operating and service manual with the kit.

Option 002 replaces the four 7 mm adapters with four type-N adapters. The four type-N adapters are:

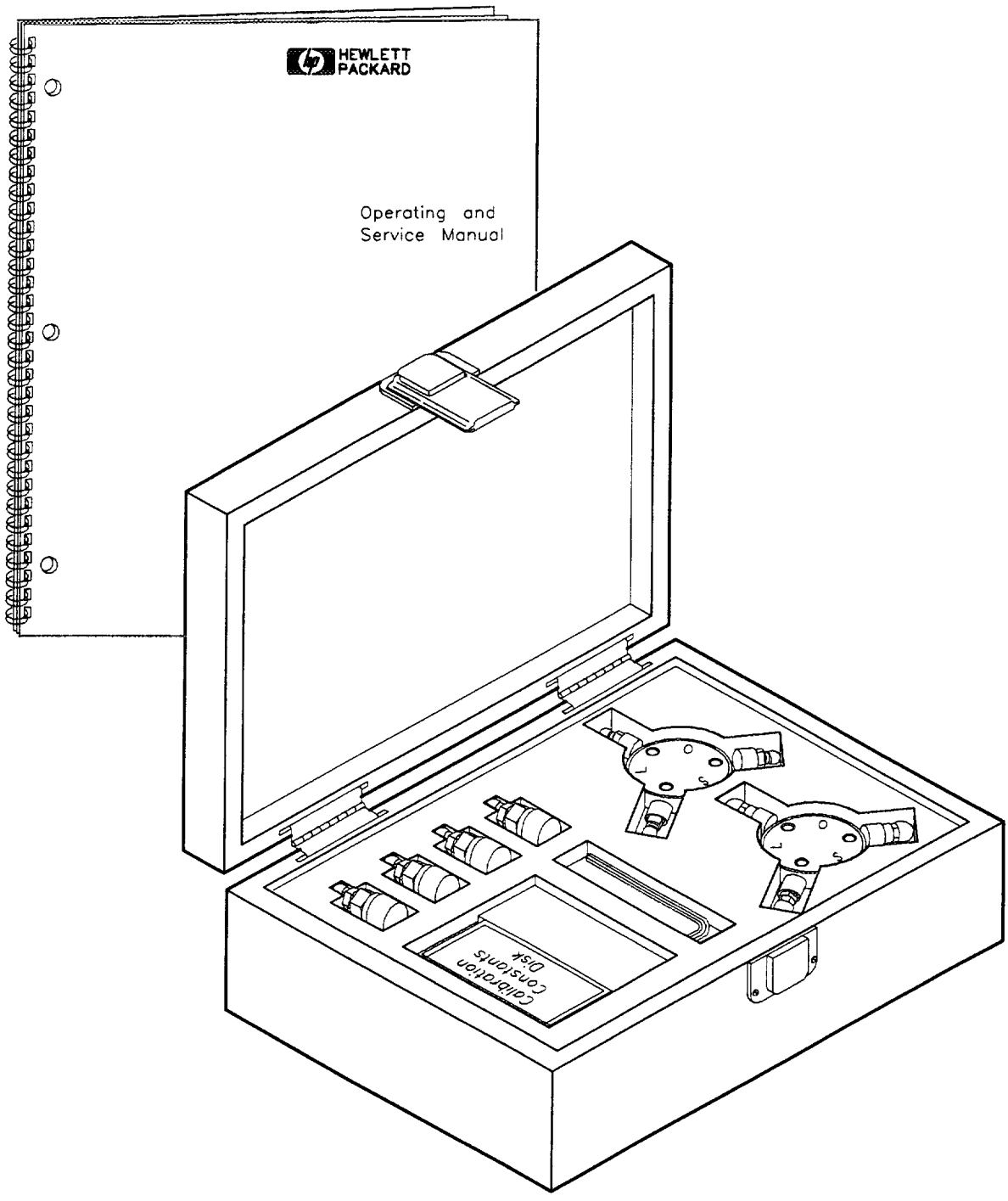
- Type-N male to 3.5 mm male
- Type male to 3.5 mm female
- Type-N female to 3.5 mm female
- Type-N female to 3.5 mm male

Incoming Inspection

Refer to Figure 1-2 to verify a complete shipment. Use Table 1-1 to record the serial numbers of all serialized devices in your kit. To verify the electrical performance of the devices in this kit, see Chapter 5.

The foam-lined storage case provides protection during shipping. If the case or any device appears damaged, contact the nearest Hewlett-Packard sales or service office. (See Table 6-1.) Hewlett-Packard 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 Hewlett-Packard, 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
- the model number and serial number of the kit
- the part number and serial number of the kit or device
- the type of service required
- any applicable information



wj62d

Figure 1-2. Calibration Kit Contents

Clarifying Connector Sex

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

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 connectors.

Preventive Maintenance

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

- routine visual inspection and cleaning
- periodic gaging
- correct connection techniques

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 4-1) or from poor connection techniques, can also damage these devices.

Visual inspection, cleaning techniques, proper gaging for pin depth, and connection techniques are all described in Chapter 4.

2

Specifications

Environmental Requirements

Table 2-1. Environmental Requirements

Parameter	Limits
Operating Temperature[1]	15° to 35°C (59° to 95°F)
Error-Corrected Temperature Range[2]	±1°C of measurement calibration temperature
Storage Temperature	−40° to +75°C (−40° to +167°F)
Altitude	
Operation	< 4,500 metres (≈15,000 feet)
Storage	< 15,000 metres (≈50,000 feet)
Relative Humidity	Always Non-Condensing
Operation	0 to 80% (26°C maximum dry bulb)
Storage	0 to 95%

1 The temperature range over which the calibration standards maintain performance to their specifications.

2 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

Due to the small dimensions of the calibration devices, electrical characteristics will change with temperature. Therefore, the operating temperature is a critical factor in their performance. During a measurement calibration, the temperature of the calibration devices must be stable and within the range shown in Table 2-1.

Remember Your fingers are a heat source, so avoid handling the devices unnecessarily during calibration.

Mechanical Characteristics

The relevance of center conductor protrusion and pin depth

Mechanical characteristics such as center conductor protrusion and pin depth are *not* performance specifications. They are, however, important supplemental characteristics related to electrical performance. Hewlett-Packard 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 and have proper pin depth when the kit leaves the factory.

Chapter 4 explains how to use the gages listed in Chapter 7 to determine if the kit devices have maintained their mechanical integrity. (Refer to Table 4-1 for *typical* and *observed* pin depth limits.)

Electrical Specifications

The electrical specifications in Table 2-2 apply to the devices in the HP 85033D 3.5 mm calibration kit.

Table 2-2. Electrical Specifications for 3.5 mm Devices

Device	Specification	Frequency (GHz)
Broadband Loads	Return Loss $\geq$ 46 dB ($\rho \leq 0.005$)	DC to $\leq$ 1.3
(male and female)	Return Loss $\geq$ 44 dB ($\rho \leq 0.006$)	> 1.3 to $\leq$ 3
	Return Loss $\geq$ 38 dB ($\rho \leq 0.013$)	> 3 to $\leq$ 6
Offset Opens[1]	±0.65° From Nominal	DC to $\leq$ 1.3
(male and female)	±0.65° From Nominal	> 1.3 to $\leq$ 3
	±0.85° From Nominal	> 3 to $\leq$ 6
Offset Shorts[1]	±0.48° From Nominal	DC to $\leq$1.3
(male and female)	±0.50° From Nominal	> 1.3 to $\leq$ 3
	±0.55° From Nominal	> 3 to $\leq$ 6

1 The specifications for the open and short are given as allowed deviation from the *nominal* model as defined in the standard definitions (see Table A-3).

Supplemental electrical characteristics

Supplemental characteristics are values which are typically met by a majority of the calibration kit devices tested at Hewlett-Packard. These supplemental characteristics are intended to provide information useful in calibration kit applications by giving typical, but non-warranted performance parameters. Table 2-3 lists the typical characteristics of the adapters in the standard as well as Option 002 kit.

Table 2-3. Electrical Characteristics for Adapters

Adapter	Typical Value	Frequency (GHz)
7 mm to 3.5 mm	Return Loss $\geq$ 34 dB ($\rho \leq 0.020$)	DC to $\leq$6
Type-N male to 3.5 mm male[1]	Return Loss $\geq$ 28 dB ($\rho \leq 0.040$)	DC to $\leq$6
Type-N male to 3.5 mm female[1]	Return Loss $\geq$ 28 dB ($\rho \leq 0.040$)	DC to $\leq$6
Type-N female to 3.5 mm female[1]	Return Loss $\geq$ 28 dB ($\rho \leq 0.040$)	DC to $\leq$6
Type-N female to 3.5 mm male[1]	Return Loss $\geq$ 24 dB ($\rho \leq 0.060$)	DC to $\leq$6

1 Applies only to Option 002

3

User Information

The Design of the Calibration Devices

The HP 85033D 3.5 mm calibration kit contains three types of calibration devices with both male and female connectors: broadband loads, offset short circuits, and offset open circuits.

The following briefly describes the design and construction of all the calibration kit devices.

Broadband loads

The broadband loads are metrology-grade, 50 ohm terminations which have been optimized for broadband performance up to 6 GHz. The rugged internal structure provides for highly repeatable connections. A distributed resistive element on sapphire provides excellent stability and return loss.

Offset opens and shorts

The offset opens and shorts are built from parts which are machined to the current state-of-the-art in precision machining. The offset short's inner conductors have a one-piece construction, common with the shorting plane. This construction provides for extremely repeatable connections. The offset opens have inner conductors which are supported by a strong, low-dielectric-constant plastic to minimize compensation values. Both the opens and shorts are constructed so that the pin depth can be controlled very tightly, thereby minimizing phase errors. The lengths of the offsets in the opens and shorts are designed so that the difference in phase of their reflection coefficients is approximately 180 degrees at all frequencies.

Adapters

Like the other devices in the kit, the adapters are built to very tight tolerances to provide good broadband performance. The 3.5 mm interface is compatible with SMA connectors and provides a rugged, precision reference plane. 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.

Loading the Calibration Constants

The calibration constants for the devices in this kit must be present in the network analyzer prior to performing a calibration. The calibration constants may already be present, or they can be loaded from the disk supplied in this kit or be entered from the front panel.

For the HP 8752C, HP 8753D/E, and HP 8711C/12C/13C/14C

The calibration constants for the HP 85033D are permanently stored in the firmware of the HP 8752C, HP 8753D/E, and HP 8711C/12C/13C/14C network analyzers.

Note Although the calibration constants for this kit permanently reside in the above-mentioned instruments, these analyzers have the capability to have calibration constants loaded into a user-defined kit as well. Refer to the user's guides of those analyzers for more information.

For the HP 8752A/B and HP 8753B/C

Loading from a disk

Use the calibration constants disk supplied with the kit for the following procedure.

1. Connect an HP 9122 disk drive to the instrument with an HP-IB cable.
2. Insert the calibration constant disk into the disk drive.
3. Press (RECALL) `LOAD FROM DISK READ FILE TITLES`.
4. Select one of the following softkeys:
   - `LOAD A5235D` for the HP 8752A/B
   - `LOAD C5335D` for the HP 8753B/C

   The analyzer loads the constants into the `USER KIT`.
5. To check the operation, press (CAL). Observe that softkey number 6 shows `MODIFY [3.5 mmD]`.

The nominal calibration constants are stored in the non-volatile memory and will be available under `USER KIT`. They will remain there unchanged until they are over-written by another kit, or become modified and saved. The calibration constants will not be lost if the power is turned off.

For the HP 8753A

The calibration constants disk included in this kit does not contain a data file for the HP 8753A network analyzer, therefore, the calibration constants cannot be loaded from a disk. To enter the HP 85033D calibration constants into the HP 8753A, follow the steps described in "Using the front panel to examine or modify calibration constants".

Using the front panel to examine or modify calibration constants

Calibration constants can be loaded into the analyzer's user-defined kit via front panel entry. Refer to Table A-3 in the appendix of this manual for the standard definitions that should be entered for this kit. Follow the procedure below to enter, modify, or examine standard definitions on the HP 8752 and HP 8753 network analyzer.

1. Press (CAL) CAL KIT .
2. Select the softkey that corresponds to the kit you want to modify or examine.
3. Press MORE , if it is displayed, otherwise go to the next step.
4. Press MODIFY .
5. Press DEFINE STANDARD and use the front panel entry keys to enter the number of the standard you want to examine or modify. (Refer to Table A-3 in the appendix of this manual for standard numbers.) For example, to select a short, press (1) (X1).
6. Press the underlined softkey. If you selected a short in the previous step, SHORT should be the underlined softkey.
7. This step applies only to the *open*. Go to the next step if you selected any other standard.

   Press C0 . Observe the value on the analyzer screen. To change the value, use the entry keys on the front panel. Repeat this step for C1 , C2 , and C3 .
8. Press SPECIFY OFFSET .
9. Press OFFSET DELAY and observe the value on the analyzer screen. To change the value, use the entry keys on the front panel. Repeat this step for the softkeys listed below:
   - OFFSET LOSS
   - OFFSET Z0
   - MINIMUM FREQUENCY
   - MAXIMUM FREQUENCY
10. Ensure that COAX is underlined.
11. Press STD OFFSET DONE STD DONE (DEFINED) .
12. Repeat steps 5 through 11 for the remaining standards.

Saving the modified calibration constants

If you made modifications to any of the standard definitions, follow the remaining steps in this procedure to assign a kit label and store them in the non-volatile memory. The new set of standard definitions will be available under USER KIT until they are over-written by another kit or become modified and saved.

13. LABEL KIT ERASE TITLE and follow the instructions on the analyzer. You can enter a total of 10 characters.
14. DONE KIT DONE (DEFINED) .

15. To save the standard definitions in the **USER KIT**, press the softkeys that apply to your analyzer:

   - For the HP 8752B or HP 8753 A/B/C, press **RETURN CALKIT SAVE USER KIT**.
   - For the HP 8752C or HP 8753D, press **SAVE USER KIT**.

Using the Open-Short-Load Holders

The open-short-load (OSL) holders are included for your convenience. The OSL holders allow you to keep all the calibration devices in two handy assemblies. Load each OSL holder with calibration devices of the same connector sex so that you can perform a calibration with just one assembly. Use the 2.5 mm hex key included with this kit to secure the calibration devices in the holders. (See Figure 3-1.)

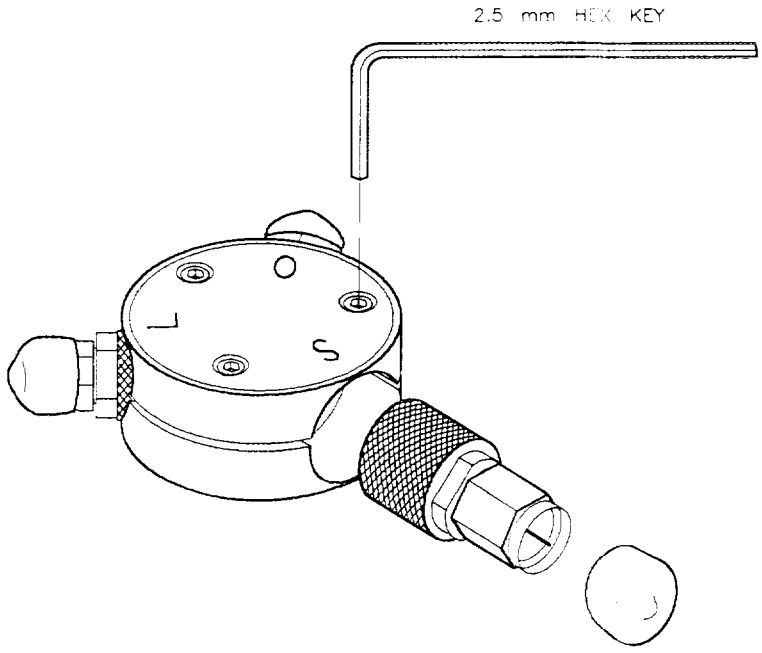


Figure 3-1. Open-Short-Load Holder

4

Gaging and Making Connections

Electrostatic Discharge

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

Static electricity builds up on the body and can easily damage sensitive internal circuit elements when discharged by contact with the center conductor. Static discharges too small to be felt can cause permanent damage. Devices such as calibration components and devices under test can also carry an electrostatic charge.

- Always have a grounded antistatic mat in front of your test equipment and wear a grounded wrist strap attached to it.
- 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 briefly to discharge static from your body.
- Discharge static electricity from a device before connecting it: touch the device briefly (through a resistor of at least 1 MΩ) to either the outer shell of the test port or to another exposed ground. This discharges static electricity and protects test equipment circuitry.

Refer to Chapter 7 for information on ordering supplies for ESD protection.

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. This is especially true with female connectors. The contact fingers on the inner contact of slotless connectors may become bent or broken. The use of a microscope with a magnification $\geq 10\times$ is recommended to detect this type of damage. 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.

Devices with damaged connectors should be discarded. Try to determine the cause of damage before connecting a new, undamaged connector in the same configuration.

Inspecting 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 4-1.) 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. Try to determine the cause of damage before connecting a new, undamaged connector in the same configuration.

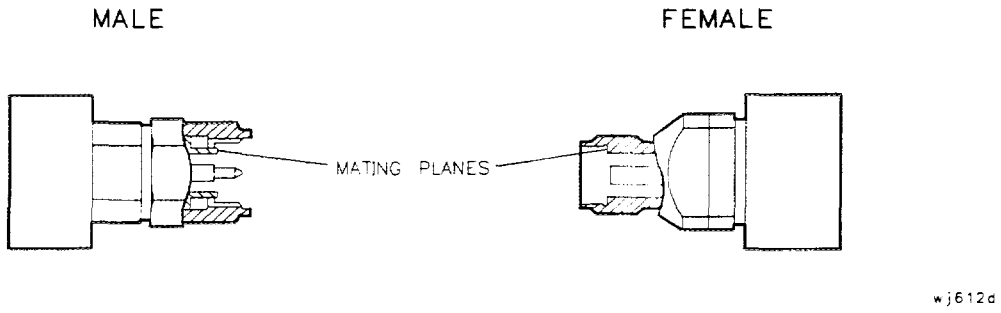


Figure 4-1. Mating Plane Surfaces

Inspecting precision slotless connectors

Precision slotless female connectors are used to improve accuracy. The slotless contacts are not affected by the slight variations in male contact pin diameter, however, they are fragile and should be inspected regularly for damage such as bent or broken inner contacts in the center conductor. (See Figure 4-2.) Remember to use sufficient magnification when inspecting the inner contacts.

Damaged inner contacts may be replaced without affecting the performance of the device by using a 3.5 mm slotless contact repair kit. Refer to Chapter 7 for ordering information.

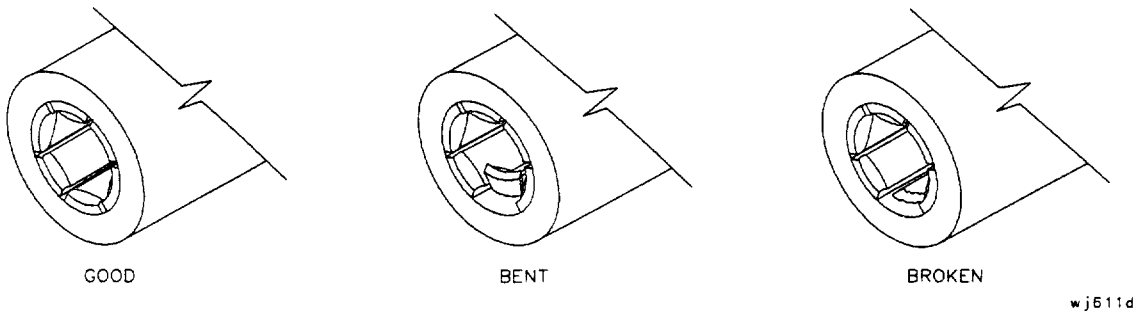


Figure 4-2. Examples of Good, Bent, and Broken Inner Contacts on a Slotless Connector

What causes connector wear

Connector wear eventually degrades performance. 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. 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.

Cleaning Connectors

Clean connectors are essential for ensuring the integrity of RF and microwave coaxial connections. Use the following procedure to clean the connectors in this kit:

1. **Use Compressed Air or Nitrogen**

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

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

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 a very low velocity (< 414 kPa or 60 psi). High-velocity air can cause electrostatic effects when directed into a connector.

2. **Clean the Connector Threads**

   For dirt or stubborn contaminants on a connector that you cannot remove with compressed air or nitrogen, try a lint-free swab or cleaning cloth moistened with isopropyl alcohol:

   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.

3. **Clean the Mating Plane Surfaces**

   Apply a small amount of isopropyl alcohol to a new swab and clean the center and outer conductor mating plane surfaces. (Refer to Figure 4-1.) When cleaning a female connector, avoid snagging the swab on the center conductor contact fingers by using short strokes. An illuminated magnifying glass is helpful.

Caution Do not apply excessive force when cleaning the center conductors with a swab. It is possible to damage the center conductor support of the device.

4. **Dry the Connector**

   After cleaning, blow the connector dry with a gentle stream of clean compressed air or nitrogen. Always completely dry a connector before you reassemble or use it.

5. **Reinspect**

   Inspect the connector again under a magnifying glass to be sure that no particles or residues remain.

Refer to Chapter 7 for information on ordering connector cleaning supplies and Hewlett-Packard's *Microwave Connector Care Manual* which provides additional information on inspecting, cleaning, and handling of connectors.

Pin Depth

Pin depth is the distance the center conductor mating plane differs from being flush with the outer conductor mating plane. (See Figure 4-3.) The pin depth of a connector can be in one of two states, either protruding or recessed. *Protrusion* is the condition when the center conductor extends beyond the outer conductor mating plane, and will measure a positive value on the connector gage. *Recession* is when the center conductor is set back from the outer conductor mating plane, and will measure negative.

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 4-1 lists the typical pin depths and customer 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 4-3 for a visual representation of proper pin depth (slightly recessed).

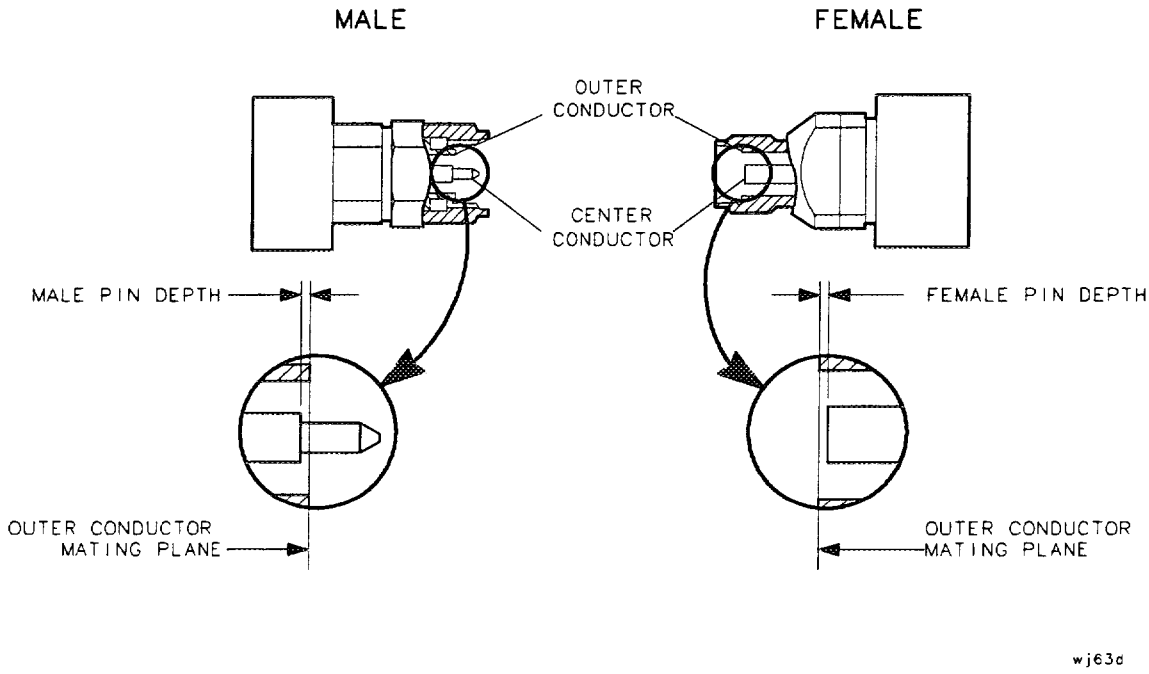


Figure 4-3. Connector Pin Depth

Gaging Connectors

What is the intent of the connector gages

The gages available from Hewlett-Packard (see Chapter 7) are intended for preventive maintenance and troubleshooting purposes only. They are effective in detecting *excessive* center conductor protrusion or recession and connector damage on DUTs, test accessories, and the calibration kit devices. *Do not use the gages for precise pin depth measurements.*

How accurate are the connector gages

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 then, the resultant average can be in error by as much as ± 0.0001 inch due to systematic (biasing) errors usually resulting from worn gages and gage masters. Table 4-1 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 could become more significant in the accuracy of the measurement.

The measurement uncertainties (see Table 4-1) are primarily a function of the assembly materials and design, and the unique interaction each device type has with the gage. Therefore, these uncertainties can vary among the different devices. For example, note the difference between the uncertainties of the *Open* and *Short* in Table 4-1.

The *observed* pin depth limits in Table 4-1 add these uncertainties to the *typical* factory pin depth values to provide practical limits that can be referenced when using the gages. Refer to Chapter 3 for more information on the design of the calibration devices in this kit.

Table 4-1. Pin Depth Limits

3.5 mm Device	Typical Pin Depth micrometers (10^{-4} inches)	Measurement Uncertainty[1] micrometers (10^{-4} inches)	Observed Pin Depth Limits micrometers (10^{-4} inches)
Opens	0 to −12.7 (0 to −5.0)	+6.4 to −6.4) (+2.5 to −2.5	+6.4 to −19.1 (+2.5 to −7.5)
Shorts	0 to −12.7 (0 to −5.0)	+4.1 to −4.1 (+1.6 to −1.6)	+4.1 to −16.8 (+1.6 to −6.6)
Fixed Loads	−2.5 to −25.4 (−1.0 to −10.0)	+4.1 to −4.1 (+1.6 to −1.6)	+1.6 to −29.5 (+0.6 to −11.6)

1 Approximately +2 sigma to −2 sigma of gage uncertainty based on studies done at the factory using the HP 11752 gages (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 4-1 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

How to zero the gage

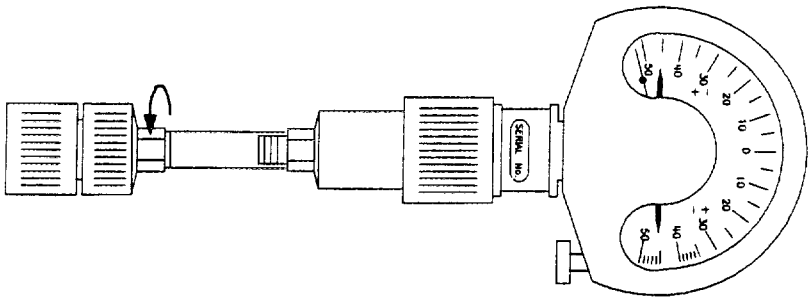
Note Hold a connector gage by the gage barrel, below the dial indicator. This gives the best stability, and improves measurement accuracy (cradling the gage in your hand or holding it by the dial applies stress to the gage plunger mechanism through the dial indicator housing).

1. Select the proper gage for your connector. (Refer to Chapter 7 for gage part numbers.)
2. Inspect and clean the gage:
   a. Inspect the connector gage and the gage master carefully, exactly as you inspected the connector itself.
   b. Clean or replace the gage and the gage master if necessary. Dirt on either the gage or the gage master makes gage measurements inaccurate, and can damage a connector.
3. Zero the connector gage (see Figure 4-4):
   a. While holding the gage by the plunger barrel, use the connecting knurl to screw on the gage master just until you meet resistance.
   b. Use the torque wrench supplied with the kit to tighten the connecting nut of the gage master.
   c. As you watch the gage pointer, gently tap the barrel of the gage to settle the reading.

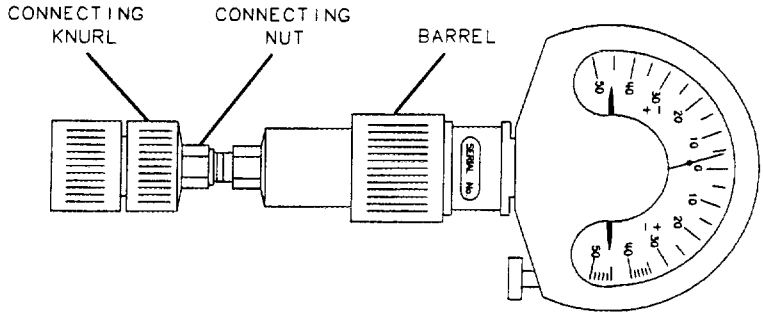
   The gage pointer should line up exactly with the zero mark on the gage. If not, adjust the zero set knob until the gage pointer exactly lines up with zero.

Note Check gages often to make sure that the zero setting has not changed. Generally, when the pointer on a recently zeroed gage does not line up exactly with the zero mark, the gage or gage master needs cleaning. Clean both of these carefully and check the zero setting again.

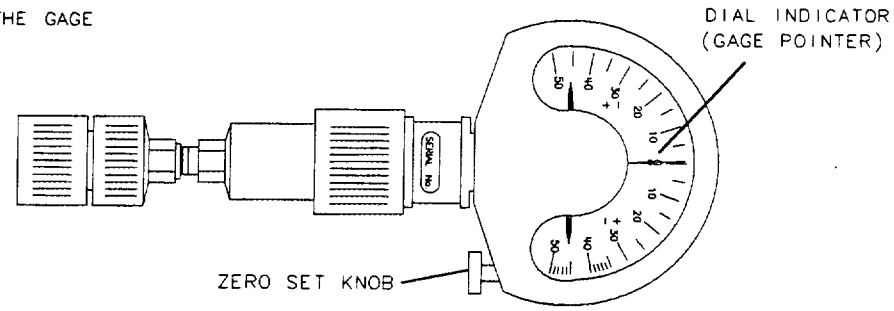
- HAND TIGHTEN THE GAGE MASTER ONTO THE GAGE



- TORQUE THE GAGE MASTER ONTO THE GAGE AND GENTLY TAP THE BARREL TO SETTLE THE GAGE READING



- ZERO THE GAGE



wj64d

Figure 4-4. Zeroing a Connector Gage

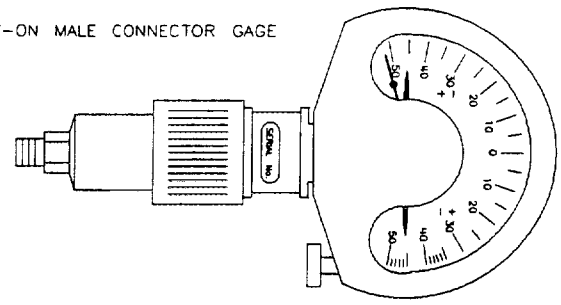
How to measure the connectors

Measuring male 3.5 mm connectors

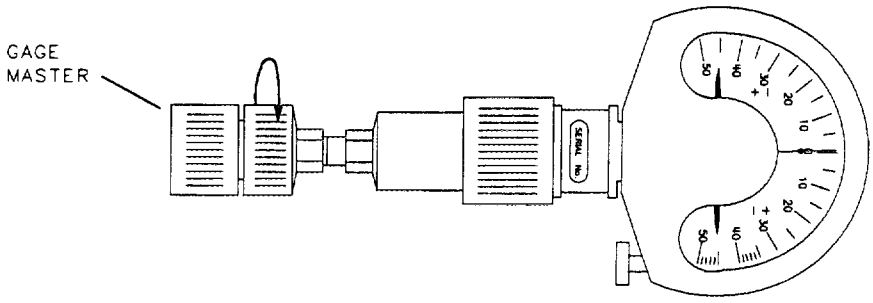
1. Refer to Figure 4-5.
2. Zero the gage as described in "How to zero the gage".
3. While holding the gage by the barrel, screw on the connector of the device being measured. Without turning the gage or the device, connect the nut finger-tight.
4. Torque the connector onto the gage to 90 N-cm (8 in-lb).
5. Gently tap the barrel of the gage with your finger to settle the gage reading.
6. Read the gage indicator dial. Read *only* the black ± signs; not the red ± signs.
7. For maximum accuracy, measure the connector a minimum of three times and take an average of the readings.
8. Compare the average reading with the *observed* pin depth limits in Table 4-1.

Note When you are performing pin depth measurements, use different orientations of the gage within the connector. Average a minimum of three readings, each taken after a quarter-turn rotation of the gage to reduce measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.

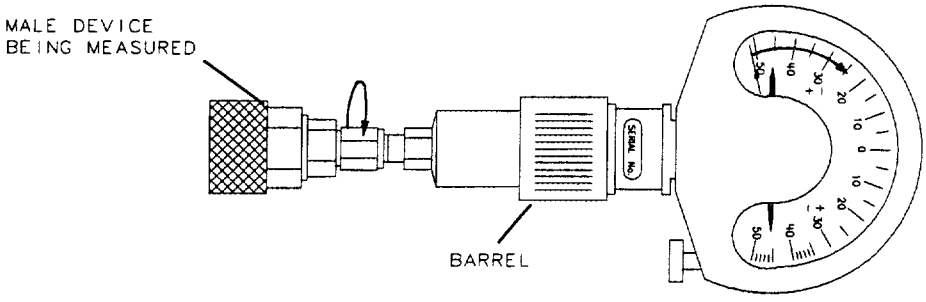
● USE THE SCREW-ON MALE CONNECTOR GAGE



● ZERO THE GAGE USING THE GAGE MASTER



● SCREW THE DEVICE ONTO THE GAGE. TORQUE THE CONNECTING NUT. GENTLY TAP THE BARREL TO SETTLE THE GAGE READING. READ RECESSION OR PROTUSION FROM THE GAGE.



wj65d

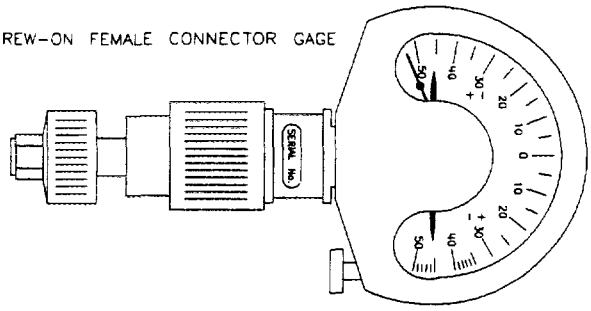
Figure 4-5. Gaging a 3.5 mm Male Connector

Measuring female 3.5 mm connectors

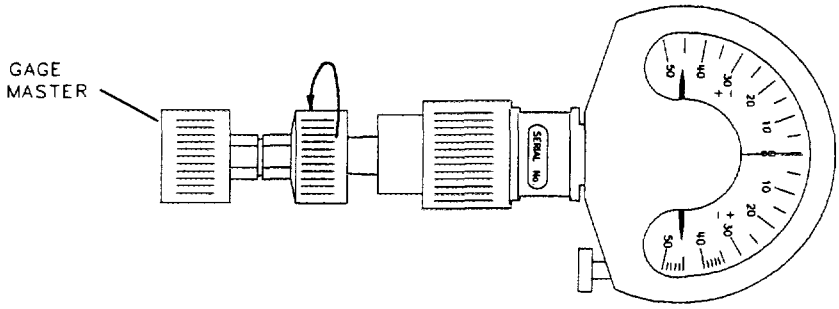
1. Refer to Figure 4-6.
2. Zero the gage as described in "How to zero the gage".
3. While holding the gage by the barrel, screw it onto the connector of the device being measured. Without turning the gage or the device, connect the nut finger-tight.
4. Torque the connector onto the gage to 90 N-cm (8 in-lb).
5. Gently tap the barrel of the gage with your finger to settle the gage reading.
6. Read the gage indicator dial. Read *only* the black ± signs; not the red ± signs.
7. For maximum accuracy, measure the connector a minimum of three times and take an average of the readings.
8. Compare the average reading with the *observed* pin depth limits in Table 4-1.

Note When you are performing pin depth measurements, use different orientations of the gage within the connector. Average a minimum of three readings, each taken after a quarter-turn rotation of the gage to reduce measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.

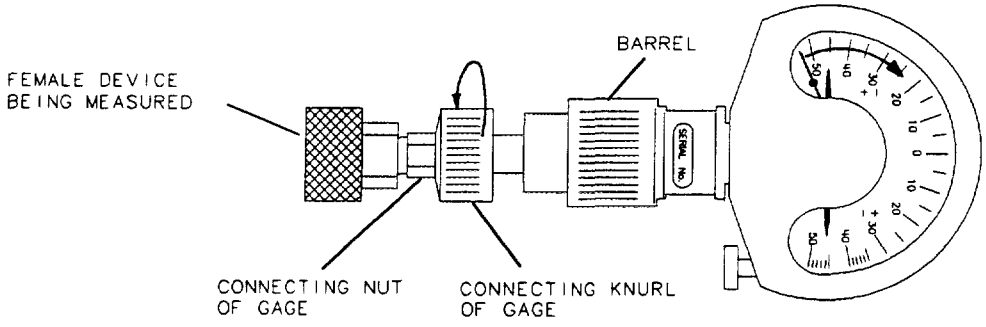
● USE THE SCREW-ON FEMALE CONNECTOR GAGE



● ZERO THE GAGE USING THE GAGE MASTER



● SCREW THE GAGE ONTO THE DEVICE. TORQUE THE CONNECTING NUT. GENTLY TOP THE BARREL TO SETTLE THE GAGE READING. READ RECESSION OR PROTUSION FROM THE GAGE.



wj66d

Figure 4-6. Gaging a 3.5 mm Female Connector

Connections

Good connections require a skilled operator. Instrument sensitivity and coaxial connector mechanical tolerances are such that slight errors in operator technique can have a significant effect on measurements and measurement uncertainties.

Note The most common cause of measurement error is poor connections.

How to make a connection

1. Ground yourself and all devices. Wear a grounded wrist strap and work on an antistatic mat.
2. Visually inspect the connectors.
3. If necessary, clean the connectors.
4. Use a connector gage to verify that all center conductors are within the *observed* pin depth values in Table 4-1.
5. Carefully align the connectors.

   The male connector center pin must slip concentrically into the contact fingers 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. Major 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.

   At this point all you want is a connection in which the outer conductors make gentle contact at all points on both mating surfaces. Very light finger pressure is enough.
8. Relieve any side pressure on the connection from long or heavy devices or cables.

How to use a torque wrench

1. Use a torque wrench to make the final connection. Table 4-2 provides information on the torque wrench required for the connector type found in this kit.

Table 4-2. Torque Wrench Information

Connector Type	Torque Setting	Torque Tolerance	Torque Wrench HP Part Number
3.5 mm	90 N-cm (8 in-lb)	±5.6 N-cm (±0.5 in-lb)	8710-1765

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 going to tighten. 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. Position both wrenches within 90 degrees of each other before applying force. (See Figure 4-7.) 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. (See Figure 4-8.) This is especially true when several devices are connected together.

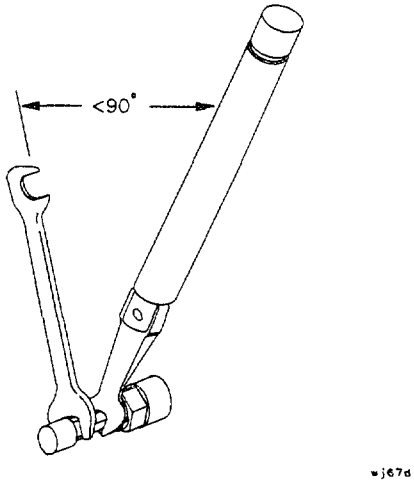


Figure 4-7. Correct Wrench Position

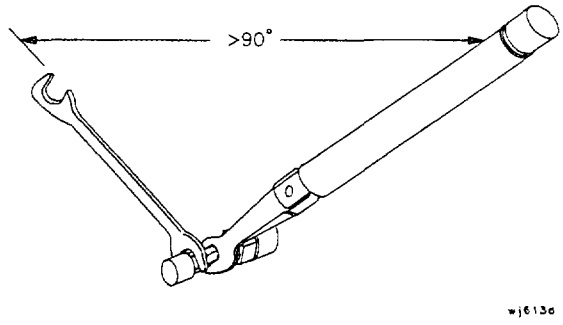


Figure 4-8. Incorrect Wrench Position

3. Hold the torque wrench lightly, at the end of the handle only (beyond the groove). (See Figure 4-9.)

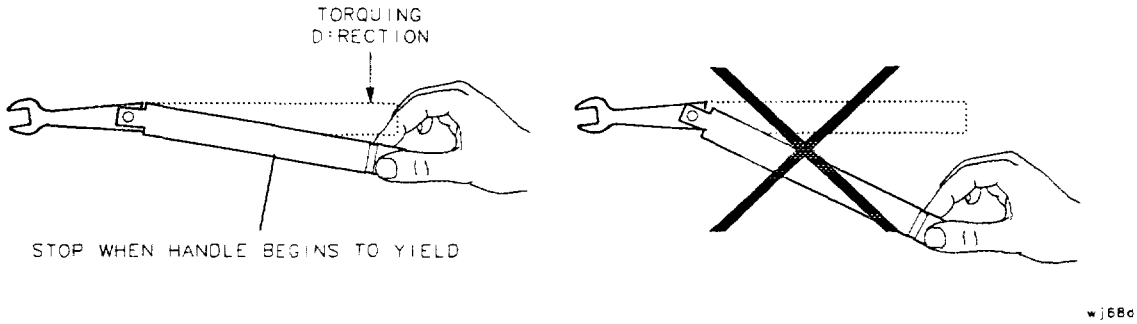


Figure 4-9. Using the Torque Wrench

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

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

5. Tighten the connection just to the torque wrench *break point*. The wrench handle gives way at its internal pivot point. (See Figure 4-9.) Do *not* tighten the connection further.

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

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

Do *not* twist the head of the wrench relative to the outer conductor mating plane. If you do, you apply more than the recommended torque.

How to make a disconnection

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

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 disconnection by hand, turning only the connector nut.

Caution Turn the connector nut, not the device body. Major damage to the center conductor can occur if the device body is twisted.

4. Pull the connectors straight apart without twisting or bending.

Handling and Storage

- Store calibration devices in a foam-lined storage case.
- 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.
- When you are not using a connector, use plastic end caps over the mating plane surfaces to keep them clean and protected.

5

Performance Verification

The performance of your calibration kit can only be verified by returning the kit to Hewlett-Packard 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.

What Recertification Provides

The following will be provided with a recertified kit:

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

Note A list of NIST (United States National Institute of Standards and Technology) traceable numbers may be purchased upon request to be included in the calibration report.

Hewlett-Packard offers both a *Standard* and a *U.S. MIL-STD 45662A* calibration for the recertification of this kit. For more information, contact the nearest Hewlett-Packard office. (See Table 6-1.)

How Often to Recertify

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

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

Where to Send a Kit for Recertification

Contact the sales and service office nearest you for information on where to send your kit for recertification. (Offices are listed in Table 6-1.)

When you return the kit, fill out and attach a service tag. (Refer to "Returning a Kit or Device to HP" in Chapter 6 for details.)

How Hewlett-Packard Verifies the Devices in this Kit

Hewlett-Packard verifies the specifications of these devices as follows:

The residual microwave error terms of the test system are verified with precision airlines and shorts, or low frequency resistance which is directly traced back to NIST (United States 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.

Each calibration device is electrically tested on this system. For the initial (before sale) testing of the calibration devices, Hewlett-Packard 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 Hewlett-Packard to the extent allowed by the Institute's calibration facility. The devices in this kit are traceable to NIST through Hewlett-Packard.

6

Troubleshooting

If you suspect a bad calibration or if your network analyzer does not pass performance verification, follow the steps in Figure 6-1.

Returning a Kit or Device to HP

If your kit or device requires service, contact the HP office nearest you for information on where to send it. (See Table 6-1.) When you send the kit or device to Hewlett-Packard, 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
- the model number and serial number of the kit
- the part number and serial number of each device
- the type of service required
- any applicable information

More Information

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

If you need additional information, contact your local Hewlett-Packard representatives. (Sales and service offices are listed in Table 6-1.)

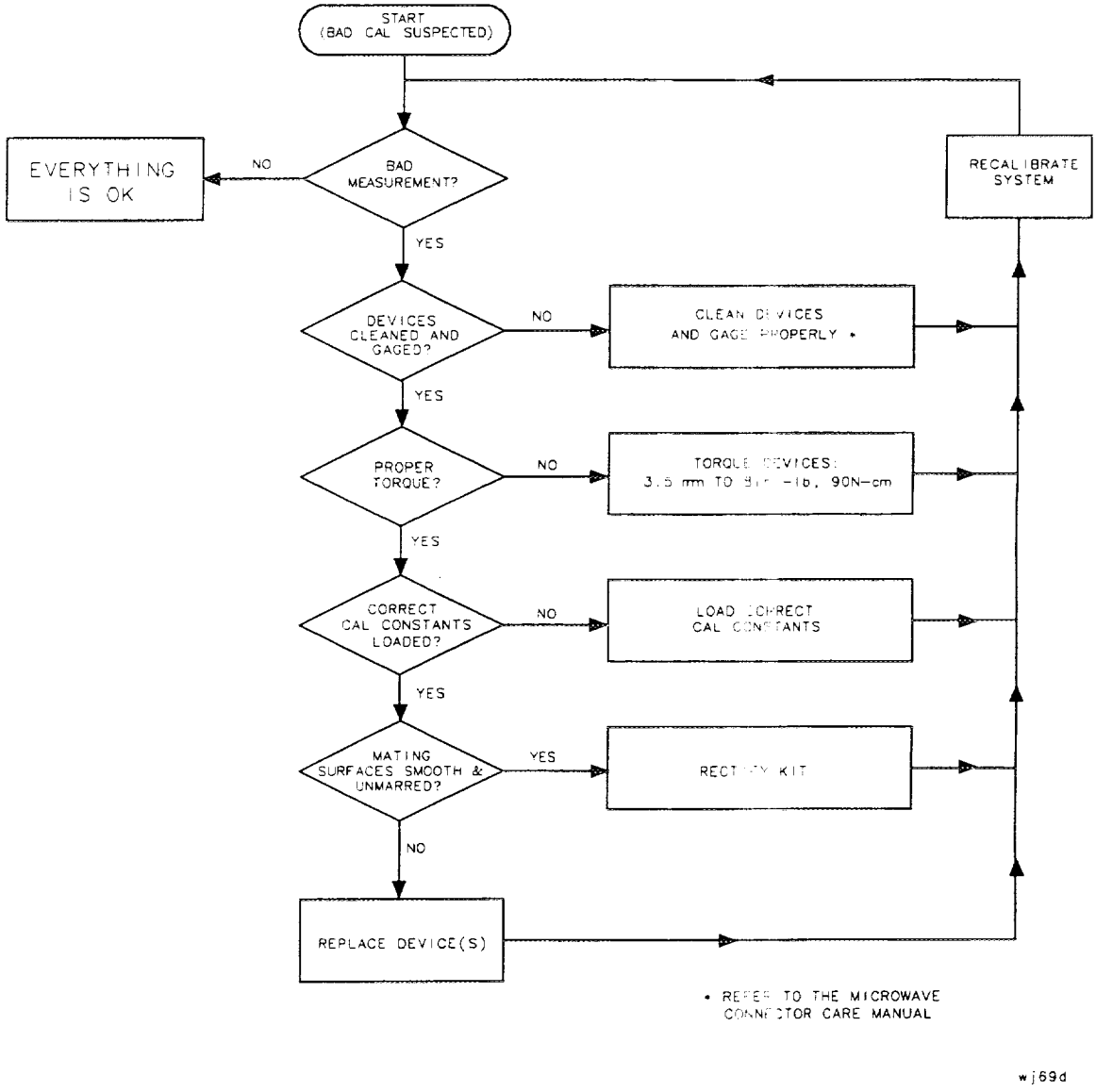


Figure 6-1. Troubleshooting Flowchart

Table 6-1. Hewlett-Packard Sales and Service Offices

UNITED STATES

Instrument Support Center
Hewlett-Packard Company
(800) 403-0801

EUROPEAN FIELD OPERATIONS

Headquarters
Hewlett-Packard S.A.
150, Route du Nant-d'Avril
1217 Meyrin 2/Geneva
Switzerland
(41 22) 780.8111

France
Hewlett-Packard France
1 Avenue Du Canada
Zone D'Activite De Courtaboeuf
F-91947 Les Ulis Cedex
France
(33 1) 69 82 60 60

Germany
Hewlett-Packard GmbH
Hewlett-Packard Strasse
61352 Bad Homburg v.d.H
Germany
(49 6172) 16-0

Great Britain
Hewlett-Packard Ltd.
Eskdale Road, Winnersh Triangle
Wokingham, Berkshire RG41 5DZ
England
(44 734) 696622

INTERCON FIELD OPERATIONS

Headquarters
Hewlett-Packard Company
3495 Deer Creek Road
Palo Alto, California, USA
94304-1316
(415) 857-5027

Australia
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130
(61 3) 895-2895

Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2X8
Canada
(514) 697-4232

China
China Hewlett-Packard Company
38 Bei San Huan X1 Road
Shuang Yu Shu
Hai Dian District
Beijing, China
(86 1) 256-6888

Japan
Hewlett-Packard Japan, Ltd.
9-1 Takakura-Cho, Hachioji
Tokyo 192, Japan
(81 426) 60-2111

Singapore
Hewlett-Packard Singapore (Pte.) Ltd.
150 Beach Road
#29-00 Gateway West
Singapore 0718
(65) 291-9088

Taiwan
Hewlett-Packard Taiwan
8th Floor, H-P Building
337 Fu Hsing North Road
Taipei, Taiwan
(886 2) 712-0404

7

Replaceable Parts

Table 7-1 lists the replacement part numbers for the HP 85033D calibration kit contents. To order a listed part, note the description, HP part number, and the quantity desired. Telephone or send your order to the nearest Hewlett-Packard sales and service office. (See Table 6-1.)

Table 7-1. Replaceable Parts for the HP 85033D

Item No.	Description	Qty Per Kit	HP Replacement Part Number
	Calibration Devices		
1	3.5 mm Male Broadband Load	1	85033-60009
2	3.5 mm Female Broadband Load	1	85033-60010
3	3.5 mm Male Offset Open	1	85033-60011
4	3.5 mm Female Offset Open	1	85033-60012
5	3.5 mm Male Offset Short	1	85033-60013
6	3.5 mm Female Offset Short	1	85033-60014
	Adapters (not included with option 001)		
7	7 mm to 3.5 mm Male	2	85052-60004
8	7 mm to 3.5 mm Female	2	85052-60003
	Adapters (Option 002)		
	Type-N Male to 3.5 mm Male	1	1250-1743
	Type-N Male to 3.5 mm Female	1	1250-1744
	Type-N Female to 3.5 mm Female	1	1250-1745
	Type-N Female to 3.5 mm mm Male	1	1250-1750
	Protective End Caps for Connectors		
9	For 7 mm Connectors	4	1401-0214
10	For 3.5 mm Male Connectors	5	1401-0208
11	For 3.5 mm Female Connectors	5	1401-0202
	Calibration Kit Storage Case		
12	Box (without foam pads)	1	85033-80015
13	Foam Pads (top and bottom)	1	85033-80016
14	Disk Holder	1	5180-8491
	Miscellaneous Items		
15	Open-Short-Load Holder	2	85033-40001
16	2.5 mm Hex Key	1	8710-1181
17	Calibration Constants Disk	1	85033-10010
18	Operating and Service Manual	1	85033-90027
	Items Not Included in Kit		
	3.5 mm Gage Set (for male connectors)		85052-60043
	3.5 mm Gage Set (for female connectors)		85052-60042
	5/16 in., 90 N-cm (8 in-lb) Torque Wrench		8710-1765
	Isopropyl Alcohol (30 ml)		8500-5344
	Cleaning Swabs (100)		9301-1243
	Microwave Connector Care Manual		08510-90064
	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		9300-1126
	3.5 mm Slotless Contact Repair Kit		85052B Opt. K11

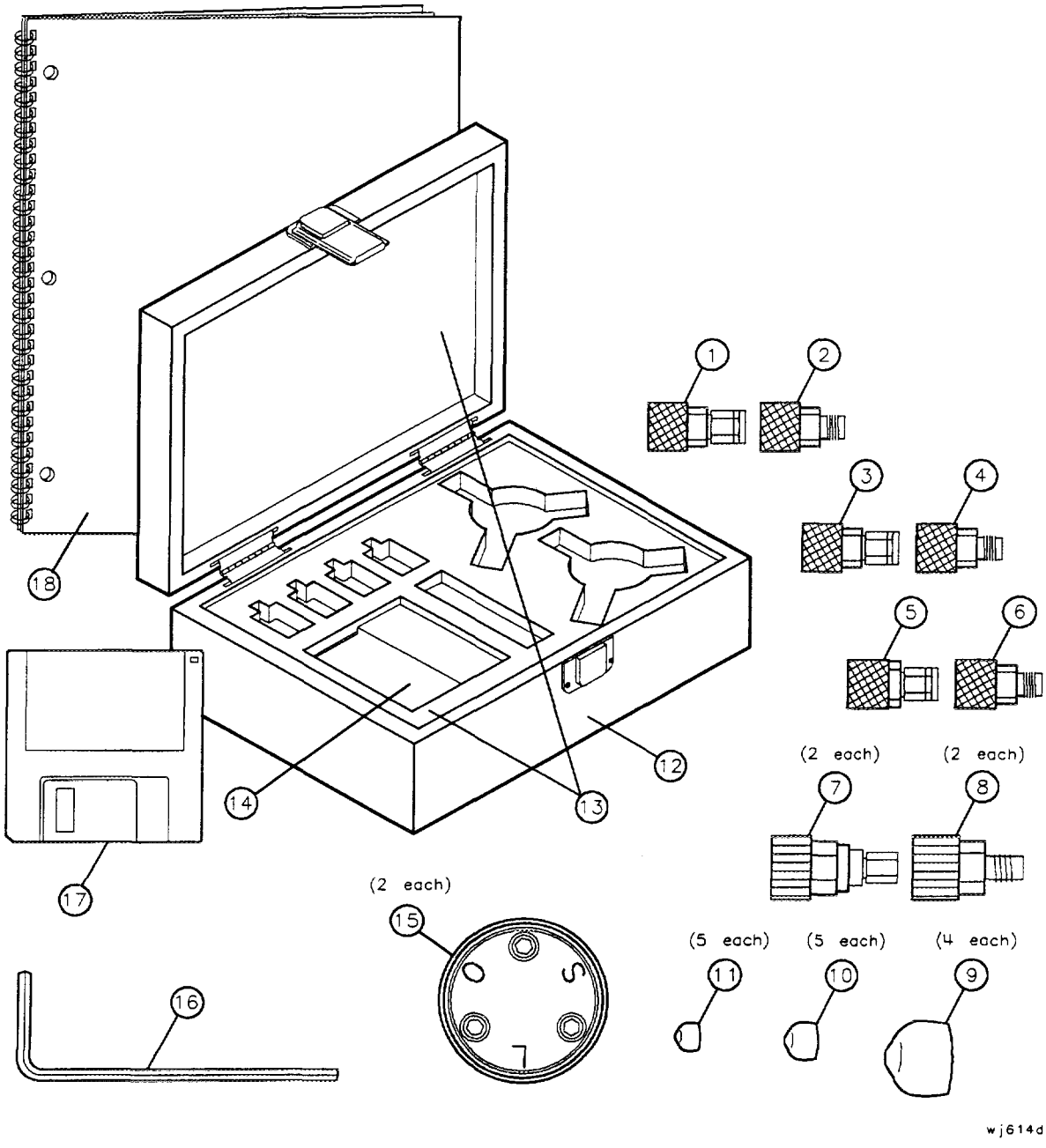


Figure 7-1. Replaceable Parts

Blank form

The blank form (Table A-2) is provided for use in modifying the standard class assignments to meet your individual requirements.

Table A-2.
Standard Class Assignments
Blank Form

Calibration Kit Label: _____

Disk File Name: _____

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 in order to perform valid calibrations. Refer to Chapter 3 for information on how to load, examine, and modify calibration constants.

Note The values in the standard class assignments and in the standard definitions tables 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 by doing the following:

1. Press (CAL) MORE SET Z0.
2. Observe the display to determine *current* system impedance.
3. If it is not 50 ohms, press (50) (X1).

Table A-3. Standard Definitions

System Z_0[a] = 50.0 Ω **Calibration Kit Label: 3.5 mmD**

Disk File Name (HP 8752A/B): A5235D

Disk File Name (HP 8753B/C): C5335D

STANDARD[b]		C0 $\times 10^{-15}$ F	C1 $\times 10^{-27}$ F/Hz	C2 $\times 10^{-36}$ F/Hz^2	C3 $\times 10^{-45}$ F/Hz^3	FIXED[c] or SLIDING	OFFSET			FREQ (GHz)		COAX or WG	STND LABEL
NO.	TYPE						DELAY s	Z_0 Ω	LO SS Ω/s	MIN	MAX		
1	Short	0	0	0	0		31.808p	50	2.36G	0	999	Coax	Short
2	Open	49.43	−310.13	23.17	−0.16		29.243p	50	2.2G	0	999	Coax	Open
3	Load					Fixed	0	50	2.3G	0	999	Coax	Broadband
4	Delay/Thru						0	50	2.3G	0	999	Coax	Thru
5													
6													
7													
8													

[a] Ensure system Z_0 of network analyzer is set to 50 ohms.
[b] Open, short, load, delay/thru, or arbitrary impedance.
[c] Load or arbitrary impedance only.