Operating and Service Manual

HP 85054B Type-N Calibration Kit

SERIAL NUMBERS

This manual applies directly to HP 85054B calibration kits with serial number prefix 3101A.

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).

HEWLETT PACKARD

HP Part No. 85054-90049
Printed in USA January 1997

Edition 2.1

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General Information

Calibration Kit Overview

The HP 85054B type-N calibration kit is used to calibrate network analyzer systems (such as the HP 8510 or HP 8720 series) for measurements of components with type-N connectors up to 18 GHz.

The calibration kit consists of the following:

- Offset opens and shorts, lowband and sliding load terminations.
- Four type-N to 7 mm adapters.
- Two type-N to type-N adapters.
- A type-N connector gage set.
- A 3/4 inch, 135 N-cm (12 in-lb) torque wrench for use on the type-N connectors.
- A spanner wrench.
- A data disk that contains the calibration constants of the devices in the kit for HP 8510C systems.

The standards in this calibration kit allow you to perform simple 1- or 2-port and TRM (thru-reflect-match) calibrations.

This manual describes the HP 85054B calibration kit and provides replacement part numbers, specifications, and procedures for using, maintaining and troubleshooting the kit.

Option 002 consists of the following:

- A data tape that contains the calibration constants of the devices in the kit for HP 8510A/B systems.

Option 1BP

Adds a MIL-STD 45662A Certificate of Calibration and the corresponding calibration data to the instrument. This option must be ordered when the instrument order is placed.

Option 1BN

Adds a MIL-STD 45662A Certificate of Calibration to the instrument. This option must be ordered when the instrument order is placed.

Note

This manual assumes you know proper connector care. If not, refer to "Principles of Microwave Connector Care—Quick Reference Card", located in the back of this manual. Refer to Chapter 7, "Replaceable Parts", for HP part number if another copy is needed.

Or, contact your nearest HP Sales office for the customer training course: "Understanding Connectors Used With Network Analyzers".

- HP 85050A + 24A (on site)
- HP 85050A + 24D (at HP sales office)

Equipment Required but Not Supplied

Open–end wrenches are required for use on the wrench flats of the connectors and gages in this kit. These wrenches and various connector cleaning supplies are *not* provided in this kit. (Refer to Chapter 7, "Replaceable Parts", 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.

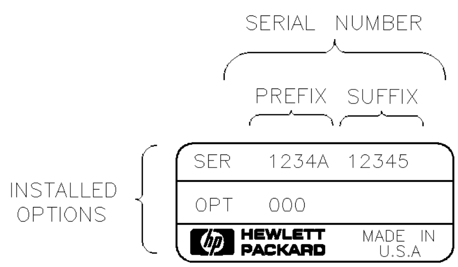

Figure 1-1. Typical Kit Serial Number Label

Calibration Kits Documented in this Manual

This manual applies to any HP 85054B calibration kit whose serial prefix is listed on the title page. If your calibration kit has a different serial number prefix than the one listed on the title page, refer to the "Calibration Kit History" section below for information on how this manual applies.

Calibration Kit History

This section describes calibration kits with serial number prefixes lower than the ones listed on the title page.

HP 85054B Kits with Serial Prefix 2906A

These calibration kits did not have the calibration constants disk to support the HP 8510C network analyzer. The part numbers provided in this manual are the recommended replacement parts for these kits. The devices in these kits should meet the specifications published in this manual.

Device Serial Numbers

In addition to the kit serial number, the devices in this kit are individually serialized (serial numbers are either labeled on or scribed 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 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	______________
Lowband Load (m)	______________
Lowband Load (f)	______________
Open (m)	______________
Open (f)	______________
Short (m)	______________
Short (f)	______________
Sliding Load (f)	______________
Sliding Load (m)	______________
Connector Gage (f)	______________
Gages	
Gage Master (f)	______________
Connector Gage (m)	______________
Gage Master (m)	______________
Adapters	
Type-N (m) to Type-N (m)	______________
Type-N (f) to Type-N (f)	______________
Type-N (f) to 7 mm	______________
Type-N (m) to 7 mm	______________

Incoming Inspection

Refer to Figure 7-1 and Figure 7-2 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, "Performance Verification."

The foam-lined storage case provides protection during shipping. If the case or any device appears damaged, contact the nearest Hewlett-Packard sales and service office. 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.
- If you are returning a complete kit, include the model number and serial number.
- If you are returning one or more devices, include the part numbers and serial numbers.
- Indicate the type of service required.
- Include any applicable information. If a repair is needed, please describe the problem.

Precision Slotless Connectors

The female type-N connectors in this calibration kit are metrology-grade, precision slotless connectors (PSC). A characteristic of metrology-grade connectors is direct traceability to national measurement standards through their well-defined mechanical dimensions.

Conventional female center conductors are slotted. When mated, the female center conductor is flared by the male pin. Because physical dimensions determine connector impedance, electrical characteristics of the female connector (and connection pair) are dependent upon the mechanical dimensions of the male pin. While connectors are used in pairs, their male and female halves are always specified separately as part of a standard, instrument, or device under test. Because of these facts, making precision measurements with the conventional slotted connector is very difficult, and establishing a direct traceability path to primary dimensional standards is nearly impossible.

The precision slotless connector was developed to eliminate these problems. All PSCs are female. A PSC incorporates a center conductor with a solid cylindrical shell that defines the outside diameter of the female center pin. Its outside diameter and, therefore, the impedance in its region does not change. The inner part provides an internal contact that flexes to accept the allowed range of male pin diameters.

The calibration of a network analyzer having a conventional slotted female connector on the test port remains valid only when the device under test and all calibration standards have identical male pin diameters. For this reason PSC test port adapters are supplied in most Hewlett-Packard calibration kits.

Precision slotless connectors have the following characteristics:

- There is no loss of traceable calibration on test ports when the male pin diameter of the connector on the device under test is different from the male pin diameter of the calibration standard.
- The female PSC and its mating male connector can be measured and specified separately as part of the device either is attached to.
- All female connectors can have a known, stable impedance based only on the diameters of their inner and outer conductors.
- Female calibration standards can be fully specified. Their specifications and traceability are unaffected by the diameter of the male mating pin.
- A fully traceable performance verification is made using a precision 50Ω airline having a PSC.
- Measurement repeatability is enhanced due to non–changing connector characteristics with various pin diameters.

With PSCs on test ports and standards, the percentage of accuracy achieved when measuring at 50 dB return loss levels is comparable to using conventional slotted connectors measuring devices having only 30 dB return loss. This represents an accuracy improvement of about 10 times.

Clarifying Connector Sex

In this manual, devices are referred to in terms of their connector unless otherwise stated. For example, a male open has a male connector.

During a measurement calibration, however, the HP 8510 and HP 8720 softkey menus will label a type–N calibration device with the sex of the analyzer's test port connector – *not* the device connector. For example, the label SHORT (F) on the display refers to the short that will be connected to the *female* test port.

Preventive Maintenance

The best techniques for maintaining the integrity of the devices in this kit include routine visual inspection and cleaning, and proper gaging and 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, "Gaging and Making Connections."

2

Specifications

Environmental Requirements

Table 2-1. Environmental Requirements

Parameter	Required Values/Ranges
Operating Temperature[1]	20° to 26°C (68° to 79°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 meters (≈15,000 feet)
Storage	< 15,000 meters (≈50,000 feet)
Relative Humidity	Always Non–Condensing
Operation	0 to 80% (26°C maximum dry bulb)
Storage	0 to 90%

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 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.

Performance verification and measurements of devices under test need not be performed within the operating temperature range of the calibration devices, but they must be within the error–corrected temperature of the network analyzer (±1°C of the measurement calibration temperature). For example, if the calibration is performed at +20°C, the error–corrected temperature range is +19° to +21°C. It is then appropriate to perform measurements and performance verifications at +19°, which is outside the operating temperature range of the calibration devices, since only the actual calibration must be performed within the operating temperature range.

Mechanical Characteristics

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, "Gaging and Making Connections", explains how to use the gages provided in this kit 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

Table 2-2. Electrical Specifications

Device	Frequency (GHz)	Parameter	Specification
Lowband Loads	DC to ≤ 2	Return Loss	≥ 48 dB ($\leq 0.00398\ \rho$)
Sliding Loads[1]	> 2 to ≤ 18	Return Loss	≥ 42 dB ($\leq 0.00794\ \rho$)
Adapters	DC to ≤ 8	Return Loss	≥ 34 dB ($\leq 0.0200\ \rho$)
(both types)	> 8 to ≤ 18	Return Loss	≥ 28 dB ($\leq 0.0398\ \rho$)
Offset Opens[2]	at 18	Deviation from Nominal:	
		Phase	$\pm 1.5°$
Offset Shorts[2]	at 18	Deviation from Nominal:	
		Phase	$\pm 1.0°$

1 The specifications for the sliding load termination include the quality of the airline portions within the sliding load combined with the effective stability of the sliding element.

2 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-4 and Table A-5).

Residual Errors after Calibration

The HP 8510 "Specifications and Performance Verification" software can be used to obtain a printout of the residual errors after a calibration has been performed. Refer to the "Specifications and Performance Verification" section of the HP 8510C *On–Site Service Manual* for information on how to use the software.

3

User Information

The Calibration Devices and Their Use

The HP 85054B type-N calibration kit contains four types of type-N calibration devices with both male and female connectors: 50 ohm lowband loads, offset short circuits, offset open circuits, and sliding loads.

For measurement convenience, the kit also contains two type-N to type-N adapters and four type-N to 7 mm adapters. The adapters are primarily intended for use in measuring non-insertable devices, but can also be used as connector savers.

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

Lowband Loads

The lowband loads are metrology-grade, 50 ohm terminations which have been optimized for lowband performance up to 2 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 precision machined. 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, and to ensure stable, repeatable connections. 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 (such as adapter removal).

Sliding Loads

The sliding loads in this kit are designed to provide excellent performance from 2 GHz to 18 GHz. The inner and outer conductors of the airline portion are precision machined to state-of-the-art tolerances. Although the sliding load has exceptional return loss, its superior load stability qualifies it as a high performance device.

With customer usability in mind, the sliding load was designed with the ability to extend the inner conductor for connection purposes and then pull it back to a preset pin depth. This feature is critical since it minimizes the possibility of damage during the connection while at the same time maintaining a minimum pin depth to optimize performance.

Using the Sliding Load

When performing a sliding load calibration, it is recommended that the sliding ring be set at the marked positions (rings) along the sliding load body (except for the third set mark where you should make the entry approximately 0.2 inches past it). Using the set marks ensures that a broad distribution of phase angles is selected, thereby optimizing the calibration. Follow the steps below while referring to Figure 3-1 to perform a sliding load calibration.

1. Move the sliding ring forward as far as possible toward the connector end of the load. The front edge of the sliding ring should be almost flush with the first set mark.
2. On the analyzer, select the softkey `SLIDE IS SET`.
3. Slowly move the sliding ring back until its front edge lines up with the next set mark.
4. On the analyzer, select the softkey `SLIDE IS SET`.

Note After a calibration has begun, always move the sliding ring toward the center conductor pullback end of the sliding load. If you slightly overshoot the desired mark, do not move the sliding ring, but continue with the calibration as if the sliding ring is set to the proper position.

5. Repeat steps 3 and 4 until the prompt `PRESS 'DONE' IF FINISHED WITH STD(S)` appears on the analyzer display. If you want more set marks sampled, you may continue.
6. Select the softkey `SLIDING LOAD DONE`.

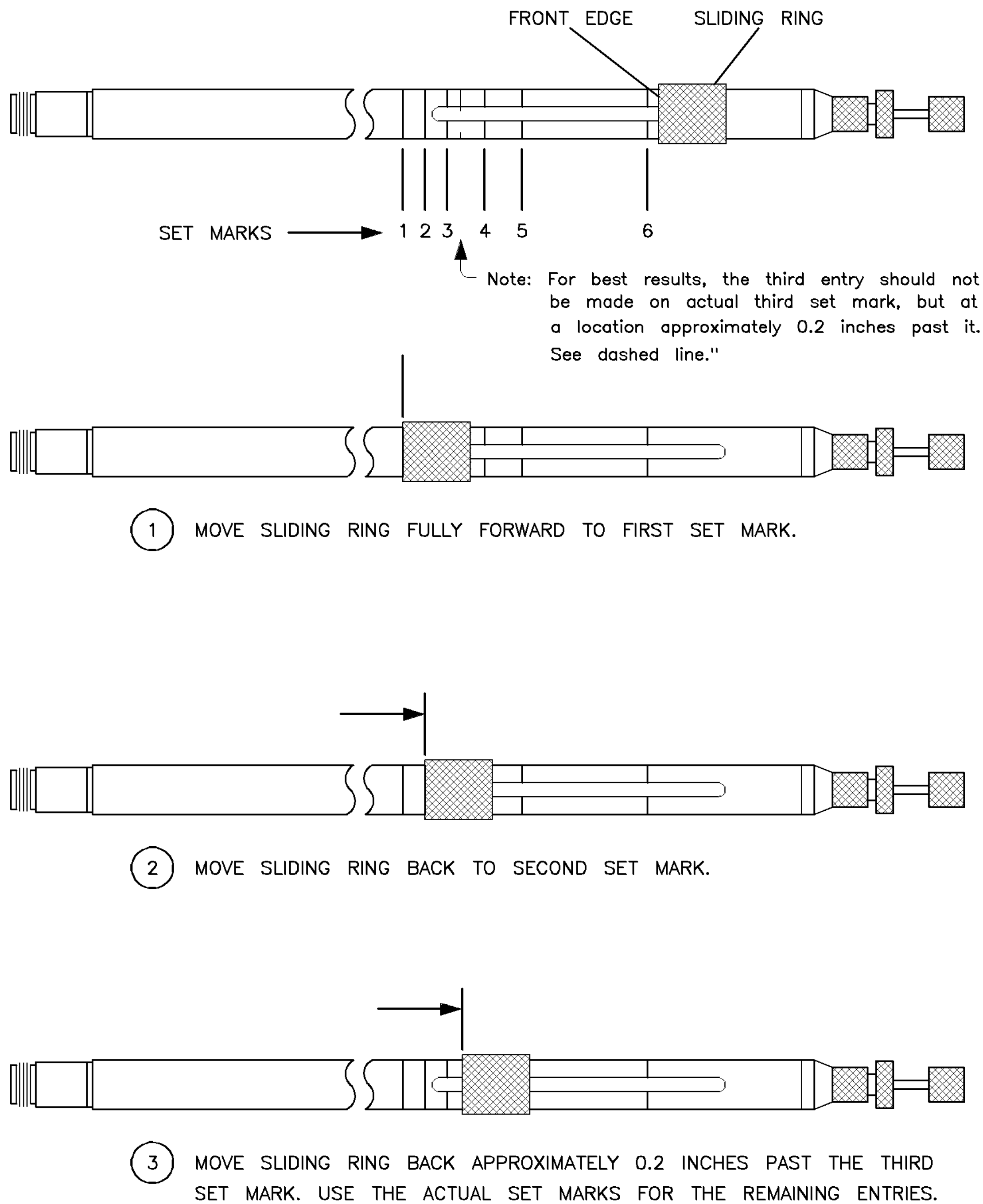

Figure 3-1. Using the Sliding Load

HP 8510 Information

Loading Calibration Constants

Use one of the following procedures to load the calibration constants into HP 8510 memory.

For HP 8510A/B

1. Insert the calibration constants tape (optin 002) into the HP 85101 drive.
2. Press (TAPE/DISC).
3. Select LOAD.
   The analyzer displays SELECT DATA TYPE TO LOAD.
4. Select CAL KIT 1--2.
5. Select either * 1 or * 2.
   The analyzer displays SELECT CAL KIT FILE TO LOAD.
6. Select * FILE 1 to load the calibration constants into memory.
7. Remove the tape from the drive.

For HP 8510C

1. Insert the calibration constants disk into the HP 85101 drive.
2. Press (DISC).
3. Select LOAD.
   The analyzer displays SELECT DATA TYPE TO LOAD.
4. Select CAL KIT 1--2.
5. Select either * 1 or * 2.
   The analyzer displays USE KNOB OR STEP KEYS TO SELECT A FILE.
6. Select CK_NTYPB2 from the display menu.
7. Select LOAD FILE.
8. Remove the disk from the drive.

Duplicating a Calibration Constants Disk

Use the following procedure to make a backup copy of a calibration constants disk on an HP 8510C network analyzer. If you are using a different network analyzer, or are using an external disk drive, refer to the analyzer documentation.

1. Load the original calibration constants disk (see previous procedure).
2. Initialize a blank disk:
   a. Insert the disk into the HP 85101 disk drive.
   b. Press (DISC).
   c. Select STORAGE IS INTERNAL SETUP DISC INITIALIZE DISC YES.
3. With an initialized disk in the HP 85101 disk drive, transfer the calibration constants:
   a. Press (DISC) (STORE).
   b. Select CAL KIT/1--2 CAL KIT/*1.
   c. Select the appropriate data type.
4. Remove, write protect, and label the disk.

Performing a Calibration

Use the following steps to set up an HP 8510 network analyzer for a type–N calibration.

1. Be sure that the system impedance is set to 50 ohms by pressing (CAL) MORE SET Z0.
2. If the display does *not* read 50.0 Ω, press (5) (0) (x1).
3. Load the type–N file from the calibration constants disk (or tape). Refer to the "Loading Calibration Constants" section of this chapter.
4. Press (CAL) TYPE N B.2. The calibration options are available as softkeys on the display. As selections are made, more softkeys appear.
5. Follow the prompts on the display or refer to the HP 8510 *Operating Manual* for more information.

Note During the calibration, you may be asked to choose OPEN (M), OPEN (F), SHORT (M), or SHORT (F). The (M) and (F) refer to the sex of the test port connector to which you are connecting the device. It does not refer to the sex of the calibration device. This convention is used in the softkey menus of the HP 8510 network analyzer during the calibration process. It is also used in the standard definitions, Table A-4.

Examining Calibration Constants

Use the following procedure to examine the calibration constants of a short. To examine the calibration constants of a different standard, substitute the standard number in step 3 with the standard number of the device you want to examine. For example, to examine the calibration constants for an open, press (2) (x1). See Table A-4 and Table A-5, at the end of this manual, for the standard numbers.

1. Press (CAL).
2. Select:
   a. MORE .
   b. MODIFY 1 or MODIFY 2 (depending on where the calibration constants are loaded).
   c. DEFINE STANDARD .
3. Press (1) (x1) (the calibration standard number).
   The softkey SHORT is underlined.
4. Select:
   a. SHORT L0 L1 L2 L3 (the analyzer displays the value of each L–term as the softkeys are selected).
   b. SPECIFY OFFSET
   c. OFFSET DELAY (the analyzer displays the value)
   d. OFFSET LOSS (the analyzer displays the value)
   e. OFFSET Z0 (the analyzer displays the value)
   f. MINIMUM FREQUENCY (the analyzer displays the minimum frequency).
   g. MAXIMUM FREQUENCY (the analyzer displays the maximum frequency).
   The softkey COAX is underlined
5. Select (PRIOR MENU) LABEL STD .
   SHORT (M) is displayed on the analyzer (in the upper left corner of the display).
6. Press:
   a. (PRIOR MENU) three times.
   The top softkey is DEFINE STANDARD .
   b. (ENTRY OFF).

Changing Calibration Constants

Use the following procedure to change the calibration constants of a short. To change the calibration constants of a different standard, substitute the standard number in step 3 with the standard number of the device you want to change. For example, to change the calibration constants for an open, press (2) (x1). See Table A-4 and Table A-5 at the end of this manual for the standard numbers.

Note Hewlett-Packard provides this procedure for users who wish to customize standards definitions for their own special purposes. Customers who do this need to be aware that doing so may invalidate the published specifications of their network analyzer.

For more information on how to modify calibrations kit definitions, see product note 8510-5A (included in this kit or for ordering information contact your nearest Hewlett-Packard Office).

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1. Press (CAL).
2. Select:
   a. MORE.
   b. MODIFY 1 or MODIFY 2 (depending on where the calibration constants are loaded).
   c. DEFINE STANDARD.
3. Press (1) (x1) (the calibration standard number).
   The softkey SHORT is underlined.
4. Select:
   a. SHORT L0, and enter the new L–term value. Do the same for L1, L2 and L3.
   b. SPECIFY OFFSET.
   c. OFFSET DELAY, and enter the new offset delay.
   d. OFFSET LOSS, and enter the new offset loss.
   e. OFFSET Z0, and enter the new Z_0.
   f. MINIMUM FREQUENCY, and enter the new minimum frequency.
   g. MAXIMUM FREQUENCY, and enter the new maximum frequency.
   The softkey COAX is underlined.
5. Select (PRIOR MENU) LABEL STD.
   SHORT (M) is displayed on the analyzer (in the upper left corner of the display).
6. Select TITLE DONE STD DONE (DEFINED).
7. Relabel the kit:
   a. Select LABEL KIT and follow the instructions on the analyzer. You can enter a total of 10 characters.
   b. Select TITLE DONE.

HP 8720 Series Information

The calibration constants for this kit have already been stored in the memory of the HP 8720 series network analyzers (includes HP 8719 and HP 8722). It is not necessary to reload these constants.

To select the type–N calibration constants, press (CAL) Cal Kit Select Cal Kit. A menu will appear showing all of the different connector types in which the analyzer can calibrate. Select N 50Ω for use with this kit.

Refer to the appropriate HP 8720 series *Operating Manual* for step–by–step calibration procedures and system uncertainty information.

Note During the calibration, you may be asked to choose OPEN (M), OPEN (F), SHORT (M), or SHORT (F). The (M) and (F) refer to the sex of the test port connector to which you are connecting the device. It does not refer to the sex of the calibration device. This convention is used in the softkey menus of HP 8720 series network analyzers during the calibration process. It is also used in the standard definitions, Table A-5.

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 can build up on your body and can easily damage sensitive internal circuit elements when discharged by making contact with the center conductor. Static discharges too small to be felt can nevertheless 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 having a 1 MΩ resistor in series with 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.

Refer to Chapter 7, “Replaceable Parts”, 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 slotted connectors and 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.

Obvious Defects or Damage

Examine the connectors first for obvious defects or damage: badly worn plating, 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.

Any connector that has obvious defects should be discarded or sent for repair.

Mating Plane Surfaces

Flat contact between the connectors at all points on their mating plane surfaces is required for a good connection. Look especially for deep scratches or dents, and for dirt and metal particles on the connector mating plane surfaces.

Also look for bent or rounded edges on the mating plane surfaces of the center and outer conductors and 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. Damaged connectors should be discarded or sent for repair. Try to determine the cause of damage before connecting a new, undamaged connector in the same configuration.

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, it is still advisable to inspect them regularly for damage.

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. 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 test port connectors. Replace all worn connectors.

Cleaning Connectors

For details on cleaning connectors, see "Principles of Microwave Connector Care—Quick Reference Card", located in the back of this manual. Refer to Chapter 7, "Replaceable Parts", for the HP part number if another copy is needed.

Pin Depth

Definition of Pin Depth

Pin depth is the distance the center conductor mating plane differs from being flush with the outer conductor mating plane (see Figure 4-1). Some coaxial connectors (such as 2.4 mm and 3.5 mm) are designed to have these planes nearly flush. Type–N connectors, however, are designed with a pin depth offset of approximately 5.26 mm (0.207 inch) not permitting these planes to be flush. The male center conductors are recessed by the offset value while the female center conductors compensate by protruding the same amount. This offset necessitates the redefining of pin depth with regard to protrusion and recession.

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

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

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 4-1.

Importance of Pin Depth

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 4-1 for an illustration of pin depth in type–N connectors.

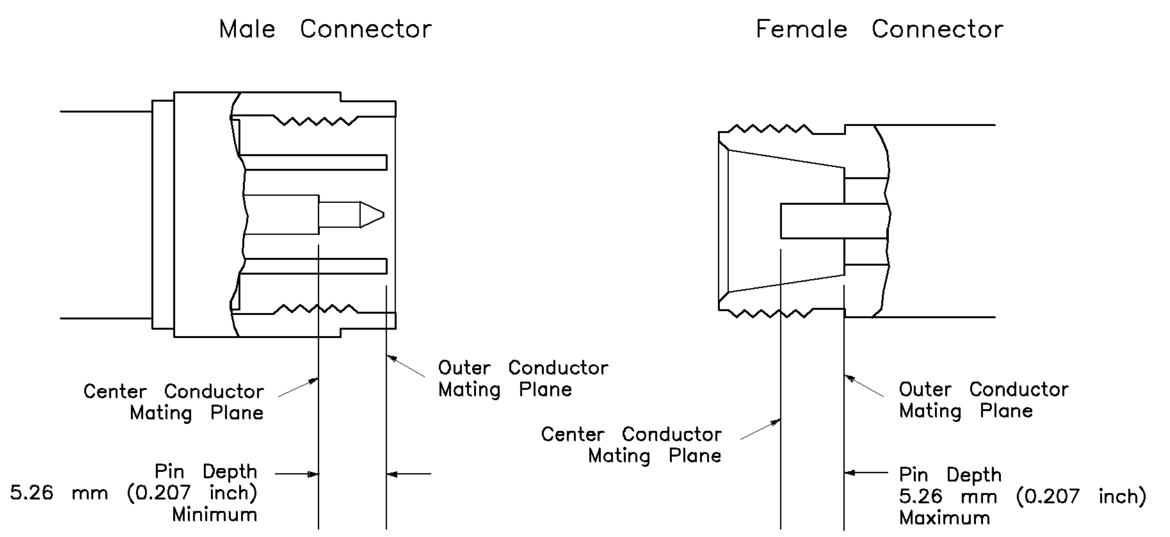


Figure 4-1. Connector Pin Depth

Gaging Connectors

Gage Intent

The gages in this kit 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. They are especially useful in determining if the pin depths of sliding loads are grossly out of adjustment. *Do not use gages for precise pin depth measurements.*

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 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.

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, "User Information", for more information on the design of the calibration devices in this kit.

Table 4-1. Pin Depth Limits

Type–N 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)	+3.8 to −3.8 (+1.5 to −1.5	+3.8 to −16.5 (+1.5 to −6.5)
Shorts	0 to −12.7 (0 to −5.0)	+3.8 to −3.8 (+1.5 to −1.5	+3.8 to −16.5 (+1.5 to −6.5)
Lowband Loads	0 to −50.8 (0 to −20.0)	+3.8 to −3.8 (+1.5 to −1.5)	+3.8 to −54.6 (+1.5 to −21.5)
Sliding Loads	0 to −7.6 (0 to −3.0)	+3.8 to −3.8 (+1.5 to −1.5)	+3.8 to −11.4 (+1.5 to −4.5)
Adapters (7 mm end)	0 to −50.8 (0 to −20.0)	+3.8 to −3.8 (+1.5 to −1.5)	+3.8 to −54.6 (+1.5 to −21.5)
Adapters (type–N end)	0 to −12.7 (0 to −5.0)	+3.8 to −3.8 (+1.5 to −1.5)	+3.8 to −16.5 (+1.5 to −6.5)

1 Approximately +2 sigma to −2 sigma of gage uncertainty based on studies done at the factory using the 85054–60049 gage 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 4-1 to evaluate the condition of device connectors.

When to Gage Connectors

Gage a connector at the following times:

- Before you use it the first time. It is recommended that you record the initial pin depth measurement of the device to compare with future readings. This serves 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.
- As a matter of routine: 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 4-2). 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 travel counterclockwise to determine the amount of *recession*. If the center conductor protrudes, the indicator will move clockwise to measure the amount of *protrusion*.

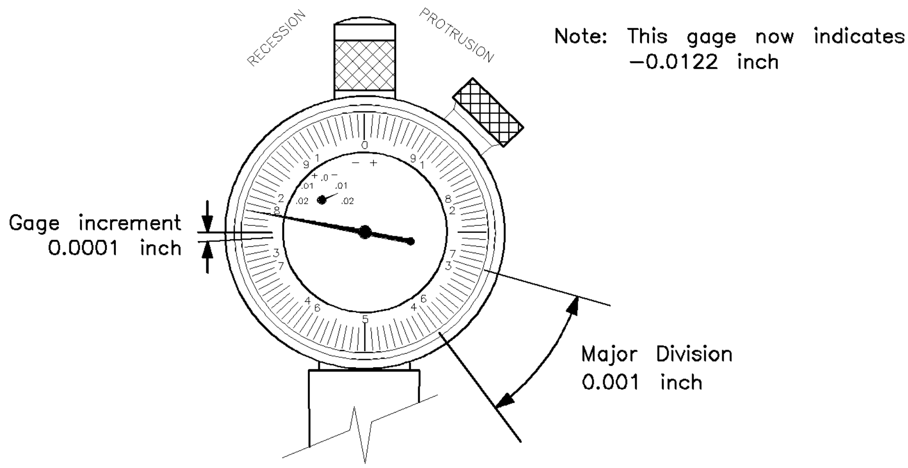


Figure 4-2. Reading the Connector Gage

Adjusting the Connector Gage

Gages are matched with gage masters at the factory. The paired master is then labeled with an offset value to compensate for its inaccuracy with its gage. This label appears on the bottom of all masters that have been paired with gages. When setting the gage with its master, always set the gage to the master offset value shown on the label and not to *zero* unless that is the offset value indicated. Use the following steps to adjust 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, "Replaceable Parts", 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. Adjust the gage (see Figure 4-3):
   a. While holding the gage by the plunger barrel, use the connecting nut 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. 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 (see Figure 4-3). 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.

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

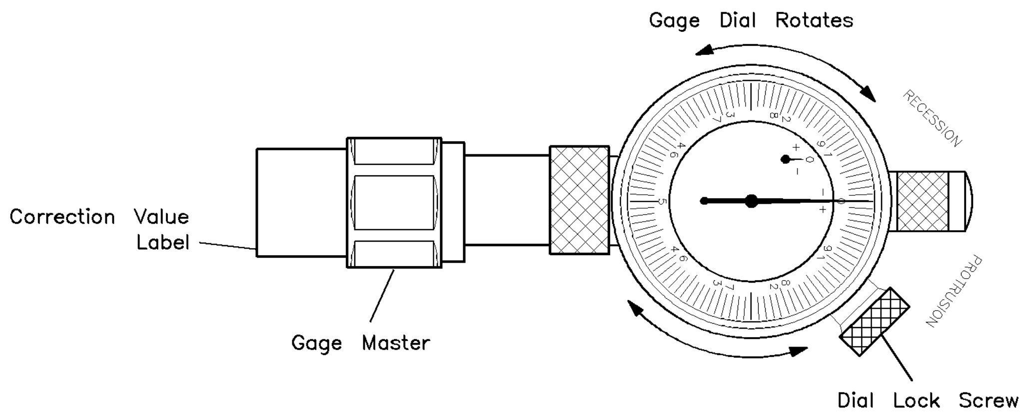


Figure 4-3. Adjusting the Connector Gage

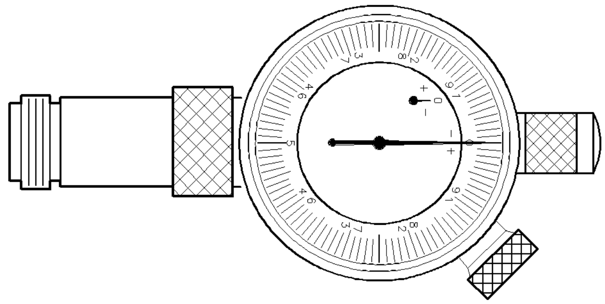
Measuring the Connector

Male Type–N Connectors

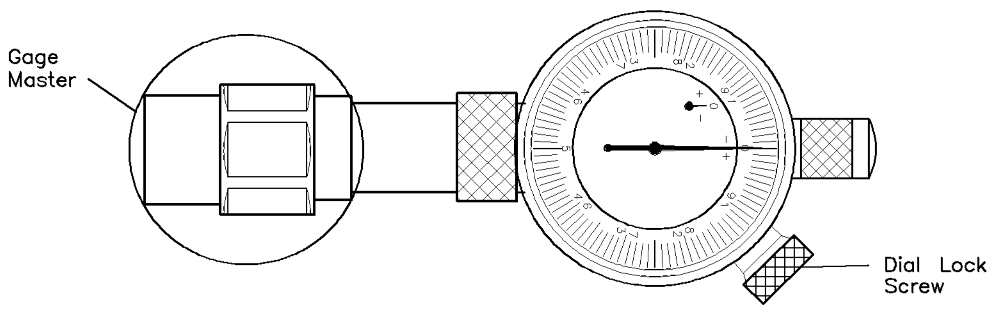
1. Refer to Figure 4-4.
2. Adjust the gage as described in "Adjusting the Connector Gage."
3. While holding the gage by the barrel, screw on the connector of the device being measured. Without turning the gage or the device, connect the nut finger–tight.
4. Torque the connector onto the gage to 135 N–cm (12 in–lb).
5. Gently tap the barrel of the gage with your finger to settle the gage reading.
6. Read the gage indicator dial. If the needle had moved clockwise, the center conductor is protruding and the value is determined by the *black* numbers. If the needle had moved counterclockwise, the center conductor is recessed by an amount determined by the *red* numbers.
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 performing pin depth measurements, use different orientations of the gage within the connector. Averaging a minimum of three readings, each taken after a quarter–turn rotation of the gage, reduces measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.

- Use screw–on male connector gage.



- Connect gage master and adjust gage to correction value called out on gage master label. Tighten dial lock screw after adjustment.



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

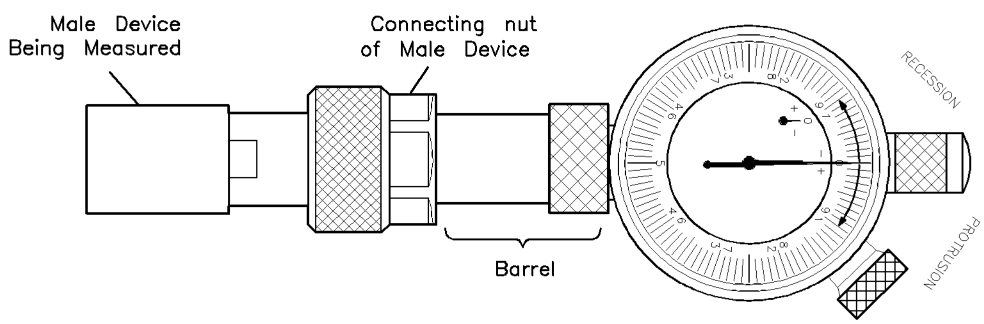


Figure 4-4. Gaging a Type–N Male Connector

Female Type–N Connectors

1. Refer to Figure 4-5.
2. Adjust the gage as described in “Adjusting the Connector 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 135 N–cm (12 in–lb).
5. Gently tap the barrel of the gage with your finger to settle the gage reading.
6. Read the gage indicator dial. If the needle had moved clockwise, the center conductor is protruding and the value is determined by the *black* numbers. If the needle had moved counterclockwise, the center conductor is recessed by an amount determined by the *red* numbers.
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 performing pin depth measurements, use different orientations of the gage within the connector. Averaging a minimum of three readings, each taken after a quarter–turn rotation of the gage, reduces measurement variations that result from the gage or the connector face not being exactly perpendicular to the center axis.

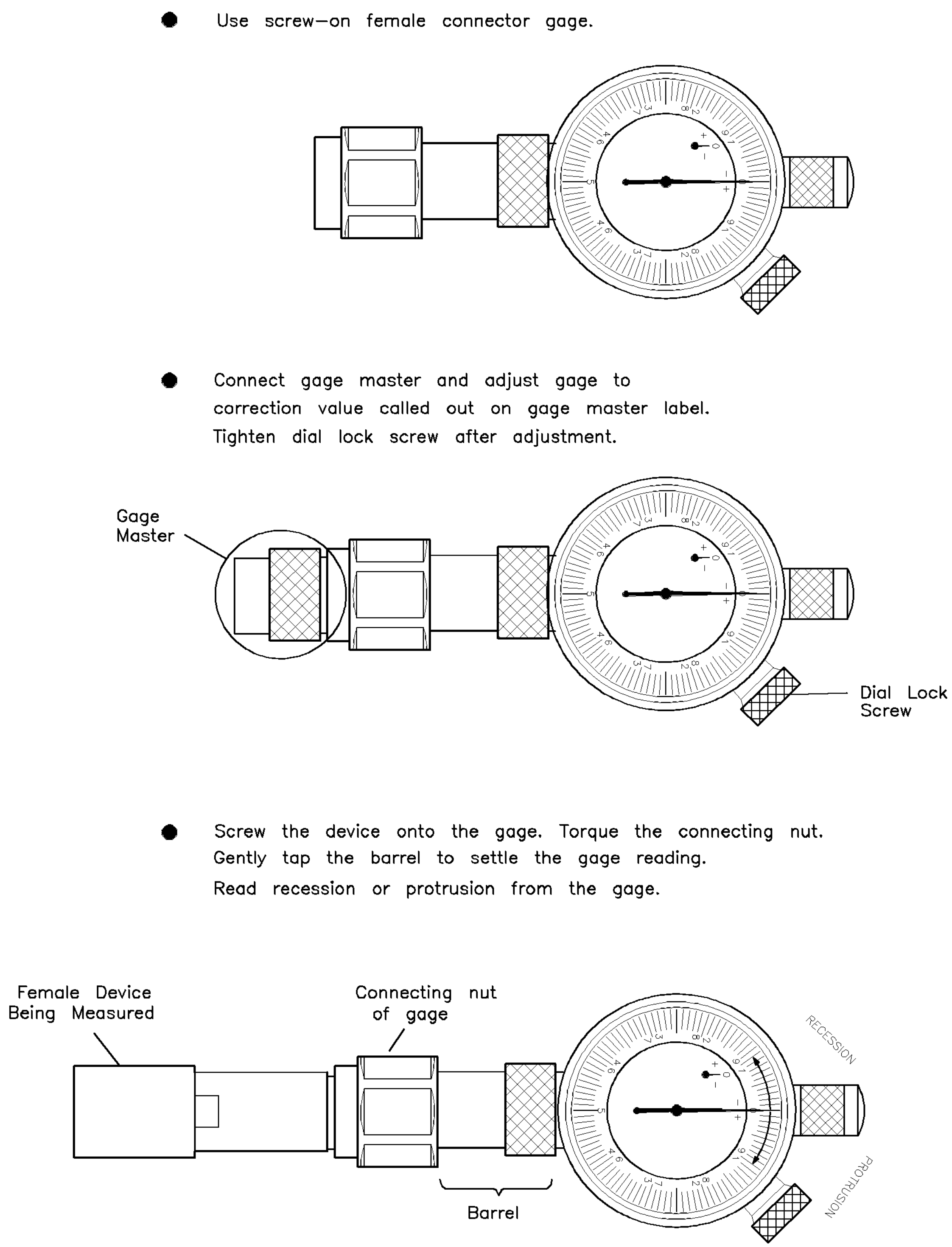


Figure 4-5. Gaging a Type–N Female Connector

Gaging the Sliding Load

Refer to Figure 4-6. Gage the sliding load before each use. If the sliding load pin depth is out of the *observed* pin depth limits (see Table 4-1), refer to “Adjusting the Sliding Load Pin Depth.”

1. Adjust the gage as described in “Adjusting the Connector Gage.”
2. Remove the protective end cap from the sliding load.
3. Loosen the center conductor pull back nut completely, and press the center conductor cap to extend the center conductor beyond the end of the connector. With the sliding ring pulled back approximately 0.5 inch, install a centering bead in the connector end of the sliding load.
4. Continue to press the center conductor cap and mate the center conductor of the sliding load with the gage’s center conductor.

CAUTION The sliding load center conductor can be damaged if the sliding load is not held in line when mating the load to a connector. Always line up the sliding load when connecting or removing it from a connector.

5. Mate the outer conductor of the sliding load with the outer conductor of the gage. Torque the connection with a 3/4 inch torque wrench to approximately 135 N–cm (12 in–lb). Retighten the center conductor pull back nut. It will “click” when it is tight.
6. Gently tap the barrel of the gage with your finger to settle the gage reading.
7. Read the gage indicator dial. If the needle had moved clockwise, the center conductor is protruding and the value is determined by the *black* numbers. If the needle had moved counterclockwise, the center conductor is recessed by an amount determined by the *red* numbers.
8. For maximum accuracy, measure the connector a minimum of three times and take an average of the readings.

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

9. Compare the average reading with the *observed* pin depth limits in Table 4-1. If the pin depth is outside the limits, follow the procedure, “Adjusting the Sliding Load Pin Depth.”
10. Loosen the connection between the gage and the sliding load, and remove the sliding load from the gage.
11. Carefully remove the centering bead from the sliding load. If the centering bead does not come out of the sliding load easily, loosen the center conductor pull back nut, and press the center conductor cap to extend the center conductor. This should expose the centering bead so that it may be removed. Retract the center conductor and retighten the pull back nut.

    If the centering bead still will not come out, hold the sliding load with the connector end pointed down. Move the sliding element up, then quickly down. The trapped air behind the centering bead helps eject it.

CAUTION Damage can occur to the sliding load during the removal of a centering bead that has slipped too far into the sliding load. Prevent damage by removing the centering bead immediately after gaging the sliding load pin depth. The sliding load will not perform to its specifications if the centering bead is not removed from the sliding load before an electrical calibration.

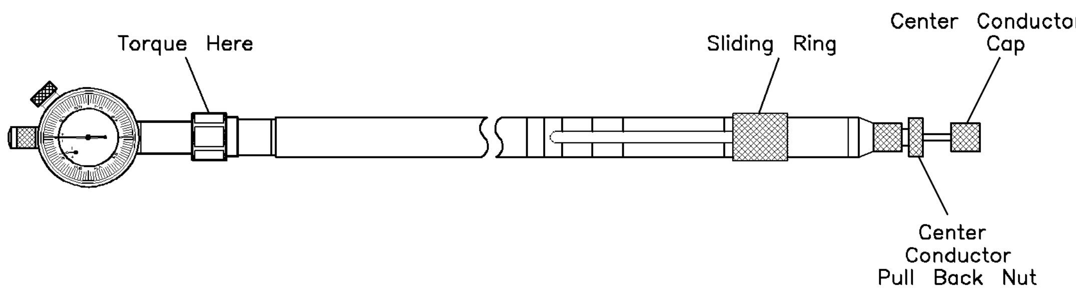


Figure 4-6. Gaging the Sliding Load

Adjusting the Sliding Load Pin Depth

Refer to Figure 4-7. The sliding loads included in this kit have a setback mechanism that allows the pin depth to be set to any desired value. The pin depth of the sliding load is preset at the factory. *This pin depth should not have to be reset each time the sliding load is used*, but should be checked before each use. If the pin depth of the sliding load is outside the *observed* limits in Table 4-1, follow the procedure below to reset it to a nominal −3.81 micrometers (-1.5×10^{-4} inches).

1. Adjust the gage as described in "Adjusting the Connector Gage." Attach the gage to the sliding load according to the procedure, "Gaging the Sliding Load." Torque the connection using the 135 N–cm (12 in–lb) torque wrench supplied with the kit. The back side of the sliding load and the face of the gage should be facing up.

CAUTION Do not loosen any hex screws other than the two largest hex screws pointed out in Figure 4-7. Doing so may render the set back mechanism in the sliding load inoperable.

2. With a 0.050 inch hex key, loosen the *two largest* hex screws by turning them one–quarter turn counterclockwise.
3. Gently turn the center conductor pin depth adjustment knob on the sliding load until the pointer on the gage reads −3.81 micrometers (-1.5×10^{-4} inches).
4. Tighten the two hex screws until they are finger tight.
5. Set the assembly down for five minutes to let the temperature stabilize. Repeat steps 2 through 5 if the reading on the gage drifts out of the *observed range* called out in Table 4-1.
6. Loosen the connecting nut and remove the gage from the sliding load. Be sure to also remove the centering bead.

Note After setting the pin depth it is recommended that at least three additional measurements be taken, each having a different gage orientation on the connector. The average value of these measurements should meet the *observed* limits in Table 4-1.

The pin depth of the sliding load is now set to the proper range listed in Table 4-1 (which allows for the gage uncertainty) and is ready for use. Replace the protective caps on the sliding load and the gage when they are not in use.

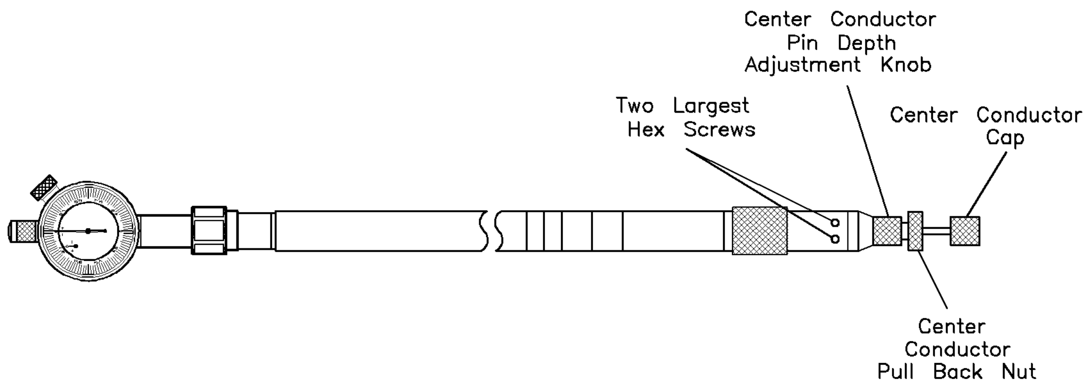


Figure 4-7. Setting the Sliding Load Pin Depth

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

Follow these recommendations for optimum connection technique:

- Clean and inspect (visually and mechanically) all connectors.
- Align connectors carefully. Look for flat physical contact at all points on the mating plane surfaces
- Make a gentle, preliminary connection.
- When you make a connection, turn *only* the connector nut. Do not rotate a device when you make a connection and do not apply lateral or horizontal (bending) force.
- Use an open–end wrench to keep the device from rotating when making the final connection with the torque wrench (see Figure 4-8).

Connection Procedure

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* twist one connector into the other (like inserting a light bulb). This happens if you turn the device body rather than 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 (no more than 2 inch–pounds of torque) is enough.
8. Relieve any side pressure on the connection from long or heavy devices or cables. This assures consistent torque in the following steps.

Using the Torque Wrench

1. Use the torque wrench supplied with the kit 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
Type–N	135 N–cm (12 in–lb)	8.1 N–cm (±5 in-lb)

Using the torque wrench guarantees that a 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). Even then, it may be difficult with small devices. 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. Wrenches opposing each other (180 degrees apart) will cause a *lifting action* which can misalign and stress the connections of the devices involved. This is especially true when several devices are connected together (see Figure 4-8).

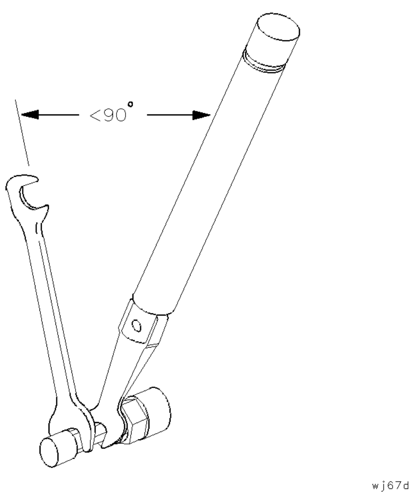


Figure 4-8. Correct Wrench Position

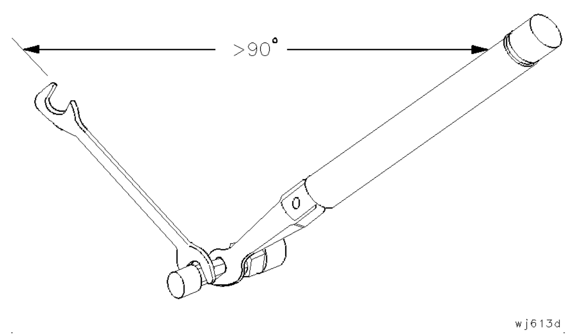


Figure 4-9. Incorrect Wrench Position

3. Hold the torque wrench lightly, at the end of the handle only (beyond the groove). (see Figure 4-10).

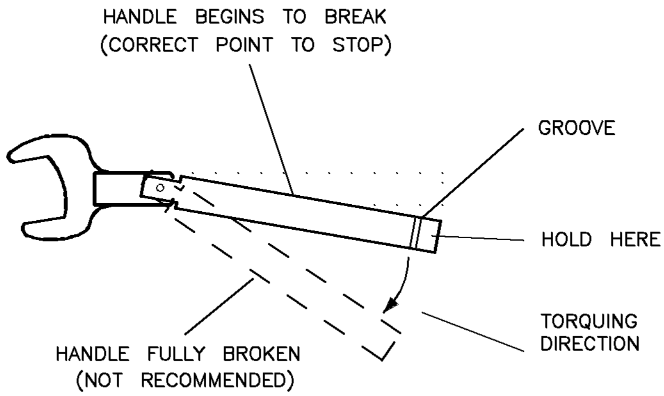


Figure 4-10. Using the Torque Wrench

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 unlimited 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 4-10). Do *not* tighten the connection further.

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

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

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

Connecting the Sliding Load to a Cable/Test Port Connector

CAUTION The sliding load center conductor can be damaged if the sliding load is not held in line when mating the load to a connector. Always line up the sliding load when connecting or removing it from a connector.

1. Refer to Figure 4-11. Loosen the center conductor pull back nut completely. Press the center conductor cap to extend the center conductor of the sliding load beyond the end of the connector.
2. Continue to press the center conductor cap and mate the center conductor of the sliding load with the cable/test port connector's center conductor.

CAUTION The sliding load center conductor can be damaged if the sliding load is not held in line when mating the load to a connector. Always line up the sliding load when connecting or removing it from a connector.

3. Release pressure on the center conductor and mate the outer conductor of the sliding load with the outer conductor of the cable/test port connector. Torque the connection with a 3/4 inch torque wrench to approximately 135 N–cm (12 in–lb).
4. Retighten the center conductor pull back nut. It will "click" when it is tight.
5. Loosen the connection between the gage and the sliding load, and remove the sliding load from the gage. Replace the protective end cap on the sliding load.

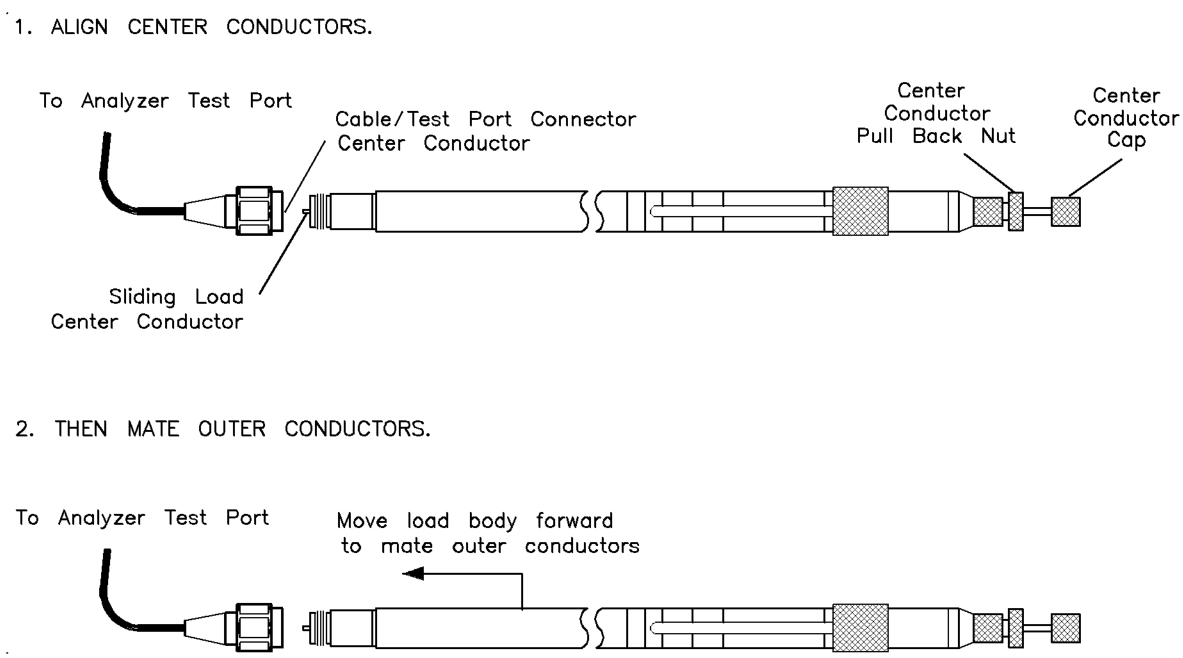


Figure 4-11. Connecting the Sliding Load

Disconnection Procedure

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 wrench to loosen the connector nut.
3. Complete the disconnection by hand, turning only the connector nut.

CAUTION Do *not* twist one connector out of the other (like removing a light bulb). 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 limits of the devices inside the kit have been specially manufactured and are not commercially available. Hewlett–Packard recognizes its responsibility to provide you with procedures to reconfirm the published specifications of any product offered. That commitment applies equally to the HP 85054B type–N calibration kit. If it is imperative that the performance test processes for this kit be explained or made available to you, contact the nearest Hewlett–Packard sales and service office listed at the back of this service manual.

To confirm that your calibration kit is performing accurate calibrations use the HP 85055A Verification Kit with the "Specifications & Performance" disk included in this kit.

What Recertification Provides

The following will be provided with a recertified kit:

- New calibration sticker affixed to the case.
- Certificate of Calibration.
- List of NIST (United States National Institute of Standards and Technology) traceable numbers.
- A calibration report for each device in the kit listing measured values, specifications, and uncertainties.

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 (sales and service offices are listed in the back of this manual).

Recertification of opens and shorts are referenced to the HP 8510 cal coefficients only. The HP 8510 is the most accurate model of the devices (the HP 8720 is not used).

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 In some cases, the first time a kit is used after being recertified occurs some time after the actual recertification date. The recertification interval should begin on the date the kit is *first used*.

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 the back of this manual). When you return the kit, fill out and attach a service tag. (Refer to "Returning a Kit or Device to HP" in Chapter 6, "Troubleshooting.")

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, and low frequency resistance. The resistance is then 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 test system to the specifications listed in this manual.

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 (sales and service offices are listed in the back of this manual). When you send the kit or device to Hewlett–Packard, include a service tag (found at the back 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.
- If you are returning a complete kit, include the model number and serial number.
- If you are returning one or more devices, include the part numbers and serial numbers.
- Indicate the type of service required.
- Include any applicable information. If a repair is needed, please describe the problem.

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 at the rear of this manual.

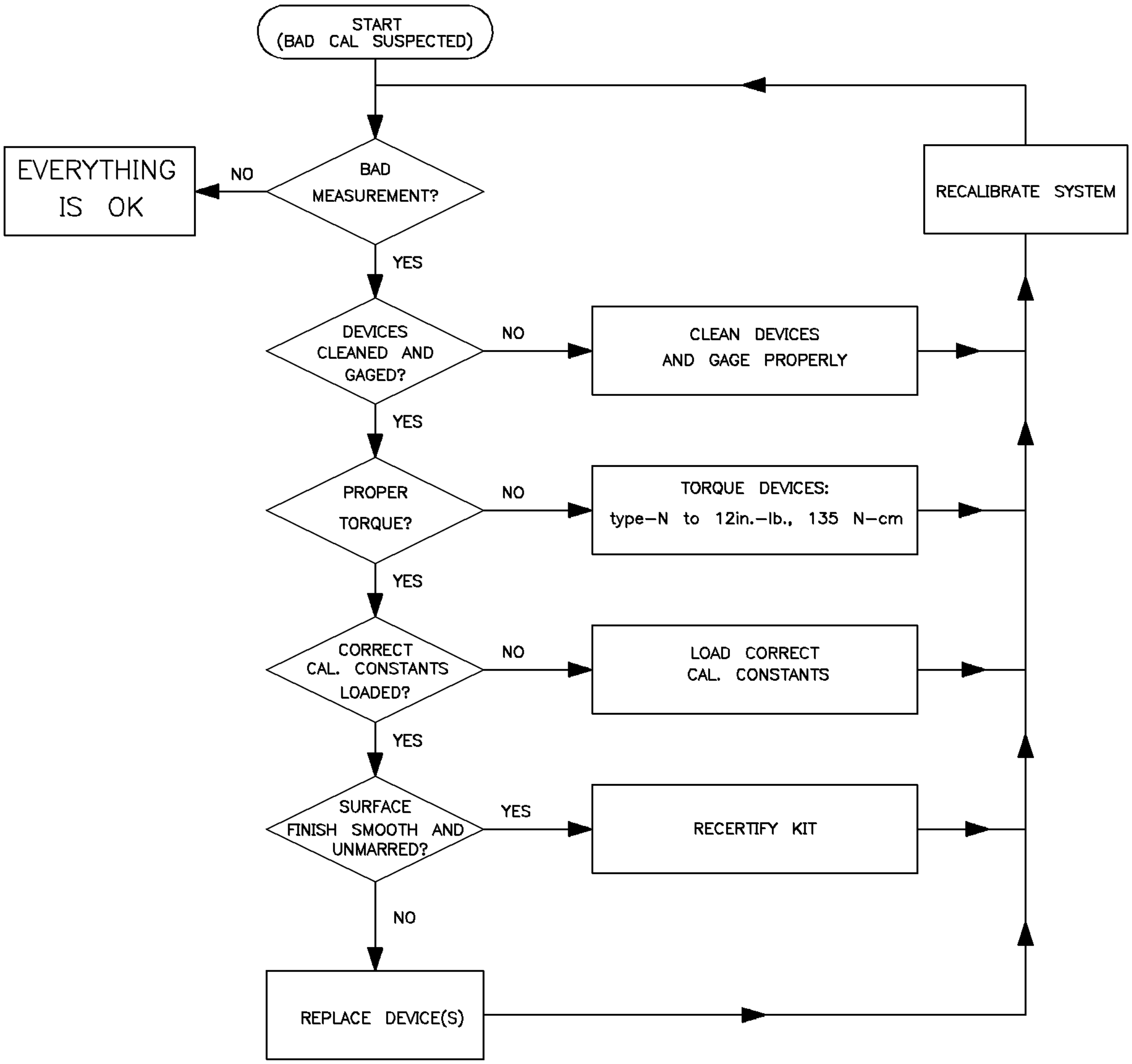


Figure 6-1. Troubleshooting Flowchart

7

Replaceable Parts

Table 7-1 lists the replacement part numbers for the HP 85054B 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 the back of this manual).

Table 7-1. Replaceable Parts

Description	Qty Per Kit	HP Replacement Part Number
Calibration Devices		
Type–N (m) Sliding Load	1	85054–60035
Type–N (f) Sliding Load	1	85054–60036
Type–N (m) Lowband Load	1	00909–60011
Type–N (f) Lowband Load	1	00909–60012
Type–N (m) Offset Short	1	85054–60025
Type–N (f) Offset Short	1	85054–60026
Type–N (m) Offset Open	1	85054–60027
Type–N (f) Offset Open	1	85054–60028
Adapters		
Type–N (m) to Type–N (m)	1	85054–60038
Type–N (f) to Type–N (f)	1	85054–60037
Type–N (f) to 7 mm	2	85054–60031
Type–N (m) to 7 mm	2	85054–60032
Wrenches		
3/4 in., 135 N–cm (12 in–lb) Torque	1	8710–1766
Spanner	1	08513–20014
Calibration Kit Storage Case		
Storage Case Assembly (includes items listed below)	1	85054–60039
Box	1	5180–7900
ID Label	1	85054–80012
Foam Pad (bottom)	1	85054–80023
Foam Pad (lid)	1	5181–5543
Disk Holder	1	5180–8491
Gages		
Screw–On N Gage	1	8504–80011
Type–N Gage Set (includes items listed below)		85054–60049
Type–N Gage (f)	1	85054–60050
Type–N Gage Master (f)	1	85054–60052
Type–N Gage (m)	1	85054–60051
Type–N Gage Master (m)	1	85054–60053
Centering Beads	2	85054–80028

Table 7-1. Replaceable Parts (continued)

Description	Qty Per Kit	HP Replacement Part Number
Miscellaneous Items		
Operating and Service Manual	1	85054–90049
Calibration Constants Tape (option 002)	1	85054–10002
Calibration Constants Disk	1	85054–10005
Specifications & Performance Verification Disk[1]	1	08510–10033
Protective End Cap (f)	8	1401–0225
Protective End Cap (m & 7 mm)	10	1401–0208
Connector Care—Quick Reference Card	1	08510-90360
Items Not Included in Kit		
Wrenches:		
1/2 in. to 9/16 in. Open–end		8710–1770
3/4 in. Open–end		8720–0011
Adapters:		
50Ω (m) Type–N to 7 mm (extendable/retractable sleeve)		85054–60009
50Ω (f) Type–N to 7 mm (extendable/retractable sleeve)		85054–60001
Blank Tape (for data backup)		9164–0166
Isopropyl Alcohol (30 ml)		8500–5344
Cleaning Swabs (100)		9301–1243
ESD Supplies:		
Grounding Wrist Strap		9300–1367
5 ft Grounding Cord for Wrist Strap		9300–0980
2 × 4 ft Conductive Table Mat and 15 ft Ground Wire		9300–0797
Heel Strap (for conductive floors)		9300–1126

1 See the HP 8510C *On–Site Service Manual* for instructions on using this disk.

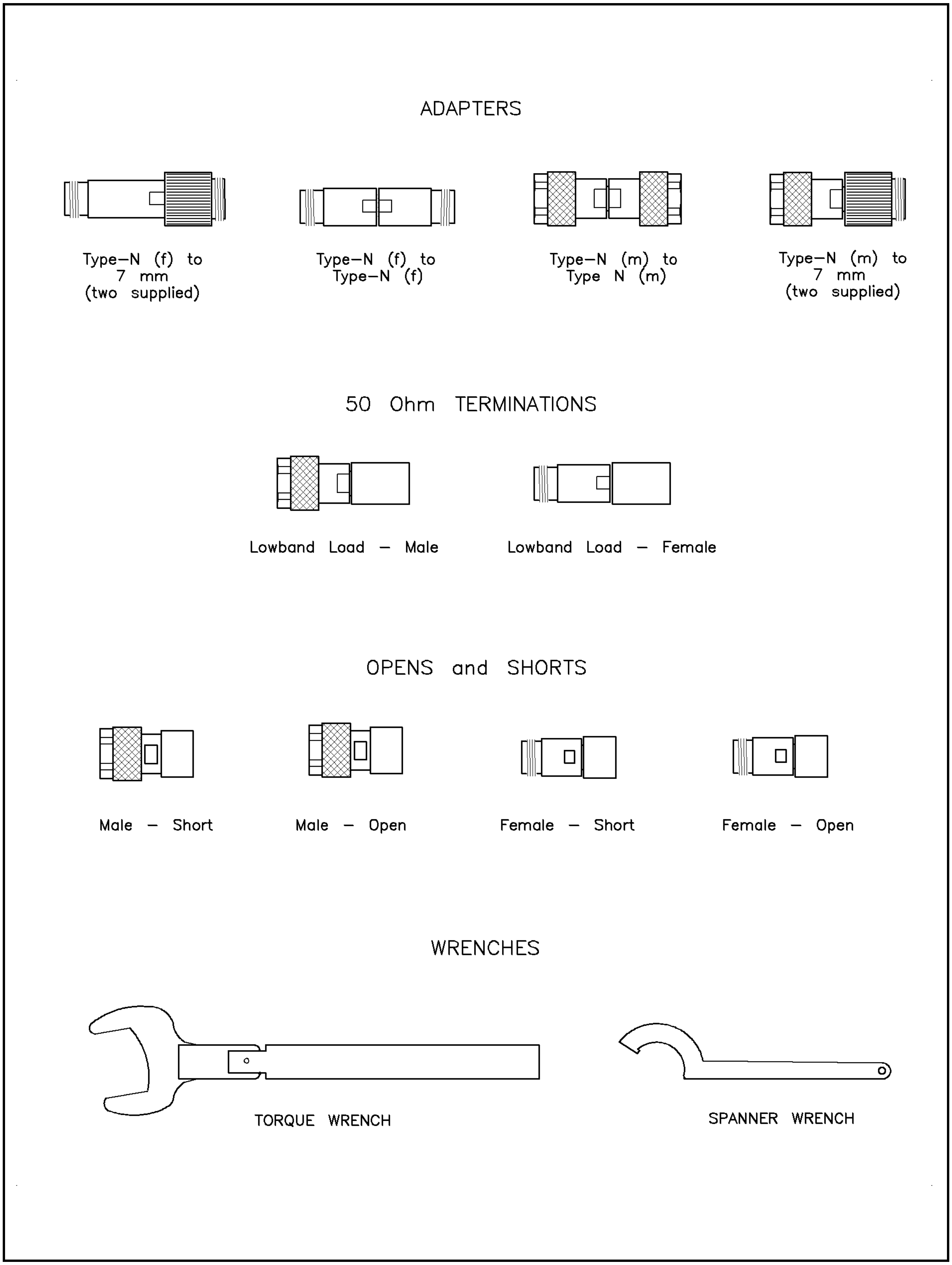
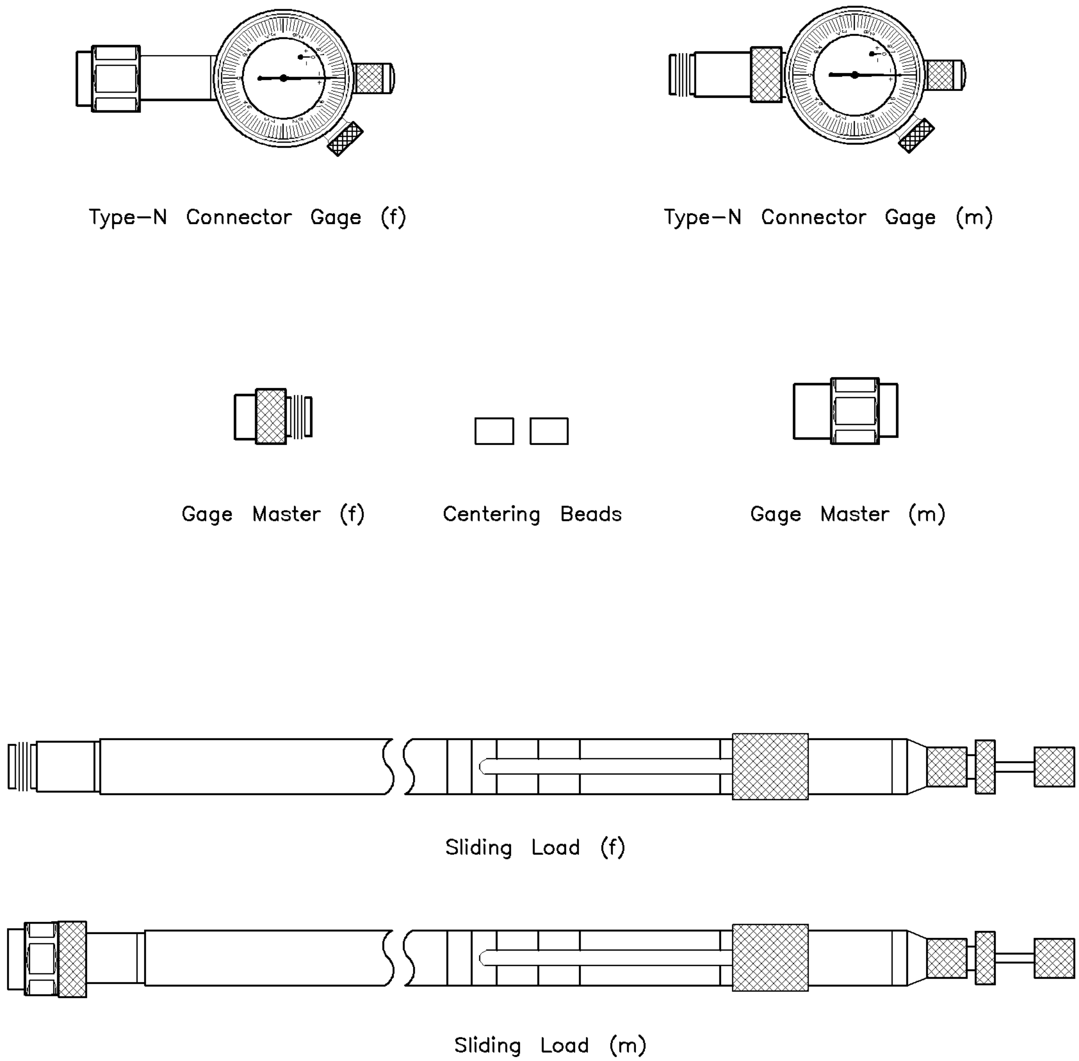


Figure 7-1. Replaceable Parts



Not Shown:

- Calibration Constants Tape
- Calibration Constants Disk
- Specs and Performance Verification Disk
- Storage Case
- Protective End Caps

Figure 7-2. Replaceable Parts

A

Standard Definitions

Electrical Characteristics

Standard Class Assignments

Class assignment organizes calibration standards into a format compatible with the error models used in measurement calibration. A class or group of classes corresponds to the systematic errors to be removed from the measured network analyzer response. Table A-1 and Table A-2 list the classes used by the HP 8510 and HP 8720 series respectively.

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, Table A-4 and Table A-5, list typical calibration kit parameters used by the HP 8510 and HP 8720 series to specify the mathematical model of each device.

Note The values in the standard class assignments and in the standard definitions tables are valid *only* over the specified operating temperature range. For information on how to generate alternate characteristics for temperatures outside this range, refer to HP product note 8510–5A, "Specifying Calibration Standards for the HP 8510 Network Analyzer." This product note provides information on modifying calibration constants, parameters, and classes.

Setting System Impedance

Ensure the system impedance (Z_0) is set to the same value as the standards being used. This kit contains only 50 ohm devices. For the HP 8510 and HP 8720 series, do the following:

1. Press (CAL) MORE SET ZO .
2. Observe the display to determine *current* system impedance.
3. If it is not 50 ohms, press (5) (0) (x1).

Version Changes

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. The disk (or option 002 tape) shipped with the kit for use with the HP 8510 will contain the most recent version. The default version that comes with the HP 8720 series network analyzer firmware may be outdated.

Table A-1.
Standard Class Assignments
for the HP 8510

Calibration Kit Label: TYPE N B.2
Disk File Name: CK_NTYPB2
Tape File Number: * FILE 1

Class	A	B	C	D	E	F	G	Standard Class Label
S_{11}A	2	4						Opens
S_{11}B	1	3						Shorts
S_{11}C	9	10	12					Loads
S_{22}A	2	4						Opens
S_{22}B	1	3						Shorts
S_{22}C	9	10	12					Loads
Forward Transmission	11							Thru
Reverse Transmission	11							Thru
Forward Match	11							Thru
Reverse Match	11							Thru
Forward Isolation[1]	9							Isol'n Std
Reverse Isolation	9							Isol'n Std
Frequency Response	1	3	2	4	11			Response
TRL Thru	14							undefined
TRL Reflect	1							undefined
TRL Line	15							undefined
Adapter	13	14						Adapters
TRL Option								
Cal Z_0: ___ System Z_0 _X_ Line Z_0								
Set Ref: _X_ Thru ___ Reflect								
Lowband Frequency: 2.0 GHz								

1 Forward isolation standard is also used for isolation part of response and isolation calibration.

Table A-2.
Standard Class Assignments
for the HP 8720 Series

Calibration Kit Label: [N 50Ω]

Class	A	B	C	D	E	F	G	Standard Class Label
S_{11}A	2	8						Opens
S_{11}B	1	7						Shorts
S_{11}C	3	5	6					Loads
S_{22}A	2	8						Opens
S_{22}B	1	7						Shorts
S_{22}C	3	5	6					Loads
Forward Transmission	4							Thru
Reverse Transmission	4							Thru
Forward Match	4							Thru
Reverse Match	4							Thru
Response	1	7	2	8	4			Response
Response & Isolation	1	7	2	8	4			Response
TRL Thru	4							Thru
TRL Reflect	2	8						Opens
TRL Line	3	5	6					Loads
TRL Option								
Cal Z_0: ___ System Z_0 _X_ Line Z_0								
Set Ref: _X_ Thru ___ Reflect								

Table A-3.
Standard Class Assignments
Blank Form

Calibration Kit Label: ____________________

Disk File Name: ____________________

Tape File Number: ____________________

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$								
$S_{11}B$								
$S_{11}C$								
$S_{22}A$								
$S_{22}B$								
$S_{22}C$								
Forward Transmission								
Reverse Transmission								
Forward Match								
Reverse Match								
Forward Isolation[1]								
Reverse Isolation								
Frequency Response								
TRL Thru								
TRL Reflect								
TRL Line								
Adapter								
TRL Option								
Cal Z_0: ___ System Z_0 ___ Line Z_0								
Set Ref: ___ Thru ___ Reflect								
Lowband Frequency: ____________								

1 Forward isolation standard is also used for isolation part of response and isolation calibration.

Table A-4. Standard Definitions HP 8510 with Type–N

System Z_0[a] = 50.0 Ω

Disk File Name: CK_NTYPB2

Calibration Kit Label: TYPE N B.2

Tape File Number: * FILE 1

STANDARD[b]		C0 $x10^{-15}$ F	C1 $x10^{-27}$ F/Hz	C2 $x10^{-36}$ F/Hz^2	C3 $x10^{-45}$ F/Hz^3	FIXED[c] or SLIDING	OFFSET			FREQ[d] (GHz)		COAX or WG	STND LABEL
NO.	TYPE	L0 $x10^{-12}$ H	L1 $x10^{-24}$ H/Hz	L2 $x10^{-33}$ H/Hz^2	L3 $x10^{-42}$ H/Hz^3		DELAY ps	Z_0 Ω	LOSS GΩ/s	MIN	MAX		
1	Short[e]	−0.1315	606.21	−68.405	2.0206		27.990	50	1.3651	0	999	Coax	Short (m)[f]
2	Open[e]	104.13	−1943.4	144.62	2.2258		22.905	50	0.93	0	999	Coax	Open (m)[f]
3	Short[e]	0.7563	459.88	−52.429	1.5846		63.078	50	1.1273	0	999	Coax	Short (f)[f]
4	Open[e]	89.939	2536.8	−264.99	13.4		57.993	50	0.93	0	999	Coax	Open (f)[f]
5													
6													
7													
8													
9	Load					Fixed	0	50	0	0	999	Coax	Broadband
10	Load					Sliding	0	50	0	1.999	999	Coax	Sliding
11	Delay/Thru						0	50	0	0	999	Coax	Thru
12	Load					Fixed	0	50	0	0	2.001	Coax	Lowband
13	Delay/Thru						134.82	50	2.2	0	999	Coax	f–f Adapter
14	Delay/Thru						196.0	50	2.2	0	999	Coax	m–m Adapter
15													
16													
17													
18													
19													
20													
21													

[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.

[d] For waveguide, lower frequency is same as F_{CO}.

[e] Typical values only. Disk/Tape file values may be different.

[f] Standard labels which specify sex, (m) or (f), refer to the sex of the test port connector.

Table A-5.
Standard Definitions
HP 8720 Series with Type–N

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

STANDARD[b]		C0 $x10^{-15}$ F	C1 $x10^{-27}$ F/Hz	C2 $x10^{-36}$ F/Hz^2	C3 $x10^{-45}$ F/Hz^3	FIXED[c] or SLIDING	OFFSET			FREQ[d] (GHz)		COAX or WG	STND LABEL
NO.	TYPE						DELAY ps	Z_0 Ω	LOSS Ω/s	MIN	MAX		
1	Short	0	0	0	0		27.99	50	800M	0	999	Coax	Short (m)
2	Open	88.31	1667.2	−146.61	9.75		22.905	50	800M	0	999	Coax	Open (m)
3	Load					Fixed	0	50	800M	0	999	Coax	Broadband
4	Delay/Thru						0	50	800M	0	999	Coax	Thru
5	Load					Sliding	0	50	800M	1.999	999	Coax	Sliding
6	Load					Fixed	0	50	800M	0	2.001	Coax	Lowband
7	Short						63.078	50	800M	0	999	Coax	Short (f)
2	Open	88.31	1667.2	−146.61	9.75		57.993	50	800M	0	999	Coax	Open (f)

[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.

[d] For waveguide, lower frequency is same as F_{CO}.

Table A-6.
Standard Definitions
Blank Form

System Z_0[a] = ___________ **Calibration Kit Label: ___________________________**

Disk File Name: _________________________ **Tape File Number: ___________________________**

STANDARD[b]		C0 $x10^{-15}$ F	C1 $x10^{-27}$ F/Hz	C2 $x10^{-36}$ F/Hz^2	C3 $x10^{-45}$ F/Hz^3	FIXED[c] or SLIDING	TERM[d] IMPED Ω	OFFSET			FREQ[e] (GHz)		COAX or WG	STND LABEL
NO.	TYPE	L0 $x10^{-12}$ H	L1 $x10^{-24}$ H/Hz	L2 $x10^{-33}$ H/Hz^2	L3 $x10^{-42}$ H/Hz^3			DELAY ps	Z_0 Ω	LOSS Ω/s	MIN	MAX		
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														

[a] Ensure system Z_0 of network analyzer is set to this value.

[b] Open, short, load, delay/thru, or arbitrary impedance.

[c] Load or arbitrary impedance only.

[d] Arbitrary impedance only, device terminating impedance.

[e] For waveguide, lower frequency is same as F_{CO}.

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