

Operating and Service  
**HP 85050C 7 mm**  
**Precision Calibration Kit**

**SERIAL NUMBERS**

This manual applies directly to HP 85050C calibration kits with serial number prefix 3106A.

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. 85050-90051  
Printed in USA September 1996

Edition 2.1

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## General Information

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### Calibration Kit Overview

This chapter explains the purpose of this kit and gives an overview of the entire documentation package. You should record the serial numbers of your kit devices in this chapter. This chapter also explains available options and other equipment required to use this calibration kit.

---

### Calibration Kit Overview

The HP 85050C 7 mm precision calibration kit is designed to be used in the TRL 2-port measurement calibration procedure with network analyzer systems (such as the HP 8510 or HP 8720 series) for measurements of components with 7 mm connectors up to 18 GHz.

The calibration kit consists of the following:

- Offset opens and shorts, lowband and broadband load terminations.
- 7 mm to 7 mm precision airline
- 7 mm to 7 mm TRL adapter
- Screw-on gage 7 mm
- Collet extractor tool
- Pin-Collet assembly
- A 3/4 inch, 135 N-cm (12 in-lb) torque wrench for use on the 7 mm connectors.
- A data disk that contains the calibration constants of the devices in the kit for HP 8510 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 85050C calibration kit and provides replacement part numbers, specifications, and procedures for using, maintaining and troubleshooting the kit.

#### **Option 002 adds 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 the “Replaceable Parts” chapter for the 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**

1/2 inch open-end wrench and various connector cleaning supplies are *not* provided in this kit. These or similar items are recommended to ensure the successful operation of this calibration kit. (Refer to the “Replaceable Parts” chapter 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.

Insert artwork here.

**Figure 1-1.**  
= serial id = serial height = 1.5in  
penwidth = “.17mm,.25mm,.35mm,.5mm,,,17mm,.12mm”>

Typical Kit Serial Number Label

## Calibration Kits Documented in this Manual

This manual applies to any HP 85050C 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 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 85050C Kits with Serial Prefix 3027A

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.

**Table 1-1. Kit and Device Serial Number Record**

Device	Serial Number
<b>Calibration Kit</b>	_____
7 mm Precision Airline	_____
Lowband Load	_____
Broadband Load	_____
Open	_____
Short (collet style)	_____
Short (threaded center conductor style)	_____
TRL Adapter	_____
Connector Gage	_____
Gage Master	_____

---

## Incoming Inspection

Refer to Figure 7-1 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, refer to the “Performance Verification” chapter.

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.

---

## 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 the “Gaging and Making Connections” chapter.

## Specifications

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### Environmental Requirements

**Table 2-1. Environmental Requirements**

Parameter	Required Values/Ranges
Operating Temperature <sup>1</sup>	20° to 26°C (68° to 79°F)
Error-Corrected Temperature Range <sup>2</sup>	±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.

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## Mechanical Characteristics

### Center Conductor Protrusion and Pin Depth

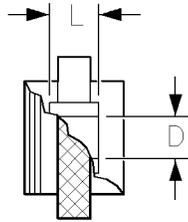
Mechanical characteristics such as center conductor protrusion and pin depth are *not* performance specifications. They are, however, important supplemental characteristics related to electrical performance. Hewlett-Packard verifies the mechanical characteristics of the devices in this kit with special 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.

The “Gaging and Making Connections” chapter 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.)

### Precision Airline

- The actual length of the calibration airline is on a label installed in a recess within the knurled portion of the outer conductor.
- Diameters “D” and “d” are matched in the factory to assure a return loss  $\geq 60$  dB. *Do not* intermix the center and outer conductors between calibration kits.
- Measurement by the user of the diameters is *not* recommended, and will cause damage to the calibration airline, due to the lack of proper measuring equipment and tooling.

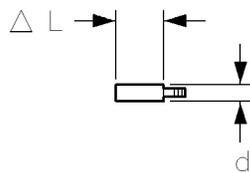
# 7mm Precision Airline



Outer Conductor

$$D^{2,3} = \begin{matrix} 0.2756 \pm 0.0002 \text{ in.} \\ 7.000 \pm 0.0051 \text{ mm} \end{matrix}$$

$$L^1 = \begin{matrix} 0.2736 \pm 0.0008 \text{ in.} \\ 6.95 \pm 0.02 \text{ mm} \end{matrix}$$



Center Conductor

$$d^{2,3} = \begin{matrix} 0.1197 \pm 0.00009 \text{ in.} \\ 3.040 \pm 0.0022 \text{ mm} \end{matrix}$$

$$\Delta L = L \pm \begin{matrix} 0.00008 \text{ in.} \\ 0.002 \text{ mm} \end{matrix}$$

**Figure 2-1. 7 mm Airline Mechanical Dimensions**

## Electrical Specifications

**Table 2-2. Electrical Specifications for 7 mm Devices**

Device	Specification	Frequency (GHz)
Lowband Load	$\geq 52$ dB Return Loss	DC to 2 GHz <sup>1</sup>
Broadband Loads	$\geq 38$ dB Return Loss	DC to 18 GHz
Short (collet style)	$\pm 0.2^\circ$ From Nominal	DC to 2 GHz <sup>2</sup>
	$\pm 0.3^\circ$ From Nominal	2 to 8 GHz <sup>2</sup>
	$\pm 0.5^\circ$ From Nominal	8 to 18 GHz <sup>2</sup>
Short (threaded center conductor style)	$\pm 0.2^\circ$ From Nominal	DC to 2 GHz <sup>2</sup>
	$\pm 0.3^\circ$ From Nominal	2 to 8 GHz <sup>2</sup>
	$\pm 0.5^\circ$ From Nominal	8 to 18 GHz <sup>2</sup>
Open	$\pm 0.3^\circ$ From Nominal	DC to 2 GHz <sup>2</sup>
	$\pm 0.4^\circ$ From Nominal	2 to 18 GHz <sup>2</sup>
	$\pm 0.6^\circ$ From Nominal	8 to 18 GHz <sup>2</sup>
Precision Airline	$>60$ dB Return Loss	2 to 18 GHz <sup>3</sup>

<sup>1</sup> This lowband fixed load is not used or specified at frequencies greater than 2 GHz in this kit. The same device having the same HP part number may be used elsewhere in another kit, or by itself and have the following characteristics:

- $\geq 52$  dB Return Loss, DC to 5 GHz (specified)
- $\geq 46$  dB Return Loss, 5 GHz to 6 GHz (specified)
- $\geq 23$  dB Return Loss, 6 GHz to 18 GHz (typical)

<sup>2</sup> Nominal, in this case, means the electrical characteristics as defined by the calibration constants supplied on the calibration constants tape (option 002).

<sup>3</sup> This specification is based on mechanical measurements. Refer to the Certificate of Calibration that came with your kit for the exact dimensions of your airline.

### 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.

## User Information

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### The Calibration Devices and Their Use

The HP 85050C 7 mm calibration kit contains five types of 7 mm calibration devices: 50 ohm broadband loads, lowband loads, short circuits (collet style), short circuits (threaded center conductor style), and 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  $\Omega$  terminations which have been optimized for broadband performance up to 18 GHz. The rugged internal structure provides for highly repeatable connections. A distributed resistive element on sapphire provides excellent stability and return loss. Broadband loads are valid substitutes for lowband load.

#### 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° at all frequencies.

#### Precision Airline

The precision airline is a metrology grade impedance reference.  $Z_0$  of the line establishes the reference impedance after error correction is applied.

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## 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 (option 002) tape 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\_7MMC3** 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 7 mm 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  $\Omega$ , press **5 0 X1**.
3. Load the 7 mm file from the calibration constants disk or tape. Refer to the “Loading Calibration Constants” section of this chapter.
4. Press **CAL 7 mm C.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.

## 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-3 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** 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-3 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.

---

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** 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 7 mm 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 **7mm** for use with this kit.

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

## Gaging and Making Connections

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### 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 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  $1\Omega$  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 the “Replaceable Parts” chapter for information on ordering supplies for ESD protection.

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### 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.

## **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.

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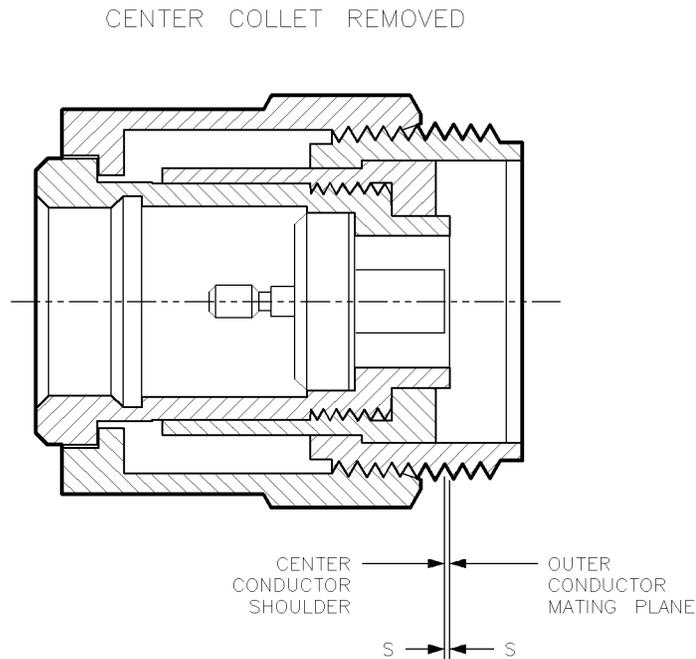
## **Cleaning Connectors**

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

## 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). 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 4-1 for a visual representation of proper pin depth (slightly recessed).



**Figure 4-1. Connector Pin Depth**

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## Gaging Connectors

### Gage Intent

Gages 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 gage is only capable of performing coarse measurements. It does 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 gage is 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  $\pm 0.0001$  inch due to systematic (biasing) errors usually resulting from a worn gage and gage master. Table 4-1 assumes a new gage and gage master, therefore, these systematic errors were not included in the uncertainty analysis. As the gage endures 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 the “User Information” chapter for more information on the design of the calibration devices in this kit.

**Table 4-1. Pin Depth Limits**

<b>7 mm Device</b>	<b>Typical Pin Depth micrometers (10<sup>-4</sup> inches)</b>	<b>Measurement Uncertainty<sup>1</sup> micrometers (10<sup>-4</sup> inches)</b>	<b>Observed Pin Depth Limits micrometers (10<sup>-4</sup> inches)</b>
Opens	0 to -12.7 (0 to -5.0)	+10.02 to -10.2) (+4.0 to -4.0)	+10.2 to -22.91 (+4.0 to -9.0)
Shorts	0 to -5.1 (0 to -2.0)	+6.4 to -6.4 (+2.5 to -2.5)	+6.4 to -11.4 (+2.5 to -4.5)
Lowband Loads	0 to -50.8 (0 to -20.0)	+4.1 to -4.1 (+1.6 to -1.6)	+4.1 to -54.9 (+1.6 to -21.6)
Broadband Loads	0 to -7.62 (0 to -3.0)	+4.1 to -4.1 (+1.6 to -1.6)	+4.1 to -11.7 (+1.6 to -4.6)
TRL Adapter (test port end)	0 to -50.8 (0 to -20.0)	+4.1 to -4.1 (+1.6 to -1.6)	+4.1 to -54.9 (+1.6 to -21.6)
TRL Adapter (airline end)	0 to -5.1 (0 to -2.0)	+4.1 to -4.1 (+1.6 to -1.6)	+4.1 to -9.1 (+1.6 to -3.6)

<sup>1</sup> 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.

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**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.

## Zeroing 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).

---

When performing 7 mm pin depth measurements.

1. 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.
2. Zero the connector gage (see Figure 4-2):
  - 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 with your finger to settle the reading.

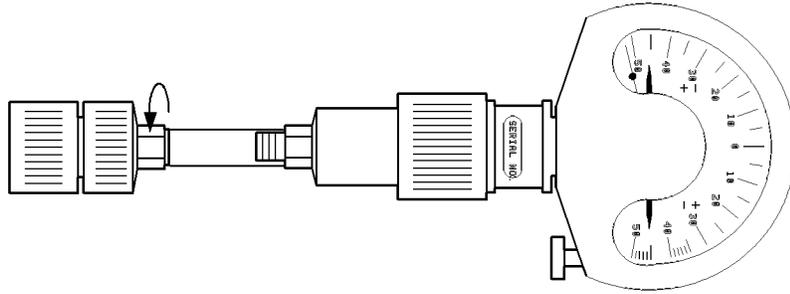
The gage pointer should line up exactly with the zero mark on the gage. If not, adjust the zero set knob until the gage pointer exactly lines up with zero.

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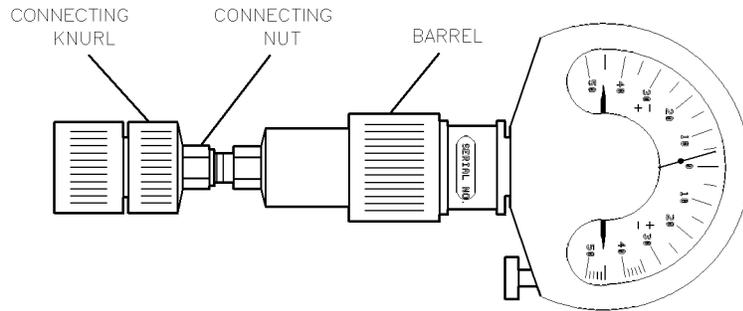
**Note** Check the gage often to make sure that the zero setting has not changed. Generally, when the pointer on a recently zeroed gage does not line up exactly with the zero mark, the gage or gage master needs cleaning. Clean both of these carefully and check the zero setting again.

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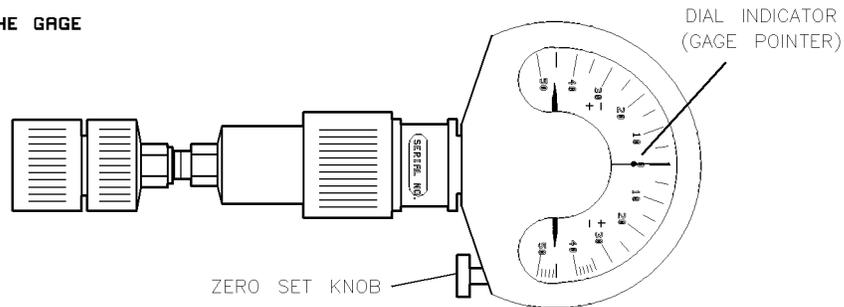
- HAND TIGHTEN THE GAGE MASTER ONTO THE GAGE



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



- ZERO THE GAGE

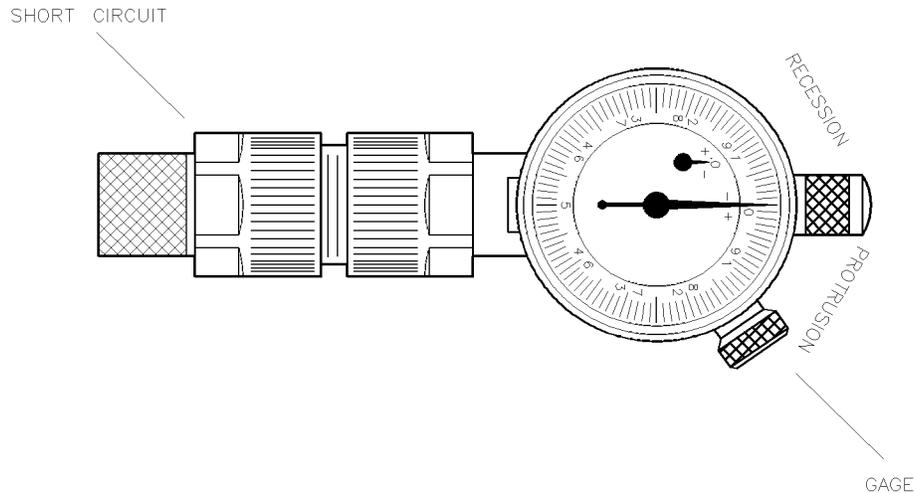


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**Figure 4-2. Zeroing a Connector Gage**

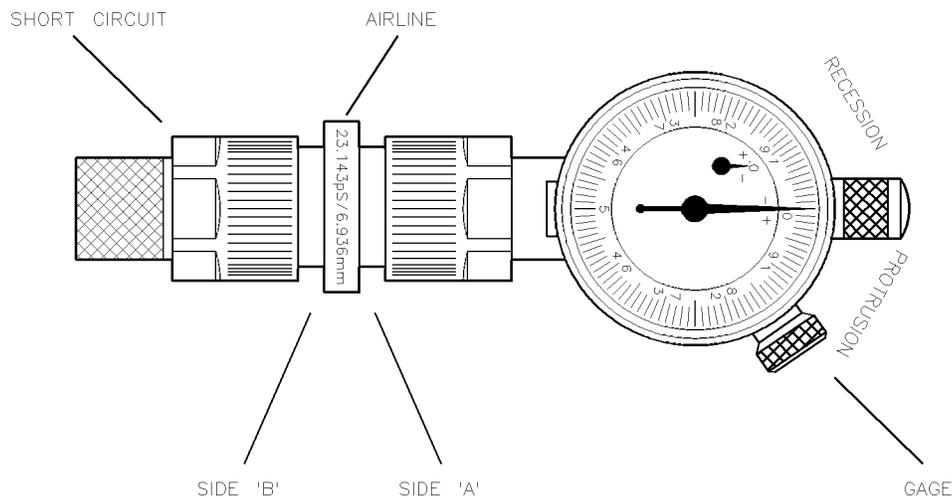
## Gaging the Airline

The airline center and outer conductor in this kit is measured and matched at the factory using special fixtures and gages. Use the following procedure to verify the length difference specification between the center and outer conductor.



**Figure 4-3. Gaging the Short Circuit**

1. Attach the short circuit with threaded center conductor to the gage. Torque the connection to 136 N-cm, (12 in-lb).
2. Adjust the dial on the gage to read flush (0.000) when the short circuit is connected.
3. Remove the short circuit from the gage.
4. Attach the center conductor of the airline to the threaded short circuit termination. Finger tighten the connection.
5. Attach the gage to the other end of the airline. Turn the nut on the gage, do not rotate the gage. Hand tighten the connections.



**Figure 4-4. Gaging the Airline**

6. Torque the airline-to-short circuit connection and the airline-to-gage connection to 136 N-cm (12 in-lb). Set the assembly down to let the temperature stabilize for five minutes.
7. The reading on the gage should be within the given tolerance band of the dimension measured 0.00025 inch;  $\pm 0.0001$  inch for factory uncertainties,  $\pm 0.0001$  inch for your gage accuracy, and  $\pm 0.00005$  inch for the mechanical tolerances of the airline ( $\leq 2.5$  minor divisions).

Reverse the above procedure to remove the gage and short circuit from the airline.

## Measuring the Connector

### 7 mm Connectors

1. Refer to Figure 4-5.
2. Zero the gage as described in “Zeroing 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 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. Read *only* the black  $\pm$  signs; not the red  $\pm$  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 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.

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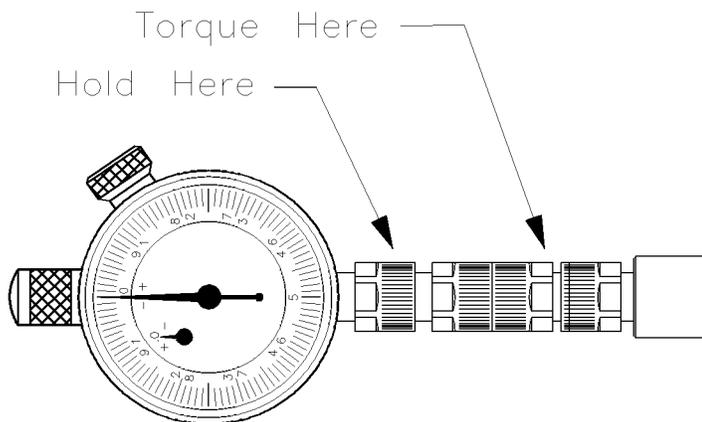


Figure 4-5. Gaging a 7 mm Connector

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## 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 4-6).

### 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

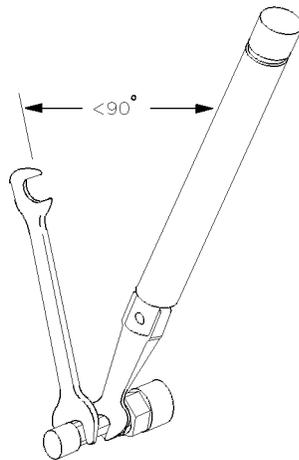
1. Use the torque wrench supplied with the kit to make the final connection. Table 4-2 provides information on the torque wrench required for the connector type found in this kit.

**Table 4-2. Torque Wrench Information**

Connector Type	Torque Setting	Torque Tolerance
7 mm	136 N-cm (12 in-lb)	8.2 N-cm ( $\pm 5$ in-lb)

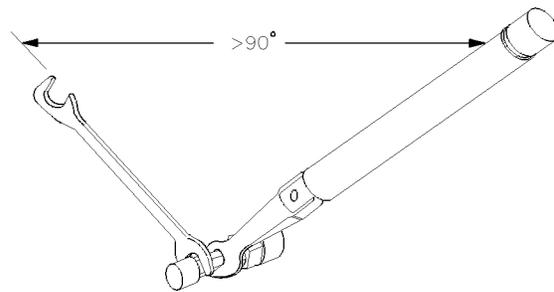
Using the torque wrench guarantees that a connection is not too tight, preventing possible connector damage. It also guarantees that all connections are equally tight each time.

2. Rotate *only* the connector nut when you tighten the connector. 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 4-6).



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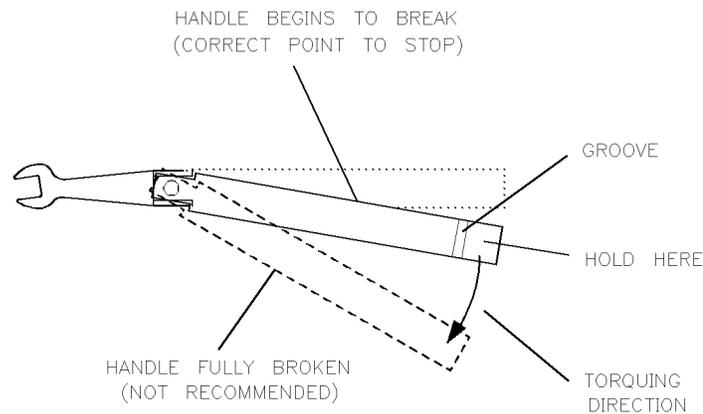
**Figure 4-6. Correct Wrench Position**



wj613d

**Figure 4-7. Incorrect Wrench Position**

3. Hold the torque wrench lightly, at the end of the handle only (beyond the groove). (see Figure 4-8).



**Figure 4-8. 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 (see Figure 4-8). 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.

## 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.

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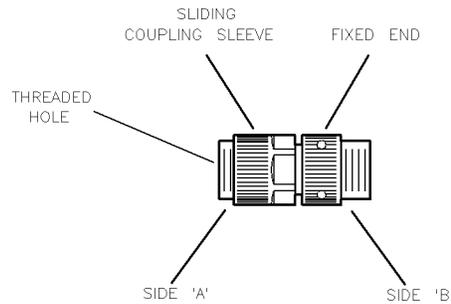
4. Pull the connectors straight apart without twisting or bending.

## TRL adapter

This procedure provides step-by-step instructions for connecting the airline to a test port or cable connector through the TRL adapter.

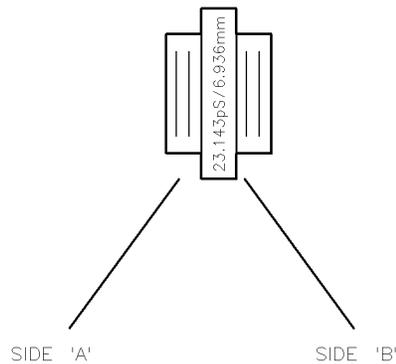
Use good electrostatic discharge practices, see “Electrostatic Discharge” section in this chapter.

- Be sure bias power to test set is OFF.



**Figure 4-9. TRL Adapter**

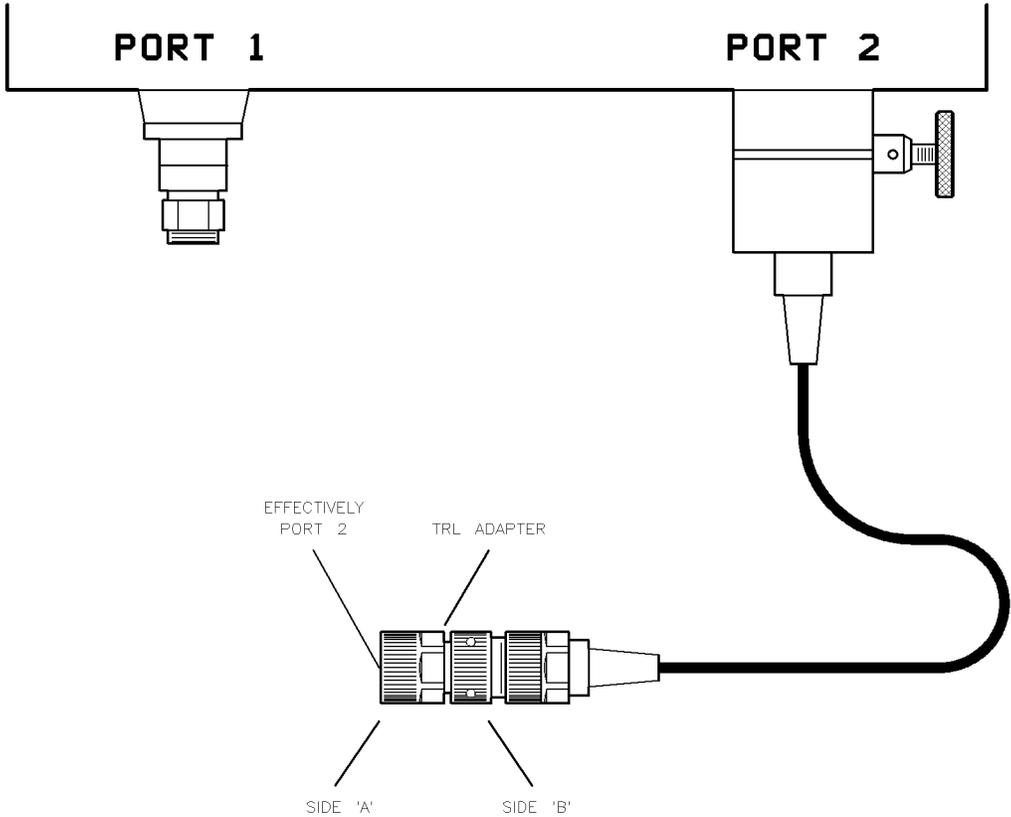
- Note the orientation of the TRL adapter. Connect side 'B' of the TRL adapter to the end of the cable on port 2.



**Figure 4-10. 7 mm Precision Airline**

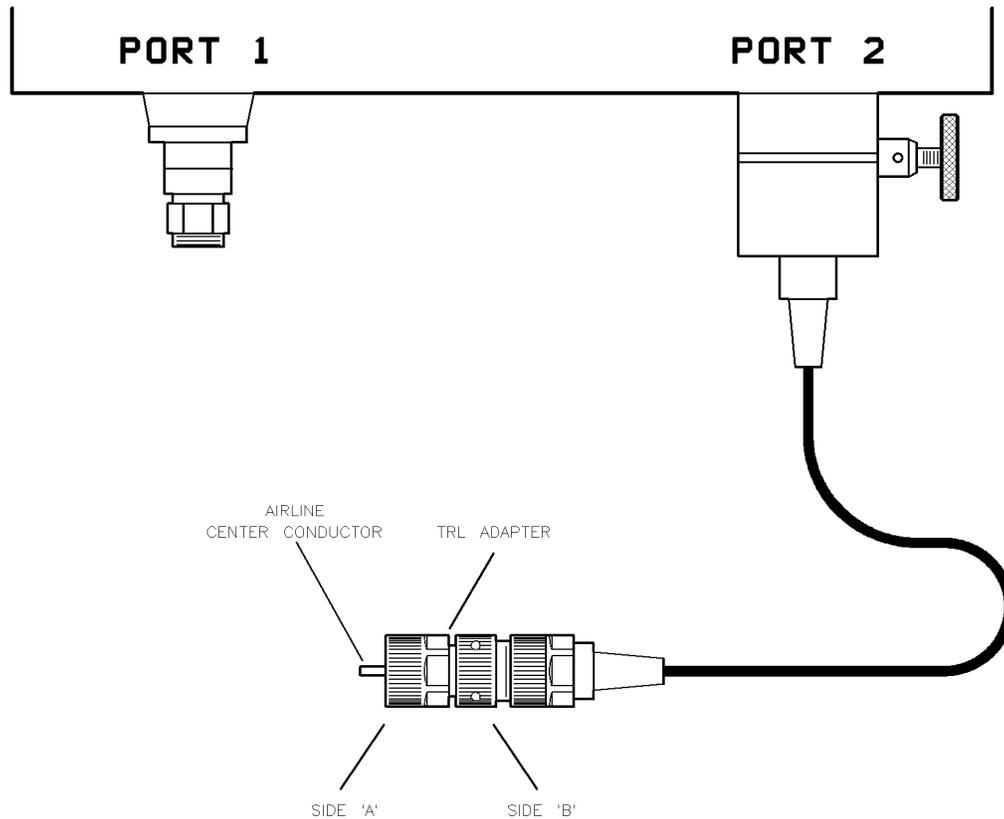
- Note the orientation of the label on the outer conductor. Always connect side 'B' of the outer conductor toward the TRL adapter, the threaded termination or the threaded short circuit.

The following configuration is assumed:



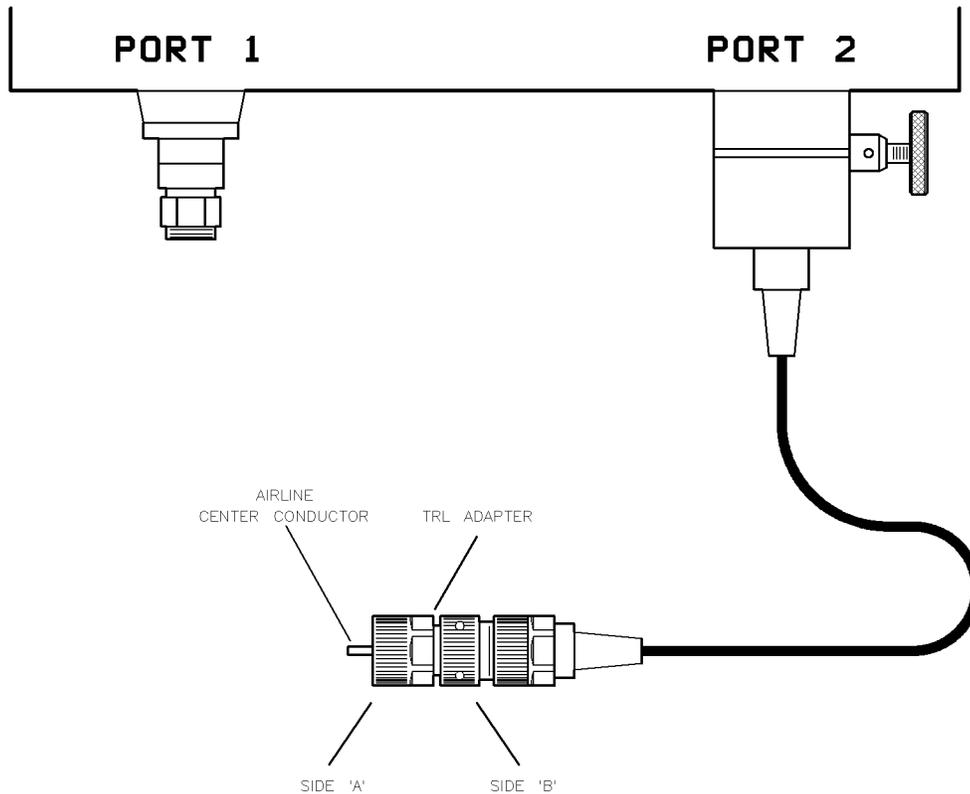
**Figure 4-11. Equipment Configuration**

Connect the TRL adapter to the cable connector as shown in Figure 4-11. Side 'A' of the TRL adapter is now port 2.



**Figure 4-12. Connecting the Center Conductor**

1. Attach the 7 mm precision airline's center conductor to side 'A' of the TRL adapter. Screw in the center conductor just until it stops moving (finger tight)



**Figure 4-13. Connecting the Outer Conductor**

2. Position side 'B' of the airline's outer conductor over the center conductor and attach it to the TRL adapter.
  3. Connect side 'A' of the airline to port 1. Torque both connections to 136 N-cm (12 in-lb).
- Reverse the above procedure to disconnect the airline from the cables.

---

## Pin/Collet Assemblies

**CAUTION** The pin/collet assemblies included in the HP 85050C precision calibration kit are for use with the airlines in the HP 85051B verification kit. These pin/collet assemblies must be used to assure valid verification data.

*Do not* use the HP 85051A verification kit to verify an HP 85050C calibration, mechanical end detail of the airlines in these verification kits are not compatible with the pin/collet assembly.

---

## Using the Pin/Collet Assemblies

1. Withdraw the centering pin from the 'B' ends of the 50 $\Omega$  airline center conductor and the 25 $\Omega$  mismatch airline center conductor.
2. Insert pin/collet assembly into the 'B' end of each center conductor and perform a verification as described in the "Performance Tests" section of your manual. The 'B' end of the airline is always connected to the TRL adapter. The TRL adapter does not have a collet of its own. Pin/collet assembly is necessary to assure a good connection between the airline and the adapter.

Pin/Collet assemblies can remain in the airline center conductors unless they are to be installed and used in other HP 85051B verification airlines.

---

**CAUTION** HP 85051B verification kits with serial numbers of 2705A00163 and below, purchased before September 30, 1987, should be returned to the Mountain View Service Center, USA for recertification. Neglecting to do this may result in irreparable mechanical damage to either the airline or to the attaching connector.

---

## Using the Centering Beads

The centering beads supplied are used when gaging the airlines contained in the HP 85051B verification kit. *Do not* use the centering beads with any device in this HP 85050C 7 mm precision calibration kit.

---

## 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.

## Verification

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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 85050C 7 mm 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.

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### What Recertification Provides

The following may be provided with a recertified kit depending on the options:

- 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.

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).

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### 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.

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**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*.

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## **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 at the rear of this manual). When you return the kit, fill out and attach a service tag. (Refer to the “Returning a Kit or Device to HP” section in the “Troubleshooting” chapter.)

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## **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. 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.

## Troubleshooting

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

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### 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 rear of this manual). 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:

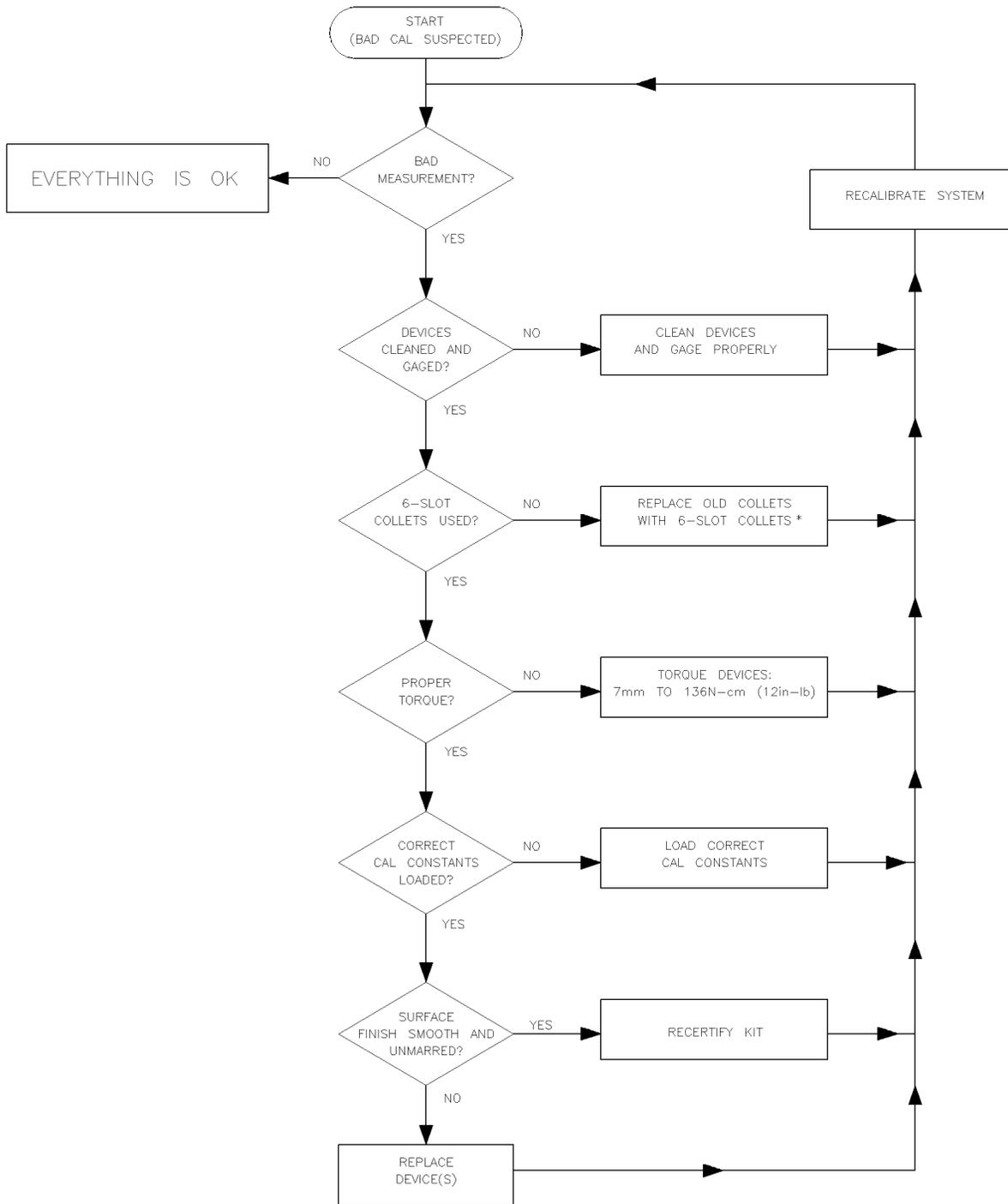
- Your company name and address.
- A technical contact person within your company, and the person's complete phone number.
- If you are returning a complete kit, include the model number and serial number.
- If you are returning one or more devices, include the part numbers and serial numbers.
- Indicate the type of service required.
- Include any applicable information.

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### Where To Look For 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 the rear of this manual.



**Figure 6-1. Troubleshooting Flowchart**

## Replaceable Parts

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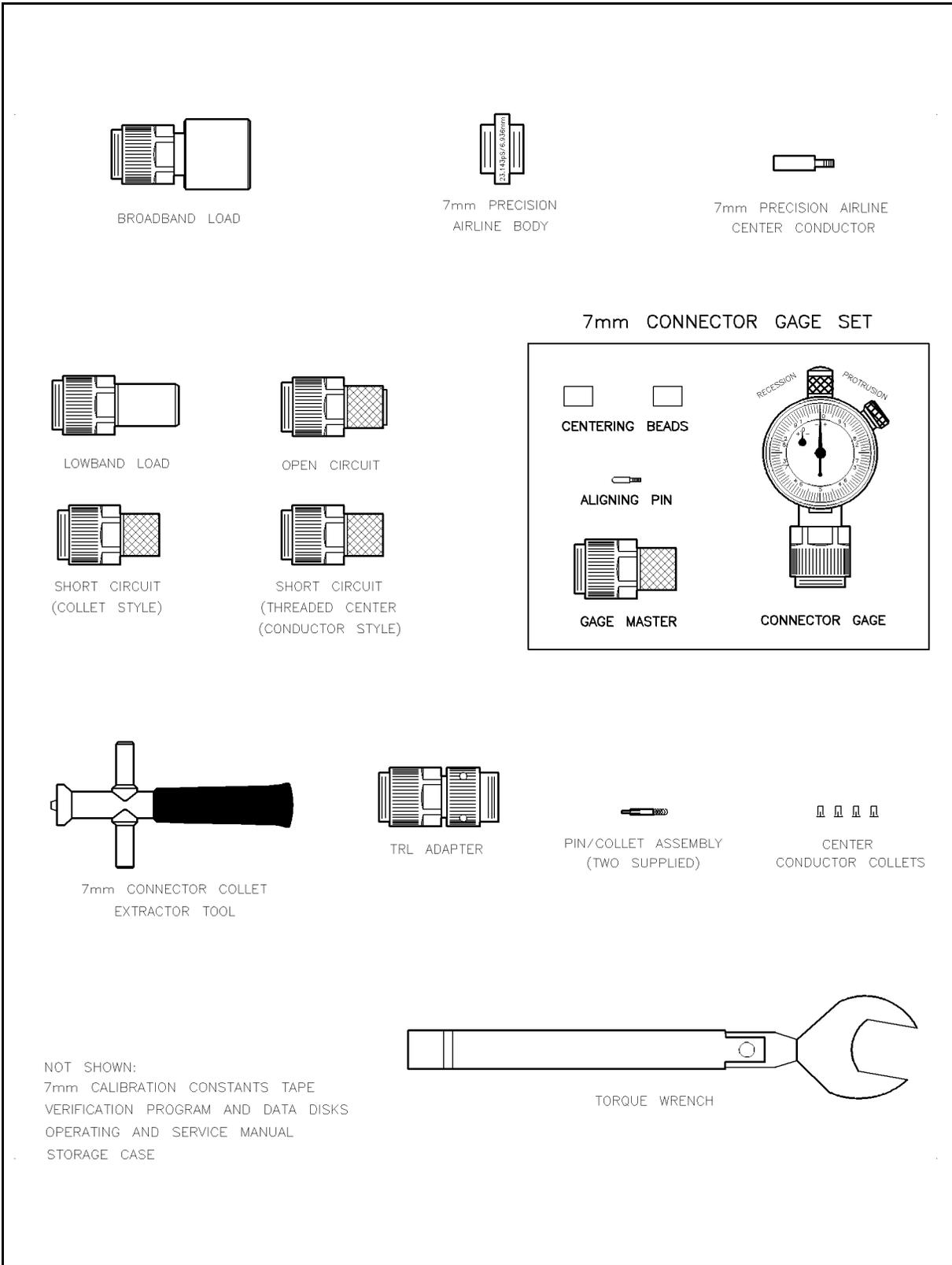
Table 7-1 lists the replacement part numbers for the HP 85050C calibration kit contents. To order a listed part, note the description, HP part number, and the quantity desired. Telephone or send your order to the nearest Hewlett-Packard sales and service office (see rear of this manual).

**Table 7-1. Replaceable Parts**

Description	Qty Per Kit	HP Replacement Part Number
<b>Calibration Devices</b>		
7 mm Broadband Load	1	85050-60006
7 mm Lowband Load	1	00909-60008
7 mm Short (collet style)	1	85050-80009
7 mm Short (threaded center conductor style)	1	85050-80008
TRL Adapter	1	85050-60005
7 mm Open	1	85052-80010
7 mm Precision Airline	1	85050-60003
<b>Tools</b>		
3/4 in., 135 N-cm (12 in-lb) Torque	1	8710-1766
7 mm Connector Collet Extractor	1	5060-0370
<b>Miscellaneous Items</b>		
Pin/Collet Assembly	2	85050-60007
Center Conductor Collets	4	85050-20001
7 mm /connector Gage Set <sup>1</sup>	1	85050-80012
Operating and Service Manual	1	85050-90051
Calibration Constants Tape (option 002)	1	85050-10003
Specifications & Performance Verification Disk <sup>2</sup>	1	08510-10033
Connector Care—Quick Reference Card	1	08510-90360
<b>Items Not Included in Kit</b>		
Blank Tape (for data backup)		9164-0166
Isopropyl Alcohol (30 ml)		8500-5344
Cleaning Swabs (100)		9301-1243
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
ESD Heel Strap (for conductive floors)		9300-1126

<sup>1</sup> Gage set includes gage, gagemaster, aligning pin and two centering beads.

<sup>2</sup> See the HP 8510C *On-Site Service Manual* for instructions on using this disk.



**Figure 7-1. Replaceable Parts**



## 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 lists the classes used by the HP 8510.

#### 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 definition, Table A-3 lists typical calibration kit parameters used by the HP 8510 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. For ordering information, contact your nearest Hewlett-Packard office.

---

#### 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, do 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 **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:** 7 mm C.2

**Disk File Name:** CK\_7MMC2

**Tape File Number:** \* FILE 1

Class	A	B	C	D	E	F	G	Standard Class Label
S <sub>11</sub> A	2	21						Open
S <sub>11</sub> B	1							Short
S <sub>11</sub> C	9	12	20					Loads
S <sub>22</sub> A	2	21						Open
S <sub>22</sub> B	1							Short
S <sub>22</sub> C	9	12	20					Loads
Forward Transmission	11							Thru
Reverse Transmission	11							Thru
Forward Match	11							Thru
Reverse Match	11							Thru
Forward Isolation <sup>1</sup>	9							Isol'n Std
Reverse Isolation	9							Isol'n Std
Frequency Response	1	2	11					Response
TRL Thru	14							undefined
TRL Reflect	1							undefined
TRL Line	15	16						undefined
Adapter	13							Adapter
<b>TRL Option</b>								
Cal Z <sub>0</sub> :    ___ System Z <sub>0</sub> <u>X</u> Line Z <sub>0</sub>								
Set Ref: <u>X</u> Thru    ___ Reflect								
Lowband Frequency: _____								

<sup>1</sup> Forward isolation standard is also used for isolation part of response and isolation calibration.

**Table A-2.  
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 <sub>11</sub> A								
S <sub>11</sub> B								
S <sub>11</sub> C								
S <sub>22</sub> A								
S <sub>22</sub> B								
S <sub>22</sub> C								
Forward Transmission								
Reverse Transmission								
Forward Match								
Reverse Match								
Forward Isolation <sup>1</sup>								
Reverse Isolation								
Frequency Response								
TRL Thru								
TRL Reflect								
TRL Line								
Adapter								
<b>TRL Option</b>								
Cal Z <sub>0</sub> :    ___ System Z <sub>0</sub> ___ Line Z <sub>0</sub>								
Set Ref:    ___ Thru    ___ Reflect								
Lowband Frequency: _____								

<sup>1</sup> Forward isolation standard is also used for isolation part of response and isolation calibration.

**Table A-3.  
Standard Definitions  
HP 8510 with 7 mm**

**System  $Z_0^a = 50.0 \Omega$**

**Calibration Kit Label: 7 mm C.2**

**Disk File Name: CK\_7MMC2**

**Tape File Number: \* FILE 1**

STANDARD <sup>b</sup>		C0 $\times 10^{-15}$ F	C1 $\times 10^{-27}$ F/Hz	C2 $\times 10^{-36}$ F/Hz <sup>2</sup>	C3 $\times 10^{-45}$ F/Hz <sup>3</sup>	FIXED <sup>c</sup> or SLIDING	OFFSET			FREQ <sup>d</sup> (GHz)		COAX or WG	STND LABEL
NO.	TYPE	L0 $\times 10^{-12}$ H	L1 $\times 10^{-24}$ H/Hz	L2 $\times 10^{-33}$ H/Hz <sup>2</sup>	L3 $\times 10^{-42}$ H/Hz <sup>3</sup>		DELAY ps	Z <sub>0</sub> $\Omega$	LOSS GΩ/s	MIN	MAX		
1	Short <sup>e</sup>	.3566	-33.392	1.7542	-.0336		0	50	0	0	999	Coax	Short
2	Open <sup>e</sup>	90.48	763.6	-63.818	6.4337		0	50	0	0	999	Coax	Open
3													
4													
5													
6													
7													
8													
9	Load					Fixed	0	50	0	0	999	Coax	Broadband
10													
11	Delay/Thru						0	50	0	0	999	Coax	Thru
12	Load					Fixed	0	50	0	0	2.001	Coax	Lowband
13	Delay/Thru						0	50	0	0	999	Coax	undefined
14	Delay/Thru						0	50	0	0	999	Coax	Thru
15	Delay/Thru						23.19	49.998	.7	0	999	Coax	2-18 Line
16	Delay/Thru						999.99	50	.7				0-2 Loads
17													
18													
19													
20	Load <sup>f</sup>					Offset	23.19	49.998	.7	1.999	999	Coax	Offset
21	Short <sup>g</sup>					Offset	23.19	49.998	.7	1.999	999	Coax	Offset

<sup>a</sup> Ensure system  $Z_0$  of network analyzer is set to 50 ohms.

<sup>b</sup> Open, short, load, delay/thru, or arbitrary impedance.

<sup>c</sup> Load or arbitrary impedance only.

<sup>d</sup> For waveguide, lower frequency is same as  $F_{CO}$ .

<sup>e</sup> Typical values only. Disk/Tape file values may be different.

<sup>f</sup> Consists of standards number 9 and 15 combined.

<sup>g</sup> Consists of standards no. 1 and 15 combined.

**Table A-4.  
Standard Definitions  
Blank Form**

System  $Z_0^a$  = \_\_\_\_\_

Calibration Kit \_\_\_\_\_

Label: \_\_\_\_\_

Disk File Name: \_\_\_\_\_

Tape File Number: \_\_\_\_\_

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

<sup>a</sup> Ensure system  $Z_0$  of network analyzer is set to this value.

<sup>b</sup> Open, short, load, delay/thru, or arbitrary impedance.

<sup>c</sup> Load or arbitrary impedance only.

<sup>d</sup> Arbitrary impedance only, device terminating impedance.

<sup>e</sup> For waveguide, lower frequency is same as  $F_{CO}$ .

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