HP 85059A
1.0 mm Precision
Calibration and Verification Kit

Operating and Service Manual

HP part number: 85059-90003
Printed in USA
March 1998

Notice

The information contained in this document is subject to change without notice.

Hewlett-Packard makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Hewlett-Packard assumes no responsibility for the use or reliability of its software on equipment that is not furnished by Hewlett-Packard.

Restricted Rights Legend

Use, duplication, or disclosure by the U.S. Government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.227-7013 for DOD agencies, and subparagraphs (c)(1) and (c)(2) of the Commercial Computer Software Restricted Rights clause at FAR 52.227-19 for other agencies.

Hewlett-Packard Company
Santa Rosa Systems Division
1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799, U.S.A.

What You'll Find in This Manual…

HP 85059A 1.0 mm Calibration and Verification Kit

Chapter 1 • General Information

Chapter 2 • Specifications

Chapter 3 • Making Connections

Chapter 4 • User Information

Chapter 5 • Performance Verification

Chapter 6 • Troubleshooting

Chapter 7 • Replaceable Parts

Chapter 8 • Standard Definitions

Warranty

Certification

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

Warranty

This Hewlett-Packard system product is warranted against defects in materials and workmanship for a period corresponding to the individual warranty periods of its component products. Instruments are warranted for a period of one year. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products that prove to be defective.

Warranty service for products installed by HP and certain other products designated by HP will be performed at Buyer's facility at no charge within HP service travel areas. Outside HP service travel areas, warranty service will be performed at Buyer's facility only upon HP's prior agreement and Buyer shall pay HP's round trip travel expenses. In all other areas, products must be returned to a service facility designated by HP

For products returned to HP for warranty service, Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

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

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

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

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

Assistance

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

For assistance, call your local Hewlett-Packard Sales and Service Office (refer to "Support and Service").

Support and Service

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your local HP sales and service office.

US Field Operation Headquarters

Hewlett-Packard Company
19320 Pruneridge Avenue
Cupertino, CA 95014
USA
(800) 752-0900

Southern California

Hewlett-Packard Company
1421 South Manhattan Avenue
Fullerton, CA 92631
(714) 999-6700

Northern California

Hewlett-Packard Company
301 E. Evelyn
Mountain View, CA 94041
(415) 694-2000

Colorado

Hewlett-Packard Company
24 Inverness Place, East
Englewood, CO 80112
(303) 649-5000

Georgia

Hewlett-Packard Company
2000 South Park Place
Atlanta, GA 30339
(404) 9554-1500

Illinois

Hewlett-Packard Company
5201 Tollview Drive
Rolling Meadows, IL 60008
(708) 342-2000

New Jersey

Hewlett-Packard Company
West 120 Century Road
Paramus, NJ 07653
(201) 599-5000

Texas

Hewlett-Packard Company
930 E. Campbell Road
Richardson, TX 75081
(214) 231-6101

European Operations Headquarters

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

France

Hewlett-Packard France
1 avenue du Canada
Zone d'Activite de Courtaboeuf
F-91947 Les Ulis Cedex
France
(33 1) 69 82 60 60

Germany

Hewlett-Packard GmbH
Hewlett-Packard-Strasse
61352 Bad Homburg
Germany
(+49 6172) 16-0

Great Britain

Hewlett-Packard Ltd.
Eskdale Road
Winnersh Triangle
Wokingham, Berkshire RG11 5DZ
England
(44 734) 696622

Intercon Operations Headquarters

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

Australia

Hewlett-Packard Australia, Ltd.
31-41 Joseph Street
Post Office Box 221
Blackburn, Victoria 3130
Australia
(61 3) 895-2895

Canada

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

China

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

Japan

Yokogawa-Hewlett-Packard, Ltd.
1-27-15 Yabe
Sagamihara
Kanagawa 229
Japan
(81 427) 59-1311

Singapore

Hewlett-Packard Singapore (Pte.), Ltd.
Alexandra Post Office Box 87
Singapore 9115
(65) 271-9444

Taiwan

Hewlett-Packard Company
8th Floor
337 Fu Hsing North Road
Taipei
Taiwan
(866 2) 712-0404

Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument This product has been designed and tested in accordance with international standards.

WARNING

The WARNING notice denotes a hazard. It calls attention to a procedure, practice, or the like, that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION

The **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

Instrument Markings

	When you see this symbol on your instrument, you should refer to the instrument's instruction manual for important information.
	This symbol indicates hazardous voltages.
	The laser radiation symbol is marked onproducts that have a laser output.
	This symbol indicates that the instrument requires alternating current (ac) input.
	The CE mark is a registered trademark of the European Community. If it is accompanied by a year, it indicates the year the design was proven.
	The CSA mark is a registered trademark of the Canadian Standards Association.
1SM1-A	This text indicates that the instrumentis an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).
	This symbol indicates that the power line switch is ON.
	This symbol indicates that the power line switch is OFF or in STANDBY position.

Safety Earth Ground

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.

Typeface Conventions

Italics

- Used to emphasize important information:
  Use this software *only* with the HP xxxxxX system.
- Used for the title of a publication:
  Refer to the *HP xxxxxX System-Level User's Guide*.
- Used to indicate a variable:
  Type `LOAD BIN` *filename.*

`Instrument Display`

- Used to show on-screen prompts and messages that you will see on the display of an instrument:
  The HP xxxxxX will display the message **`CAL1 SAVED`**.

[Keycap]

- Used for labeled keys on the front panel of an instrument or on a computer keyboard:
  Press **[Return]**.

{Softkey}

- Used for simulated keys that appear on an instrument display:
  Press ***{Prior Menu}***.

`User Entry`

- Used to indicate text that you will enter using the computer keyboard; text shown in this typeface must be typed *exactly* as printed:
  Type `LOAD PARMFILE`
- Used for examples of programming code:

```
#endif // ifndef NO_CLASS
```

`Path Name`

- Used for a subdirectory name or file path:
  Edit the file *`usr/local/bin/sample.txt`*

Computer Display

- Used to show messages, prompts, and window labels that appear on a computer monitor:
  The **Edit Parameters** window will appear on the screen.
- Used for menus, lists, dialog boxes, and button boxes on a computer monitor from which you make selections using the mouse or keyboard:
  Double-click **EXIT** to quit the program.

Contents

2. Specifications

3. Making Connections

8. Standard Definitions

1 General Information

Calibration and Verification Kit Overview

The HP 85059A 1.0 mm precision calibration and verification kit is used to calibrate and verify your network analyzer system. This kit is used for the measurement of components with 50Ω, 1.0 mm connectors with a frequency range of DC to 110 GHz.

Because it is physically impossible to construct a slotless version of the 1.0 mm female contact, the female devices in this kit use slotted contacts. The slotted female contact does not have the same electrical characteristics as a solid conductor, and therefore, the male and female devices in this kit have different coefficients.

Although the male and female devices are designed to have the same mechanical length, their electrical delays are different. This reflects the differences in the connector interface compression. When the male and female devices are torqued together the male side compresses more than the female side.

The 1.0 mm connector utilizes an air dielectric interface for the highest accuracy and repeatability. The coupling diameter and thread size were chosen to maximize strength, increase durability and provide highly repeatable connections. The connectors are designed so that the outer conductors engage before the center conductors.

To obtain the best performance possible, the manufacturing tolerances of the connectors are tighter than the standard 1.0 mm specifications per the IEEE 287 precision connector standard.

About This Manual

This manual describes the HP 85059A calibration and verification kit and provides replacement part numbers, specifications, and procedures for using, maintaining and troubleshooting this kit.

How To Identify Shorts

The shorts in this kit are identified by the number of rings (or bands) around the body of the short.

- 1.0 x 1.30 mm short has 1 ring or band and is identified as Short 1
- 1.0 x 1.825 mm short has 2 rings or bands and is identified as Short 2
- 1.0 x 2.45 mm short has 3 rings or bands and is identified as Short 3
- 1.0 x 3.0 mm short has 4 rings or bands and is identified as Short 4

Kit Contents Checklist

- ❑ M short 1
- ❑ F short 1
- ❑ M short 2
- ❑ F short 2
- ❑ M short 3
- ❑ F short 3
- ❑ M short 4
- ❑ F short 4
- ❑ Lossy Delay Line (2 per kit)
- ❑ M to M Adapter
- ❑ F to F Adapter
- ❑ M to F Adapter
- ❑ Mismatch Thru Adapter (verification device)
- ❑ Match Thru Adapter (verification device)
- ❑ F to F Test Port Cable (8.8 cm in length)
- ❑ M Load (50 GHz)
- ❑ F Load (50 GHz)
- ❑ M Open
- ❑ F Open
- ❑ 6 mm Open-end Wrench
- ❑ 4 in-lb Torque Wrench
- ❑ 10X Magnifying Glass
- ❑ Verification Data Disk
- ❑ Calibration Data Disk
- ❑ Cleaning Swabs

Achieving Specified Frequency Performance

The standards in this calibration and verification kit allow you to perform simple 1- or 2-port calibrations, as well as TRM (thru-reflect-match) calibrations, and to verify your network analyzer system.

NOTE Above 50 GHz, offset shorts are substituted for the opens and loads.

Calibration Standards

Table 1-1 Calibration Techniques and Standards

Frequency Range	Calibration Technique	"Open" Standard	"Short" Standard	"Load" Standard	"Thru" Standard (not used for 1-port cal)
DC - 50 GHz	SOLT	Open	Short 3	Load	Thru
50 - 75 GHz	Offset Shorts	Short 3	Short 1	Short 4	Thru
75 - 110 GHz	Offset Shorts	Short 3	Short 1	Short 2	Thru
		To Combine Ranges[1]			
DC - 75GHz	SOLT and Offset Shorts	Open Short 3	Short 3 Short 1	Load Short 4	Thru
50 - 110 GHz	Offset Shorts	Short 3	Short 1	Short 4 Short 2	Thru
DC - 110 GHz	SOLT and Offset Shorts Offset Shorts	Open Short 3 Short 3	Short 3 Short 1 Short 1	Load Short 4 Short 2	Thru

1. Use the combinations in the lower half of this table to combine the appropriate calibration standards and techniques.

Broadband SOLT Calibration

As a time saver, you can use an alternate SOLT technique. You can calibrate from DC to 110 GHz using the standards in Table 1-2. The broadband SOLT technique is quicker than the full calibration outlined in Table 1-1 on page 1-3, but it is substantially *less* accurate.

NOTE

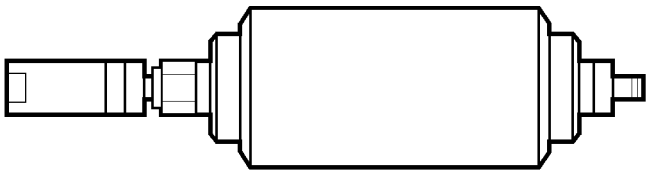
The broadband SOLT technique is not recommended. It is meant to be used *only* in situations where measurement accuracy is *not* critical.

Table 1-2 Broadband SOLT

Frequency Range	Calibration Technique	"Open" Standard	"Short" Standard	"Load" Standard	"Thru" Standard (not used for 1-port cal)
DC - 110 GHz	SOLT	Open (broadband)	Short 3 (broadband)	Load (broadband)	Thru

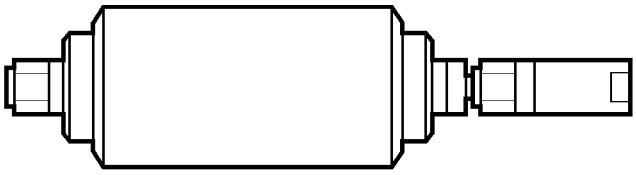
Broadband Load Construction

For broadband calibration it is necessary to add the Lossy Delay Line to the appropriate load (see Figure 1-1 and Figure 1-2).



lossyf

Figure 1-1 Lossy Delay Line (male end) Attached To Load (female end)



lossym

Figure 1-2 Lossy Delay Line (female end) Attached To Load (male end)

Equipment Required but Not Supplied

Various connector cleaning supplies and electrostatic discharge safety supplies are *not* provided in this kit. (Refer to Chapter 7, “Replaceable Parts” for ordering information.)

Serial Numbers and Kit Contents

Serial Number Prefix

A serial number label is attached to the calibration and verification kit. A typical kit serial number label is shown in Figure 1-3. The prefix is made up of six numbers. The first two digits show the country, the second two digits represent the year, and the last two digits designate the week of manufacturing.

Serial Number Suffix

The last five digits are the suffix numbers. The suffix numbers are unique to each calibration kit.

serial

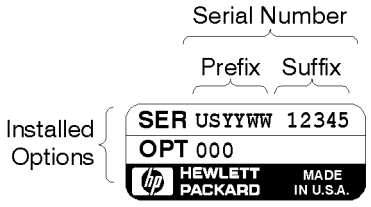


Figure 1-3 Typical Kit Serial Number Label

Device Serial Numbers

In addition to the kit serial number, the devices in this kit are individually serialized (serial numbers are printed on an attached label, or scribed onto the body of each device). Record these serial numbers in Table 1-3 on page 1-7. This can help you avoid confusing the devices in this kit with similar devices from other kits. Only the adapters for verification (matched and mismatched thru) need to have their serial numbers recorded, as the other adapters in this kit are used for measurement convenience only, and are not regarded as devices requiring a traceable path in order to comply with MIL-STD 45662A.

Serial Number Record Log

Table 1-3 Kit and Device Serial Number Record

Device Description	Serial Number
Calibration and Verification Kit	
M Short 1	
F Short 1	
M Short 2	
F Short 2	
M Short 3	
F Short 3	
M Short 4	
F Short 4	
M Load	
F Load	
Lossy Delay Line (1)	
Lossy Delay Line (2)	
M Open	
F Open	
Mismatched Thru Adapter	
Matched Thru Adapter	

Incoming Inspection

Refer to Figure 7-1 on page 7-3 to verify a complete shipment. Use Table 1-3 on page 1-7 to record the serial numbers of all serialized devices in your kit.

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 (located at the rear 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.

Clarifying Connector Sex

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

CAUTION

During a measurement calibration, however, the HP 8510XF softkey menus will label a calibration device with the sex of the analyzer's test port connector and *not* the device connector. For example, the label ***(M)SHORT1*** on the display refers to the female short 1 that will be connected to the *male* test port.

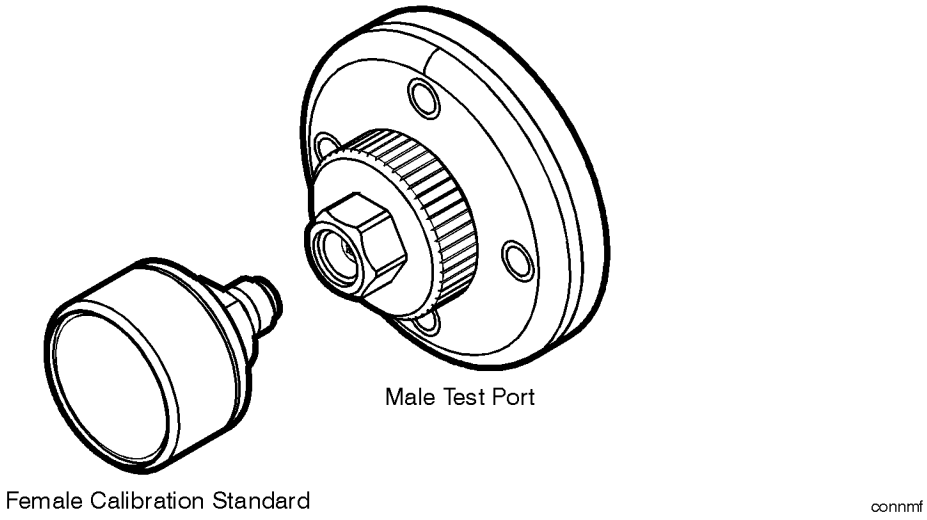


Figure 1-4 Clarifying Connector Sex

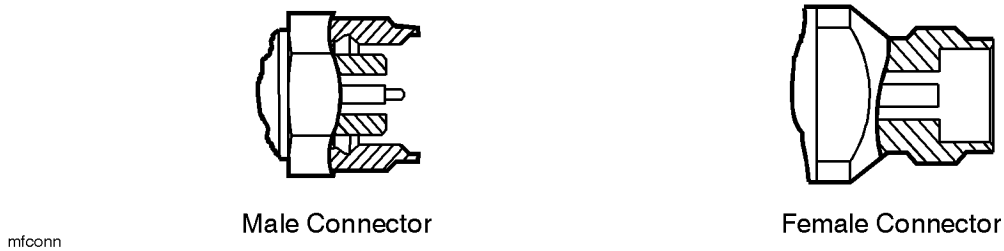


Figure 1-5 Male and Female Connectors

Preventive Maintenance

The best techniques for maintaining the integrity of the devices in this kit include routine visual inspection (using 10X magnification), cleaning and proper 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 poor connection techniques can also damage these devices.

Visual inspection, cleaning techniques, and connection techniques are all described in Chapter 3, “Making Connections”.

2 Specifications

Environmental Requirements

Table 2-1 shows the environmental requirements necessary for optimum performance.

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	< 15,000 meters (≈ 50,000 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 and tight tolerances of the calibration and verification 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 on page 2-1.

NOTE

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

Performance verification and measurements of devices-under-test (DUT's) do not need to be performed within the operating temperature range of the calibration devices. However, the DUT's must be within the error-corrected temperature range 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 even though +19° is outside the operating temperature range of the calibration devices.

Mechanical Characteristics

Supplemental Mechanical Characteristics

Supplemental mechanical characteristics are values which are typically met by the majority of calibration and verification kit devices that have been tested at Hewlett–Packard. These supplemental characteristics are intended to provide useful information in calibration and verification kit applications. These are typical but non-warranted performance parameters. The following table lists the typical mechanical characteristics of the devices in this kit.

Table 2-2 Offset Short Typical Mechanical Characteristics

Characteristic	Typical Value
Inside Diameter of Outer Conductor	1.000 ± 0.005 mm
Outside Diameter of Center Conductor	0.434 ± 0.003 mm
Offset Length	Nominal ± 0.008 mm
Pin Depth	0 (flush) to 0.010 mm (maximum recession)
Flatness of Reference Plane	0.002 mm (worst case)

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.

Electrical Characteristics

Supplemental Electrical Characteristics

Table 2-3 Offset Short Electrical Characteristics

Characteristic	Typical Value @ 50 GHz to 110 GHz
Phase Error (with respect to calibration constant model)	2.0 °
Connector Repeatability	–40 dB
Residual Directivity	–30 dB
Residual Port Match	–30 dB
Residual Reflection Tracking	±0.25 dB

Table 2-4 Adapter Electrical Characteristics

Characteristic	Typical Value @ 0 - 110 GHz
Return Loss	16 dB
Insertion Loss	< 0.50 dB

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.

Electrical Specifications

Table 2-5 Electrical Specifications for 1.0 mm 50Ω Devices

Device	Frequency	Parameter	Specifications	
			Male	Female
Loads	DC to 2 GHz 2 GHz to 18 GHz 18 GHz to 40 GHz 40 GHz to 50 GHz	Return Loss	30 dB 30 dB 26 dB 24 dB	30 dB 30 dB 26 dB 24 dB
Opens	DC to 2 GHz 2 GHz to 18 GHz 18 GHz to 50 GHz	Deviation from Nominal Phase	±1.0 degrees ±1.5 degrees ±2.5 degrees	±1.0 degrees ±3.0 degrees ±4.0 degrees
Short 3	DC to 2 GHz 2 GHz to 18 GHz 18 GHz to 50 GHz 50 GHz to 110 GHz	Deviation from Nominal Phase	±0.8 degrees ±1.2 degrees ±1.5 degrees ±3.0 degrees	±1.0 degrees ±2.0 degrees ±2.5 degrees ±5.0 degrees
Short1	50 GHz to 110 GHz	Deviation from Nominal Phase	±2.5 degrees	±4.0 degrees
Short 2	75 GHz to 110 GHz	Deviation from Nominal Phase	±2.5 degrees	±4.0 degrees
Short 4	50 GHz to 75 GHz	Deviation from Nominal Phase	±2 degrees	±3.5 degrees
Device	**Frequency**	**Parameter**	**Specifications**	
Lossy Delay Line	DC to110 GHz	Return Loss	18 dB	
Adapters	DC to 20 GHz 20 GHz to 50 GHz 50 GHz to 75 GHz 75 GHz to 110 GHz	Return Loss	24 dB 20 dB 18 dB 14 dB	
Verification Match Thru (adapter)	DC to 20 GHz 20 GHz to 50 GHz 50 GHz to 75GHz 75 GHz to 110 GHz	Return Loss	24 dB 20 dB 18 dB 14 dB	
Verification Mismatch Thru (adapter)	DC to 110 GHz	Return Loss	6 dB @ ~ 22.6 GHz intervals	

Table 2-6 Typical Electrical Specifications for 1.0 mm 50Ω Devices

Device	Frequency	Parameter	Specifications	
			Male	**Female**
Load + Lossy Delay Lines or load (broadband)	DC to 2 GHz 2 GHz to 18 GHz 18 GHz to 50 GHz 50 GHz to 110 GHz	Return Loss	25 dB 20 dB 20 dB 18 dB	25 dB 20 dB 20 dB 18 dB
Short 3	DC to 2 GHz 2 GHz to 18 GHz 18 GHz to 50 GHz 50 GHz to 110 GHz	Deviation from Nominal Phase	±1.0 degrees ±1.5 degrees ±2.0 degrees ±3.0 degrees	±1.0 degrees ±2.5 degrees ±3.0 degrees ±7.0 degrees
Open (broadband)	DC to 2 GHz 2 GHz to 18 GHz 18 GHz to 50 GHz 50 GHz to 110 GHz	Deviation from Nominal Phase	±1.0 degrees ±1.8 degrees ±2.5 degrees ±5.0 degrees	±1.5 degrees ±3.5 degrees ±4.5 degrees ±8.0 degrees
Device	**Frequency**	**Parameter**	**Specifications**	
Lossy Delay Line	DC to 110 GHz	Delay Insertion Loss	7.01 ±0.4 n-sec 1.63 dB *$(f/GHz)^{1/2}$	

3 Making Connections

Electrostatic Discharge

Protection against ESD (electrostatic discharge) is essential while cleaning, inspecting, or connecting any connector 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 of a connector. Static discharges too small to be felt, can cause permanent damage. Devices such as calibration and verification components and devices under test can also carry an electrostatic charge.

- Always have a grounded antistatic mat in front of your test equipment and wear a grounded wrist strap attached to it.
- Ground yourself before you clean, inspect, or make a connection to a static–sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port briefly to discharge static from your body.
- Discharge static electricity from a device before connecting it: touch the device briefly (through a resistor of at least 1 MΩ) to either the outer shell of the test port, or to another exposed ground. This discharges static electricity and protects test equipment circuitry.

Refer to Chapter 7, “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.

A minimum magnification of 10X is required to inspect the mating surfaces. A magnifying glass is supplied with your kit. It is also necessary to use good lighting (such as a halogen task light) to see damage on a connector. Use the following guidelines when evaluating the integrity of your connectors.

Obvious Defects or Damage

Examine the connectors first for obvious defects or damage:

- Plating
  - Bare metal showing
  - Burrs or blisters
- Deformed threads
- Center Conductors
  - Bent
  - Broken
  - Misaligned
  - Concentricity

Connector nuts should move smoothly and be free of:

- Burrs
- Loose metal particles
- Rough spots

Any connector that has obvious defects should be discarded or sent for repair (Hewlett-Packard Sales and Service offices listed in the front of this manual).

Connector Contacts

A minimum magnification of 10X is required to inspect the connector contacts. You must also use a magnifying glass to inspect for contact integrity. It is necessary to use good lighting (such as a halogen task light) to see the contacts.

NOTE

Notice the location of the cross hairs in relationship to the center of the figures.

See Figure 3-1 for visual guidelines when evaluating the contact integrity of a connector.

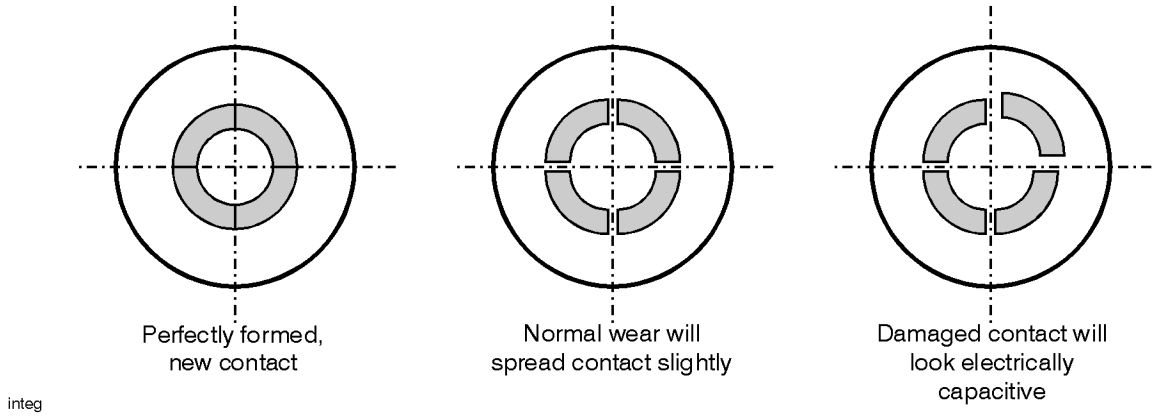


Figure 3-1 Contact Integrity

Concentricity

Figure 3-2 and Figure 3-3 on page 3-4 show the concentricity of both the male and female 1.0 mm connectors. Inspect the connectors with a minimum magnification of 10X.

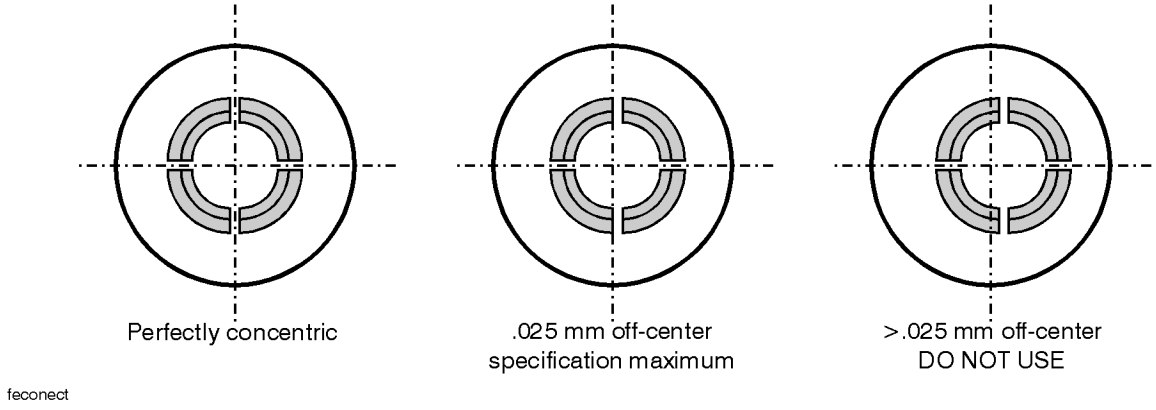


Figure 3-2 Concentricity - Female Connector

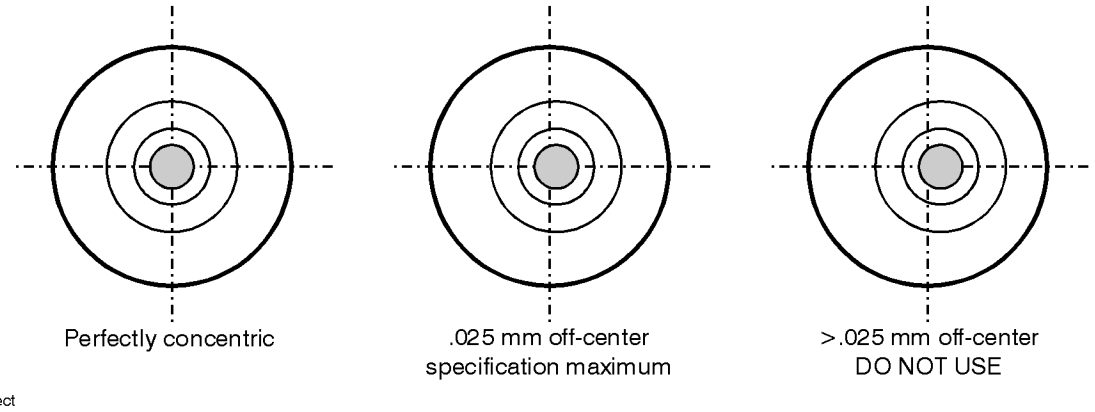


Figure 3-3 Concentricity - Male Connector

Mating Plane Surfaces

Flat contact between the connectors at all points on their mating plane surfaces is required for a good connection.

Look for deep scratches or dents, and for dirt and metal particles on the connector mating plane surfaces. Also look for “dings” on the mating plane surfaces of the center and outer conductors, and for signs of damage due to misalignment, and excessive or uneven wear.

A light burnishing of the mating plane surfaces is normal. This 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.

Clean and inspect the connector again if it shows:

- Deep scratches or dents
- Particles clinging to the mating plane surfaces
- Uneven wear

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 usage is a few times per week. The test port connectors on your network analyzer test set may have many connections each day, and therefore, are more subject to wear. It is recommended that an adapter be used as a test port saver. The use of an adapter will help to minimize the wear on your test set's connectors. When your connectors become worn, replace them.

Supplies and Equipment Needed

The supplies and equipment needed to perform the cleaning procedure, and their Hewlett-Packard part numbers are listed in Table 7-1 on page 7-1 and page 7-2.

Pin Depth

Pin depth is the distance that the center conductor mating plane differs from being flush with the outer conductor mating plane. The pin depth of a connector can be in one of two states, either protruding or recessed.

Protrusion and Recession

- **Protrusion -** the center conductor *extends* beyond the outer conductor mating plane.

CAUTION

At *no* time should the pin depth of the 1.0 mm connector be protruding.

- **Recession -** the center conductor is *set back* from the outer conductor mating plane.

The pin depth value of each calibration device in your kit is not specified, but is an important mechanical parameter. The electrical performance of the device depends, to some extent, on its pin depth.

Hewlett–Packard verifies the pin depth characteristics of the connectors 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 electrical specifications for each device in this kit take into account the effect of pin depth on the device's performance. See Figure 3-4 on page 3-7 for a visual representation of proper pin depth (slightly recessed).

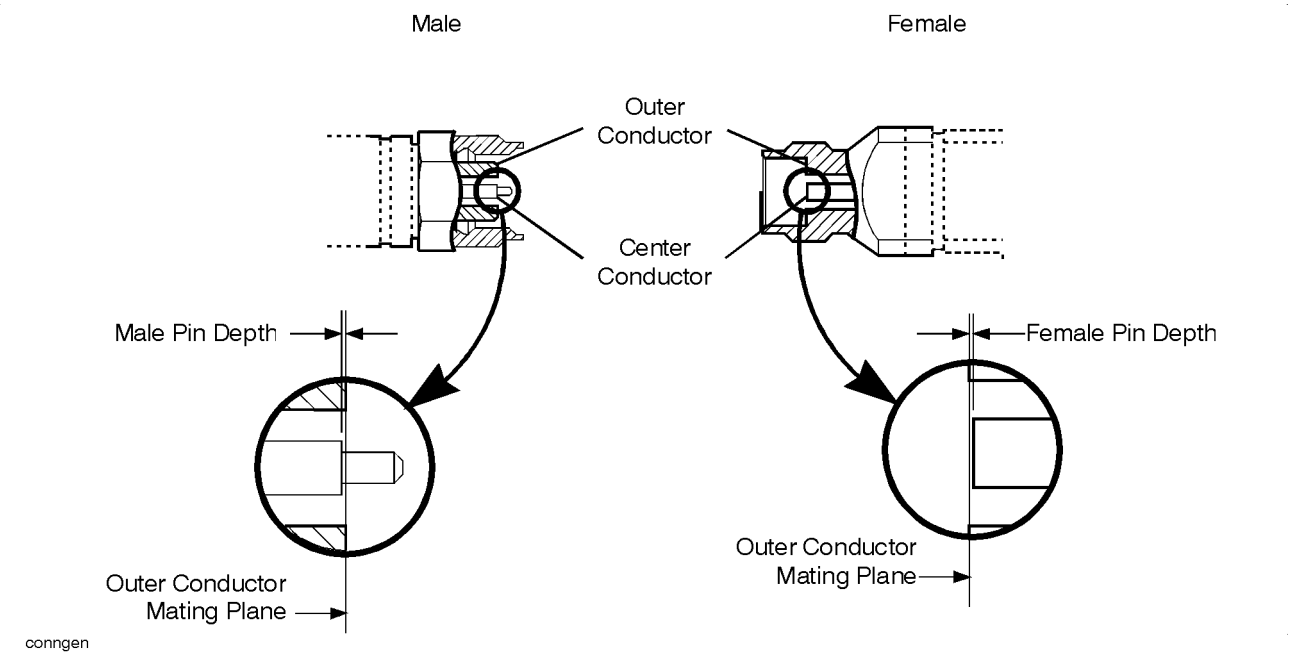


Figure 3-4 Connector Pin Depth

Making Connections

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

NOTE

*The most common cause of measurement error is poor connection*s.

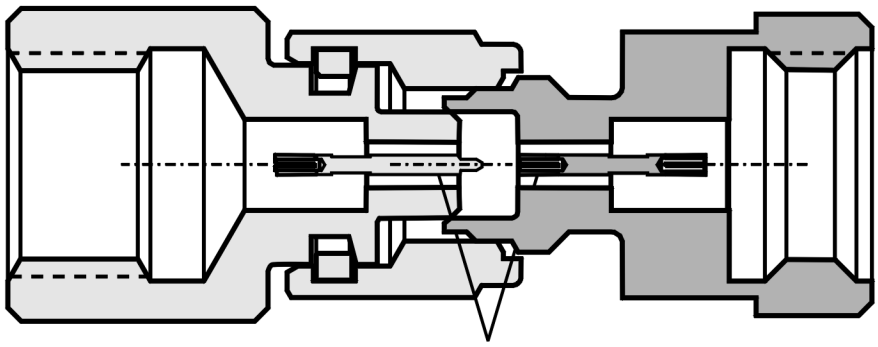
Follow these recommendations for optimum connection technique:

1. Clean and inspect (visually and mechanically) all of your connectors.
2. Align connectors carefully. Look for flat physical contact at all points on the mating plane surfaces.

Connector Alignment

If one of the connectors is free to move, this will make it possible for the connectors to self-align during connection. Self-alignment occurs because outer conductors engage before the center conductors (see Figure 3-5 and Figure 3-6 on page 3-9).

1. Make a gentle, preliminary connection.
2. When making a connection, turn *only* the connector nut. Do not rotate a device when you make a connection, and do not apply a lateral or horizontal (bending) force.
3. Use an open–end wrench to keep the device from rotating when you make a final connection with the torque wrench **(**see Figure 3-8 on page 3-14).

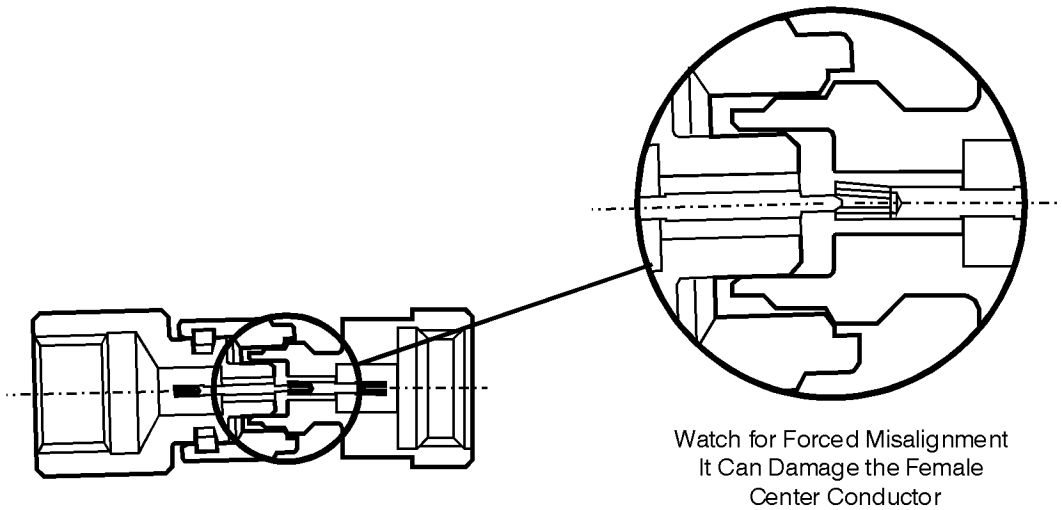


alignmnt

Figure 3-5 Alignment

Connector Misalignment

Forced misalignment could damage the female center conductor.



misalign

Figure 3-6 Misalignment

Cleaning Connectors

Supplies and Equipment Needed

The supplies and equipment that are needed to perform the cleaning procedures, and their Hewlett-Packard part numbers are listed in Table 7-1 on page 7-1 and page 7-2.

NOTE

A minimum magnification of 10X is required for all inspections of the calibration and verification parts.

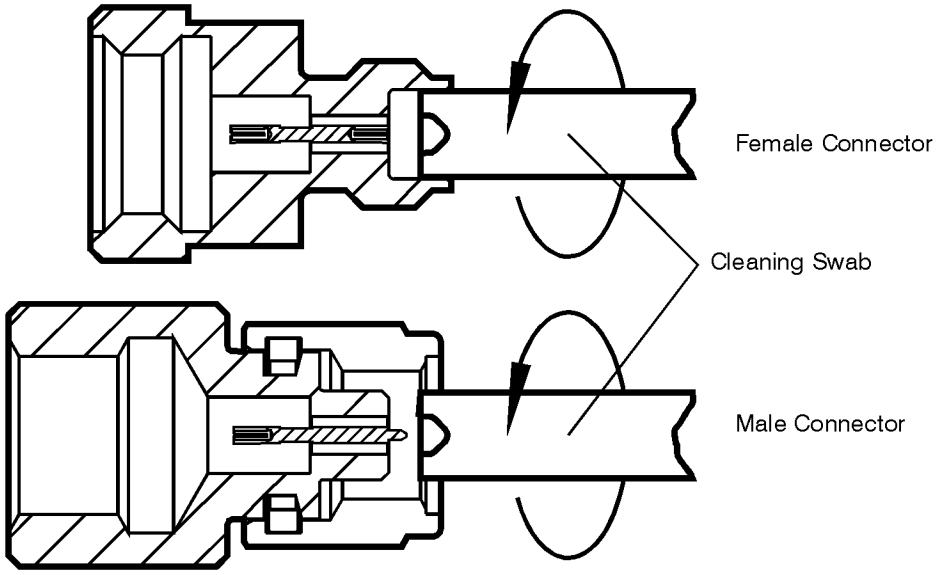
Basic Cleaning Procedure

1. Inspect the connectors for dust, dirt, metal fragments, oils or films, and debris.
2. Blow off any dust with a filtered, clean supply of compressed air.
3. Add a few drops of high-purity isopropyl alcohol to a small cleaning swab (do not apply alcohol directly to the parts).

NOTE

When using isopropyl alcohol to clean connectors *do not* allow the liquid to flow down inside the connector. This may cause measurement errors due to residue inside the connector. If possible keep the connector facing down.

4. *Gently* wipe connecting surfaces with the end of the cleaning swab (see Figure 3-7).
5. Blow dry with compressed air.
6. Inspect and repeat cleaning procedure if necessary.



cleaning

Figure 3-7 Cleaning Illustration

Making a Connection

Connection Procedure

1. Ground yourself and all devices (wear a grounded wrist strap and work on an antistatic mat).
2. Visually inspect the connectors (refer to "Visual Inspection" on page 3-2).
3. If necessary, clean the connectors (refer to "Cleaning Connectors" on page 3-10).
4. Carefully align the connectors. The male connector center pin must slip concentrically into the contact fingers of the female connector (see Figure 3-5 on page 3-9 and Figure 3-6 on page 3-9).
5. 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 when you turn the device body, rather than the connector nut. Major *damage* to the center conductor and the outer conductor can occur if the device body is twisted.

6. Initial tightening can be done by hand, or with a 6 mm open-end wrench. Tighten until "snug" or where the connectors are first making contact. 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 for the outer conductors to make gentle contact on both mating surfaces. Use very light finger pressure (no more than 2 inch–pounds of torque).

7. Relieve any side pressure on the connection from long or heavy devices, or cables. This assures consistent torque (refer to "Using the Torque Wrench" on page 3-13).

Using the Torque Wrench

Table 3-1 provides information on the required settings and tolerances for the 1.0 mm torque wrench supplied in this kit.

Table 3-1 Torque Wrench Information

Connector Type	Torque Setting	Torque Tolerance
1.0 mm	45 N–cm (4 in–lb)	5.4 N–cm (± 0.5 in–lb)

Torque Wrench Procedure

Using the torque wrench guarantees that a connection is not too tight. This will help prevent possible connector damage. It also guarantees that all connections are equally tight each time. Figure 3-10 on page 3-15 shows you where to hold the torque wrench for optimum performance.

NOTE

Do not pre-tighten the connector nut so much that there is no rotation of the nut with the torque wrench. Static friction must *not* be present during torquing.

1. Use the torque wrench supplied with your kit to make the final connections.
2. Rotate *only* the connector nut when you tighten the connector.

In *all* situations, use an open–end wrench to keep the body of the device from turning. Position both wrenches within 90 degrees of each other before applying force (see Figure 3-8 on page 3-14). Wrenches opposing each other (180 degrees apart) will cause a *lifting action.* This lifting action can misalign, and stress the connections of the devices involved. This is especially true when several devices are connected together.

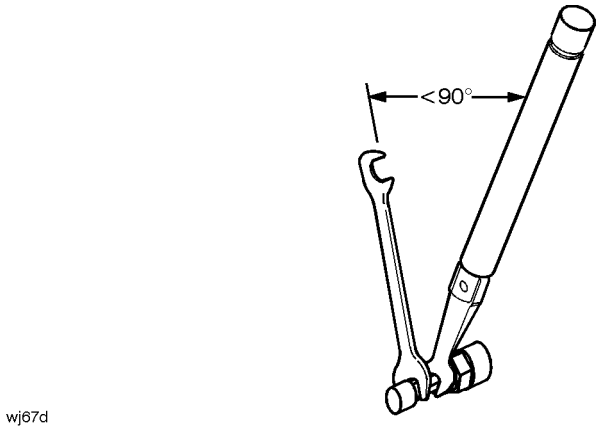


Figure 3-8 Correct Wrench Position

Narrow separation of the wrenches produces a small residual lateral force on the structure of connected devices.

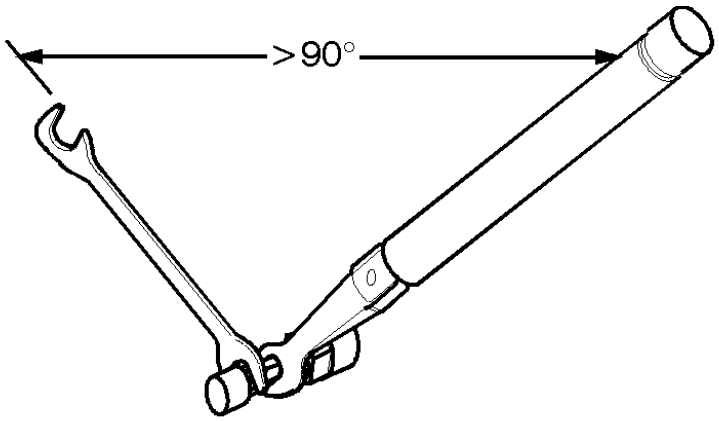


Figure 3-9 Incorrect Wrench Position

Wide separation of the wrenches produces a larger residual lateral force on the structure of connected devices. This can *degrade* connector repeatability.

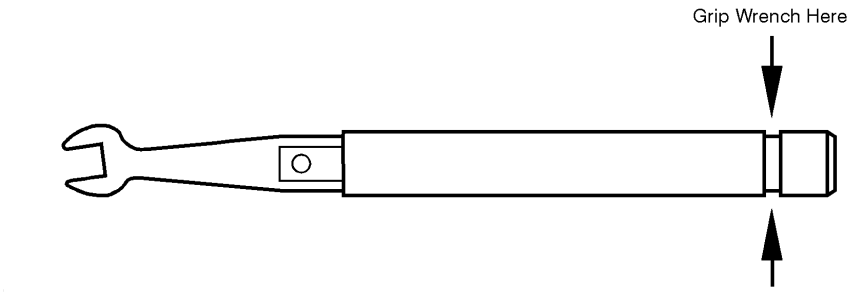


Figure 3-10 Where to Hold the Torque Wrench

3. Hold the torque wrench lightly at the end of the handle *only* (beyond the groove). See Figure 3-10.

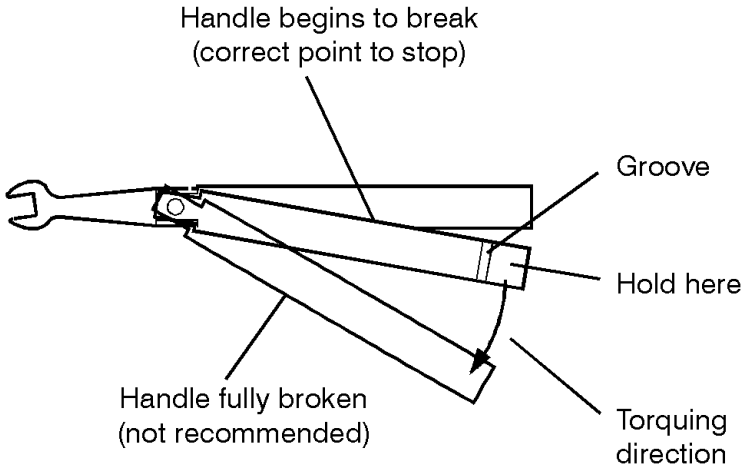


Figure 3-11 Using the Torque Wrench

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. Doing so may apply an unlimited amount of torque.

5. Tighten the connection just to the torque wrench “break” point (see Figure 3-11). 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, you may 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 will apply more than the recommended torque.

Disconnection Procedure

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 and the outer conductor can occur if the device body is twisted.

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

Handling and Storage

- Store calibration and verification devices with end caps on, 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 the 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.

4 User Information

Calibration and Verification Devices

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

Offset Opens and Shorts

The offset opens and shorts are built from parts that 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 that are supported by a strong, low dielectric plastic to provide repeatability and reliability. Both the opens and shorts are constructed so that the pin depth can be controlled very tightly, thereby minimizing phase errors. The length of the offset opens are designed so that the difference in phase of their reflection coefficients is approximately 180° at all frequencies, with respect to offset short 3.

Above 50 GHz, the offset short calibration technique is used. Different combinations of offset shorts using three different lengths are used to calibrate frequency ranges from 50 to 75 GHz and from 75 to 110 GHz. The calibration coefficients for these offset shorts are optimized for their applicable bandwidths.

Offset Shorts (3 rings)

The offset shorts with three rings have three sets of calibration coefficients. The lowband and broadband sets are optimized over the frequency range of DC to 50 GHz. The highband optimized over the 50 to 110 GHz frequency range. Again, female and male devices have different coefficients.

Verification Devices

The verification devices are designed to provide S-parameter measurement comparisons over a broad range of signal levels. The matched thru (adapter) checks the system performance for low loss and low reflection characteristics. The mismatch thru (adapter) checks the system performance over the medium to high reflection and medium loss ranges. The verification devices in this kit are not totally a pass or fail system, but should be considered probability indicators.

Adapters

Like the other devices in your kit, the adapters are built to very tight tolerances. This provides a good performance and ensures stable, repeatable connections. The adapters are designed so that their nominal electrical lengths are the same, this allows them to be used in the calibration procedures for non–insertable devices, but can also be used as connector savers.

Loads

The loads have been optimized for broadband performance up to 50 GHz. The Load can be combined with the Lossy Delay Line to construct a broadband termination. The Load and Lossy Delay Line combination can be used for such purposes as terminating an unused port on a device-under-test, or a “quick” open/short/load calibration from DC to 110 GHz.

NOTE

The best operating region of the load is from DC to 50 GHz. Performance degrades quickly above 50 GHz. For best results, the “lowband load” definition should be used. If desired, an open/short/ broadband load calibration may be performed up to 110 GHz by choosing the broadband load, broadband open and then the broadband Short 3.

Network Analyzer Calibrations

To calibrate a Network Analyzer, use the following combinations of standards listed in Table 4-1 (for 1-port calibrations), and Table 4-2 on page 4-4 (for 2-port calibrations) for the best results. For more information refer to Table 1-1 on page 1-3.

1-Port Calibrations

Table 4-1 1-Port Calibrations

Frequency Range	Calibration Type	Calibrations Standards	Standard Numbers[1]
		File: CK_1MMA1A	
DC to 50 GHz	Open	Open	2, 4
	Short	Short 3	1, 3
	Load	Load	9
50 to 75 GHz	Offset Short	Short 1	12, 16
	Offset Short	Short 3	14, 18
	Offset Short	Short 4	15, 19
75 to 110 GHz	Offset Short	Short 1	12, 16
	Offset Short	Short 2	13, 17
	Offset Short	Short 3	14, 18
		File: CK_1MMA1B[2]	
Optional:	Open	Open	6, 8
DC to 110 GHz	Short	Short 3	5, 7
	Load	Load (broadband)	10

1. Standard numbers reference the line numbers in the Standard Definitions tables (Table 8-5 on page 8-6, and Table 8-6 on page 8-7).

2. Use calibration constant file CK_1MMA1B. The performance specifications are *not guaranteed*.

2-Port Calibrations

Table 4-2 2-Port Calibrations

Frequency Range	Calibration Type	Calibrations Standards	Standard Numbers[1]
		File: CK_1MMA1A	
Dc to 50 GHz	Thru	Thru	11
	Reflect	Short 3	5, 7
	Match	Load	21
DC to 50 GHz	Open	Open	2, 4
	Short	Short 3	1, 3
	Load	Load	9
	Thru	Thru	11
50 to 75 GHz	Offset Short	Short 1	12, 16
	Offset Short	Short 3	14, 18
	Offset Short	Short 4	15, 19
	Thru	Thru	11
75to 110 GHz	Offset Short	Short 1	12, 16
	Offset Short	Short 2	13, 17
	Offset Short	Short 3	14, 18
	Thru	Thru	11
		File: CK_1MMA1B[2]	
Optional: DC to 110 GHz	Open	Open	2, 4
	Short	Short 3	1, 3
	Load	Load (broadband)	10
	Thru	Thru	11
Optional: DC to 110 GHz	Thru	Thru	11
	Reflect	Short 1	12, 16
	Match	Load (broadband)	21

1. Standard numbers reference the line numbers in the Standard Definitions tables (Table 8-5 on page 8-6, and Table 8-6 on page 8-7).

2. Use calibration constant file CK_1MMA1B. Performance specifications are *not guaranteed*.

Calibration Residual Error Specifications

Table 4-3 ***Residual System Calibration Error Specifications Using the CK_1MMA1A Calibration Constants File***

Parameter	Cal Method	Frequency Range	Residuals	
			Male	Female
Directivity	OSL	DC to 2 GHz	30 dB	30 dB
	OSL	2 to 18 GHz	30 dB	30 dB
	OSL	18 to 40 GHz	26 dB	26 dB
	OSL	40 to 50 GHz	24 dB	24 dB
	SSS	50 to 75 GHz	32 dB	28 dB
	SSS	75 to 110 GHz	30 dB	26 dB
	TRM	DC to 2 GHz	30 dB	30 dB
	TRM	2 to 18 GHz	30 dB	30 dB
	TRM	18 to 40 GHz	26 dB	26 dB
	TRM	40 to 50 GHz	24 dB	24 dB
Source Match	OSL	DC to 2 GHz	27 dB	27 dB
	OSL	2 to 18 GHz	27 dB	27 dB
	OSL	18 to 40 GHz	23 dB	23 dB
	OSL	40 to 50 GHz	21 dB	21 dB
	SSS	50 to 75 GHz	32 dB	28 dB
	SSS	75 to 110 GHz	30 dB	26 dB
	TRM	DC to 2 GHz	30 dB	30 dB
	TRM	2 to 18 GHz	30 dB	30 dB
	TRM	18 to 40 GHz	26 dB	26 dB
	TRM	40 to 50 GHz	24 dB	24 dB
Reflection Tracking	OSL	DC to 2 GHz	0.05 dB	0.1 dB
	OSL	2 to 18 GHz	0.08 dB	0.1 dB
	OSL	18 to 40 GHz	0.1 dB	0.2 dB
	OSL	40 to 50 GHz	0.2 dB	0.25 dB
	SSS	50 to 75 GHz	0.2 dB	0.3 dB
	SSS	75 to 85 GHz	0.2 dB	0.3 dB
	SSS	75 to 110 GHz	0.2 dB	0.3 dB
	TRM	DC to 2 GHz	0.1 dB	0.1 dB
	TRM	2 to 18 GHz	0.3 dB	0.3 dB
	TRM	18 to 40 GHz	0.5 dB	0.5 dB
	TRM	40 to 50 GHz	0.7 dB	0.7 dB

Table 4-4 Typical Residual Calibration Error Specifications Using the Broadband CK_1MMA1B Calibration Constants File

Parameter	Cal Method	Frequency Range	Residuals	
			Male	Female
Directivity	OSL	DC to 2 GHz	25 dB	25 dB
	OSL	2 to 18 GHz	20 dB	20 dB
	OSL	18 to 50 GHz	20 dB	20 dB
	OSL	50 to 110 GHz	18 dB	18 dB
	TRM	DC to 2 GHz	25 dB	25 dB
	TRM	2 to 18 GHz	20 dB	20 dB
	TRM	18 to 50 GHz	20 dB	20 dB
	TRM	50 to 110 GHz	18 dB	18 dB
Source Match	OSL	DC to 2 GHz	27 dB	27 dB
	OSL	2 to 18 GHz	27 dB	27 dB
	OSL	18 to 50 GHz	23 dB	23 dB
	OSL	50 to 110 GHz	21 dB	21 dB
	TRM	DC to 2 GHz	25 dB	25 dB
	TRM	2 to 18 GHz	20 dB	20 dB
	TRM	18 to 50 GHz	20 dB	20 dB
	TRM	50 to 110 GHz	18 dB	18 dB
Reflection Tracking	OSL	DC to 2 GHz	0.2 dB	0.2 dB
	OSL	2 to 18 GHz	0.3 dB	0.4 dB
	OSL	18 to 50 GHz	0.4 dB	0.6 dB
	OSL	50 to 110 GHz	0.6 dB	1.0 dB
	TRM	DC to 2 GHz	0.03 dB	0.03 dB
	TRM	2 to 18 GHz	0.09 dB	0.09 dB
	TRM	18 to 50 GHz	0.09 dB	0.09 dB
	TRM	50 to 110 GHz	0.15 dB	0.15 dB

Loading Broadband SOLT Standards

The broadband SOLT standards are an alternative to (rather than a part of) the set of standards listed in Table 1-1 on page 1-3. The calibration data disk supplied with this kit contains two separate files:

- **CK_1MMA1A** - This file contains the recommended standards for calibration. This is the cal kit definition which supports the specified performance.
- **CK_1MMA1B** - This file contains definitions which allow a full frequency broadband calibration using SOLT standards. It is included for convenience only and is not supported in the specifications.

HP 8510 Information

Loading Calibration Constants

Use the following procedure to load the calibration constants into HP 8510C memory.

1. Insert the calibration constants disk into the HP 8510C disk drive.
2. Press **DISC**.
3. Select ***LOAD***.
   - The analyzer displays **SELECT DATA TYPE TO LOAD**.
4. Select ***CAL KIT 1*** or ***CAL KIT2***.
   - The analyzer displays **USE KNOB OR STEP KEYS TO SELECT A FILE.**
5. Select **CK_1MMA1A** from the display menu. (This is the recommended choice for most users), or **CK_1MMA1B** from the display menu, (refer to "Loading Broadband SOLT Standards" on page 4-7 for more information).
6. Select ***LOAD FILE***. This loads the calibration constants into the memory of the network analyzer. When the file is loaded a screen message will indicate the process is complete.
7. Remove the disk from the HP 8510C disk drive.

Duplicating A Calibration Constants Disk

Use the following procedure to make a backup copy of the 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 network analyzer documentation.

1. Load the original calibration constants disk (see previous procedure).
2. Initialize a blank disk:
   - Insert the disk into the disk drive of the HP 8510C.
   - Press **DISC**
3. Select:
   - ***STORAGE IS INTERNAL***
   - ***SETUP DISC***
   - ***INITIALIZE DISC***
   - ***YES***
4. With an initialized disk in the HP 8510C disk drive, transfer the calibration constants:
   - Press **DISC**
   - **STORE**
5. Select:
   - ***CAL KIT/1-2***
   - ***CAL KIT/*1 or CAL KIT/*2***
   - Select the appropriate data type.
6. Remove, write protect, and label the disk.

Performing A Calibration

Using a Network Analyzer

With the calibration constants loaded, set up the network analyzer for the appropriate frequency range, step size, and averaging.

1. Set the desired frequency range using the STIMULUS keys.
2. Set the desired frequency step size using
   - ▲ STIMULUS
   - ▲ **MENU**
   - ▲ ***STEP***

   or the desired number of points, using
   - ▲ STIMULUS
   - ▲ **MENU**
   - ▲ ***NUMBER OF POINTS***
3. Set the desired averaging value by using the following.
   - ▲ RESPONSE
   - ▲ **MENU**
   - ▲ ***AVERAGING ON/restart***
4. To be sure that the system impedance is set to 50Ω press:
   - ▲ **CAL**
   - ▲ ***MORE***
   - ▲ ***SET ZO***

   if the display does not read 50.0Ω, press:
   - ▲ **5**
   - ▲ **0**
   - ▲ **X1**
5. Press:
   - ▲ **CAL**
   - ▲ ***CAL 1*** or
   - ▲ ***CAL 2***
6. Select a calibration type from the menu. The calibration options are available as softkeys on the display. As selections are made, more softkeys will appear.
7. Follow the prompts on the display, or refer to the *HP 8510C Operating Manual* for more information.

Connecting the Calibration Standards

Determine which calibration standards are appropriate for the frequency range being calibrated see Table 1-1 on page 1-3 for “Calibration Techniques and Standards”.

1. Starting from the top down, connect the first standard that is appropriate.
2. Select the softkey associated with the standard and wait until the standard softkey name is underlined.
3. If the standard previously used is still needed, repeat step 2 until all of the standards have been measured and are underlined. If the standard previously used is not needed, disconnect it and proceed to step 4.

When all appropriate standards on the menu have been measured and are underlined, select ***DONE*** or ***SAVE*** (softkey at the bottom of the menu).

a. If the menu includes a ***DONE*** softkey, this indicates that the sub-menu is complete but the calibration as a whole is not. Selecting this softkey leads back to the calibration menu that still needs to be completed.

b. If the menu includes a ***SAVE*** softkey, no other calibration sub-menus are required to complete the calibration. Selecting this softkey saves the calibration.

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**, then press **x1**. See Table 8-2 on page 8-3 for the standard numbers.

1. Press **CAL**.
2. Select:
   - ***MORE***
   - ***MODIFY 1*** or
   - ***MODIFY 2*** (depending on where the calibration constants are loaded)
   - ***DEFINE STANDARD***
3. Press:
   - **1**
   - **x1** (the calibration standard number). The softkey ***SHORT*** is underlined.
4. Select:
   - ***SHORT L0, L1, L2, L3*** (the analyzer displays the value of each L-term as the softkeys are selected).
   - ***SPECIFY OFFSET***
   - ***OFFSET DELAY*** (the analyzer displays the value).
   - ***OFFSET LOSS*** (the analyzer displays the value).
   - ***OFFSET Z0*** (the analyzer displays the value).
   - ***MINIMUM FREQUENCY*** (the analyzer displays the minimum frequency).
   - ***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:
   - **PRIOR MENU** three times. The top softkey is ***DEFINE STANDARD.***
   - **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**, then press **x1**. See Table 8-5 on page 8-6 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:
   - ***MORE***
   - ***MODIFY 1*** or
   - ***MODIFY 2*** (depending on where the calibration constants are loaded).
   - ***DEFINE STANDARD***
3. Press:
   - **1**
   - **x1** (the calibration standard number). The softkey ***SHORT*** is underlined.
4. Select:
   - ***SHORT***
   - ***L0*** enter the new L-term value.
   - Do the same for ***L1***, ***L2*** and ***L3***.
   - ***SPECIFY OFFSET***
   - ***OFFSET DELAY*** enter the new offset delay.
   - ***OFFSET LOSS*** enter the new offset loss.
   - ***OFFSET Z0*** enter the new Z_0.
   - ***MINIMUM FREQUENCY*** enter the new minimum frequency.
   - ***MAXIMUM FREQUENCY*** 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).
   - Modify the label as desired.
6. Select:
   - ***TITLE DONE***
   - ***STD DONE*** (***DEFINED***)
7. Relabel the kit select:
   - ***LABEL KIT*** and follow the instructions on the analyzer. You can enter a total of 10 characters.
8. Select:
   - ***TITLE DONE***

5 Performance Verification

System Verification

After installation of the system is complete, a performance verification is necessary to assure proper system operation. The initial verification is included with the installation of your system, but it is necessary to perform system verification at regular intervals. Included with this kit are a matched thru adapter and a mismatched thru adapter for use in system verification. For more information on system verification see the *HP 8510XF Network Analyzer Operating and Service System Manual.*

Calibration Kit Verification

The performance of your calibration and verification kit can only be verified by returning the kit to Hewlett–Packard for recertification. The equipment and calibration standards required to verify the specification limits of the devices inside this 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 85059A 1.0 mm calibration and verification 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 this kit listing measured values, specifications, and uncertainties.

For more information, contact the nearest Hewlett–Packard office (sales and service offices are listed in the front of this manual).

How Often to Recertify

The suggested initial interval for recertification is 12 months. The actual need for recertification depends on the use of your kit. After reviewing the results of the initial recertification, you may want to establish a different recertification interval that reflects the usage and wear of your 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 front of this manual). When you return the kit, fill out and attach a service tag. (Refer to "Returning a Kit or Device to HP" on page 6-1).

How HP Verifies Devices in this Kit

The appropriate test system is calibrated, and then verified using precision standards that were thoroughly characterized mechanically and electrically. High frequency electrical parameters are compared to airlines, and offset shorts. Low frequency parameters are compared to DC resistance, and low frequency capacitance standards. These reference standards provide the most direct path to fundamental standards, and the lowest possible uncertainties. The resistance and capacitance are directly traceable to NIST (United States National Institute of Standards and Technology).

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 on page 6-2.

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 front 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.

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 at the front of this manual.

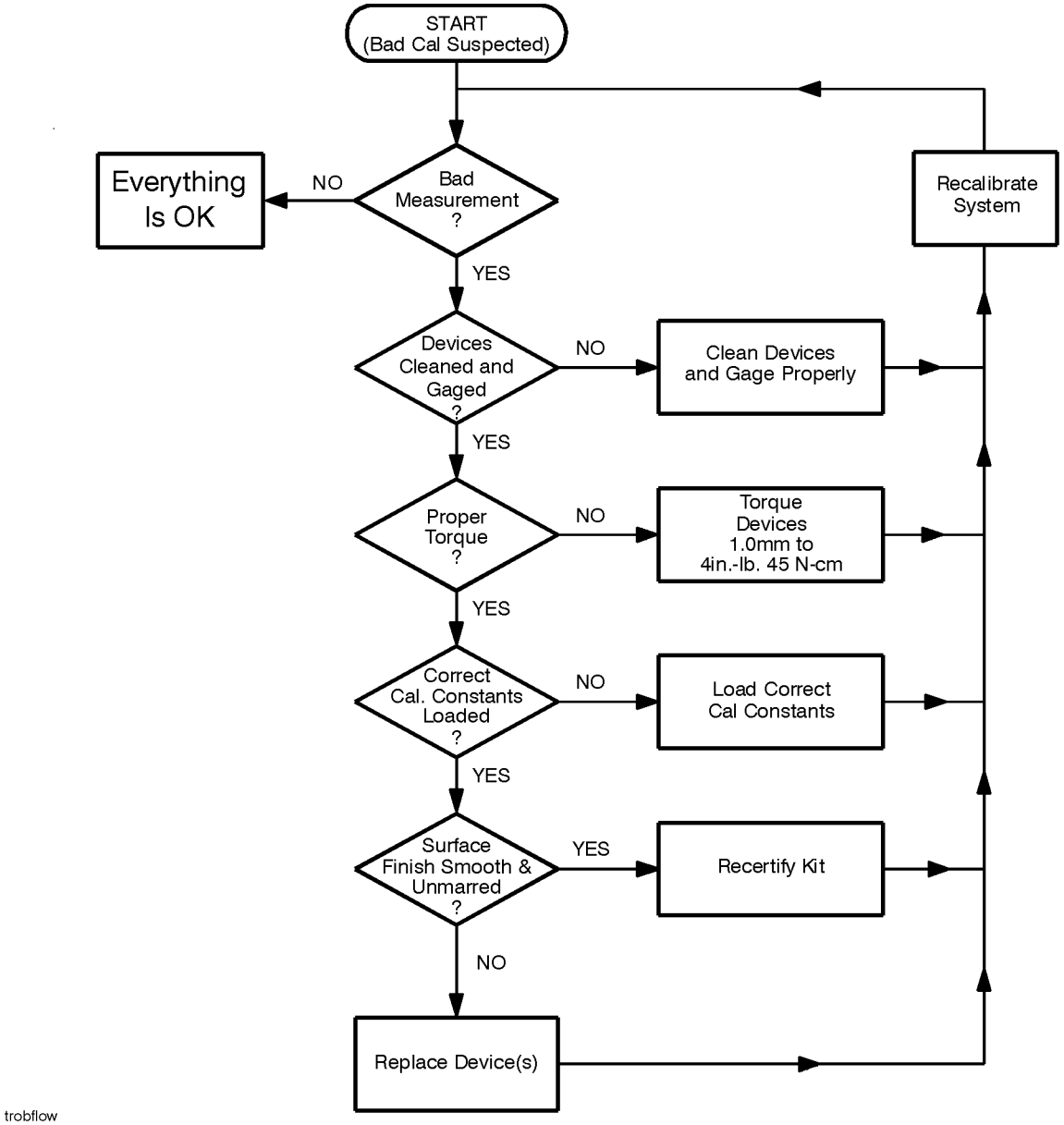


Figure 6-1 Troubleshooting Flowchart

7 Replaceable Parts

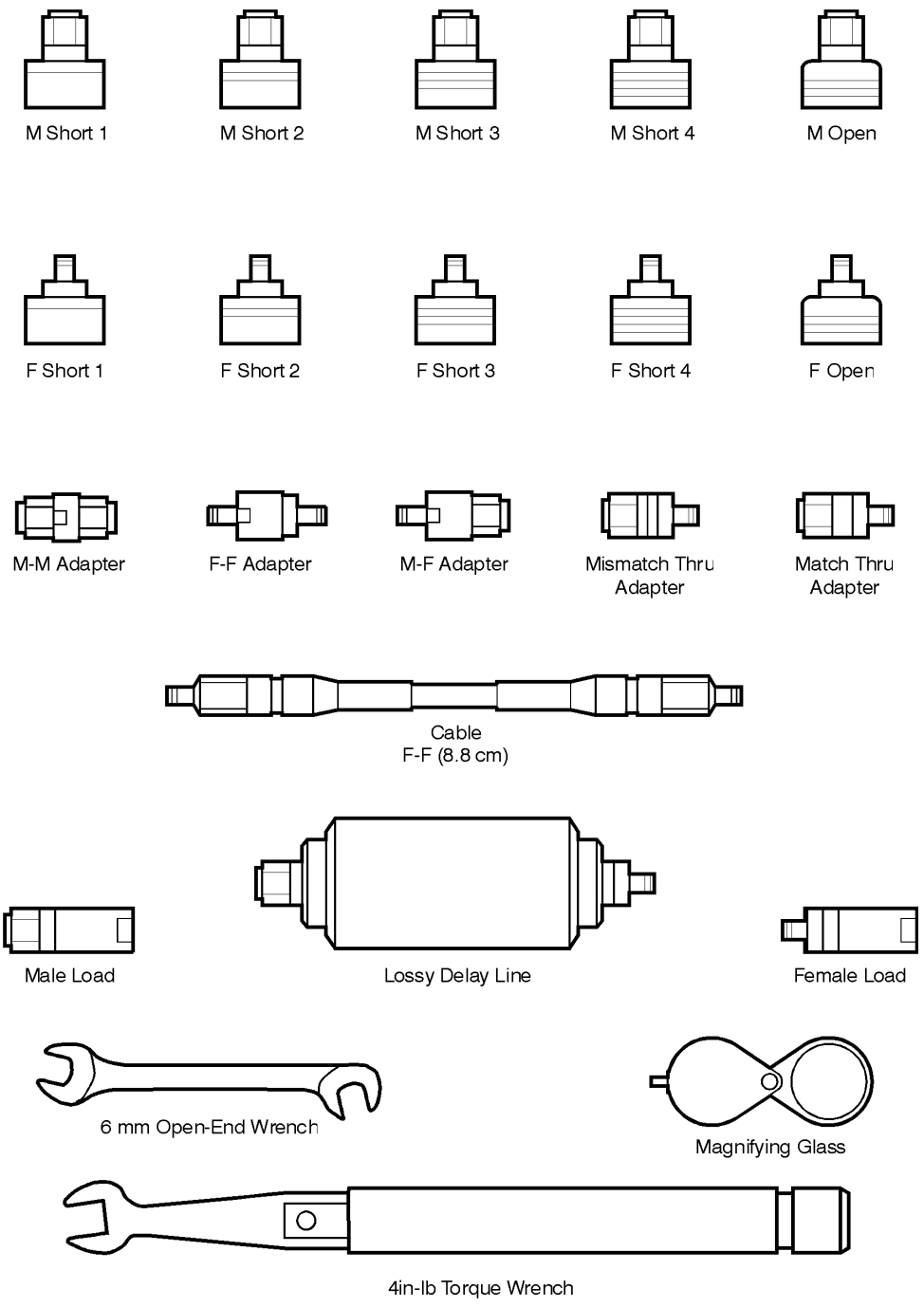
The following replaceable parts table lists the replacement part numbers for the HP 85059A calibration and verification kit contents. To order a listed part, note the description, HP part number, and the quantity desired. Telephone or send your order to the nearest Hewlett–Packard sales and service office (listed in the front of this manual).

Table 7-1 Replaceable Parts

Description	Qty Per Kit	Hewlett-Packard Replaceable Part Number
Calibration Devices		
Shorts:		
M Short 3	1	85059–60003
F Short 3	1	85059–60007
M Short 4	1	85059–60004
F Short 4	1	85059–60008
M Short 2	1	85059–60002
F Short 2	1	85059–60006
M Short 1	1	85059–60001
F Short 1	1	85059–60005
Opens:		
Male Open	1	85059–60009
Female Open	1	85059–60010
Loads:		
Male Load	1	85059–60019
Female Load	1	85059–60020
Lossy Delay Line	2	85059–60021
Adapters:		
Male to Male Adapter	1	11920–60001
Female to Female Adapter	1	11920–60002
Male to Female Adapter	1	11920–60003
Cables:		
Female to Female Cable (8.8 cm)	1	11500–60001

Table 7-1 Replaceable Parts (Continued)

Description	Qty Per Kit	Hewlett-Packard Replaceable Part Number
Verification Devices		
Mismatched Thru Adapter	1	85059–60016
Matched Thru Adapter	1	85059–60017
Wrenches		
6 mm 4 in–lb Torque	1	8710–2079
6 mm Open–end	1	8710–2156
Miscellaneous Items		
Calibration Data Disc	1	85059–10002
Verification Data Disc	1	08510–10033
Verification Disk	1	85059–10004
Disk Holder	1	5180–8491
Operating and Service Manual	1	85059–90003
Plastic Box	1	1540–1218
Cleaning Swabs	1	9300–1745
10X Magnifying Glass	1	1000–1114
Items Not Included In Kit		
Blank Disk (for data backup)		9164–0166
Isopropyl Alcohol (30 ml)		8500–5344
Grounding Wrist Strap		9300–1367
5 Foot Grounding Cord (for wrist strap)		9300–0980
2 x 4 Foot Conductive Table Mat and 15 ft Ground Wire		9300–0797
ESD Heel Strap (for conductive floors)		9300–1126



Included in HP 85059A Cal Kit but not shown:

- Calibration Data Disk
- Verification Disk
- Cleaning Swabs

Figure 7-1 Replaceable Parts

8 Standard Definitions

Electrical Characteristics

Standard Class Assignments

The class assignment forms (Table 8-2 on page 8-3 and Table 8-2 on page 8-3) organize 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.

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 tables list typical calibration kit parameters used by the HP 8510C and 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.

Setting System Impedance

Ensure the system impedance (Z_0) is set to the same value as the standards being used. This kit contains only 50Ω devices. For use with the HP 8510C do the following:

1. Press:
   - ▲ **CAL**
   - ▲ ***MORE***
   - ▲ ***SET Z0***
2. Observe the display to determine *current* system impedance.
3. If it is not 50Ω, press:
   - ▲ **5**
   - ▲ **0**
   - ▲ **x1**

Version Changes

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. The disk shipped with your kit is for use with the HP 8510C and will contain the most recent version.

Table 8-1 Standard Class Assignments for the HP 8510 Network Analyzer

Calibration Kit Label: 1.00 mm A.1A
Disk File Name: CK _1MMKA1A

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$	2	14	4	18				Open/Short
$S_{11}B$	1	12	3	16				Short
$S_{11}C$	9	15	13	19	17			Load/Short
$S_{22}A$	2	14	4	18				Open/Short
$S_{22}B$	1	12	3	16				Short
$S_{22}C$	9	15	13	19	17			Load/Short
Forward Transmission	11							Thru
Reverse Transmission	11							Thru
Forward Match	11							Thru
Reverse Match	11							Thru
Forward Isolation[1]	10							Load
Reverse Isolation	10							Load
Frequency Response	5	6	7	8	11			Response
TRL Thru	11							Thru
TRL Reflect	5	7						Short
TRL Line	21							Match
Adapter	20							Adapter
TRL Option								
Cal Z_0:	_X___System Z_0				____Line Z_0			
Set Ref:	__X___Thru				____Reflect			
Lowband Frequency:____0_____								

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

The following table is for the standard class assignments using the “quick” broadband SOLT cal. The performance specifications are not guaranteed for the “Quick” calibration using file CK_1MMA1B.

Table 8-2 Standard Class Assignments for the HP 8510 Network Analyzer

Calibration Kit Label: 1.00 mm A.1B Disk File Name: CK _1MMKA1B								
Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$	2	4						Open
$S_{11}B$	1	3						Short
$S_{11}C$	10							Load
$S_{22}A$	2	4						Open
$S_{22}B$	1	3						Short
$S_{22}C$	10							Load
Forward Transmission	11							Thru
Reverse Transmission	11							Thru
Forward Match	11							Thru
Reverse Match	11							Thru
Forward Isolation[1]	10							Load
Reverse Isolation	10							Load
Frequency Response	2	4	1	3	11			Response
TRL Thru	11							Thru
TRL Reflect	12	16						Short
TRL Line	21							Load
Adapter	20							Adapter
TRL Option								
Cal Z_0:	_X___System Z_0				____Line Z_0			
Set Ref:	__X__Thru				____Reflect			
Lowband Frequency:____0_____								

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

Table 8-3 Standard Class Assignments Blank Form

Calibration Kit Label: _____
Disk File Name: _____

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$								Open/Short
$S_{11}B$								Shorts
$S_{11}C$								Load/Short
$S_{22}A$								Open/Short
$S_{22}B$								Short
$S_{22}C$								Load/Short
Forward Transmission								Thru
Reverse Transmission								Thru
Forward Match								Thru
Reverse Match								Thru
Forward Isolation[1]								Load
Reverse Isolation								Load
Frequency Response								Response
TRL Thru								Thru
TRL Reflect								Short
TRL Line								Load
Adapter								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 8-4 Standard Class Assignments Blank Form

Calibration Kit Label: _____
Disk File Name: _____

Class	A	B	C	D	E	F	G	Standard Class Label
$S_{11}A$								Open
$S_{11}B$								Short
$S_{11}C$								Load
$S_{22}A$								Open
$S_{22}B$								Short
$S_{22}C$								Load
Forward Transmission								Thru
Reverse Transmission								Thru
Forward Match								Thru
Reverse Match								Thru
Forward Isolation[1]								Load
Reverse Isolation								Load
Frequency Response								Response
TRL Thru								Thru
TRL Reflect								Short
TRL Line								Load
Adapter								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 8-5 Standard Definitions for the HP 8510 Network Analyzer

Calibration Kit Label: 1.00mmA.1A
Disk File Name: CK_1MMA1A

STANDARD[1]		C0 X10 $^{-15}$ F	C1 X10 $^{-27}$ F/Hz	C2 X10 $^{-36}$ F/Hz ^{2}	C3 X10 $^{-45}$ F/Hz ^{3}							
NO	TYPE	L0 X10 $^{-12}$ H	L1 X10 $^{-24}$ H/Hz	L2 X10^{-33} H/Hz ^{2}	L3 X10^{-42} H/Hz ^{3}	Fixed[2] or Sliding	OFFSET Delay ps	OFFSET Zo Ω	LOSS GΩ/ s	FREQ[3] (GHz) MIN	FREQ[3] (GHz) MAX	COAX or WG	STANDARD LABEL[4]
1	Short	3.2053	-171.65	3.3888	-0.0208		8.149	50.0	7.74	0	50.50	Coax	(F) Short 3
2	Open	31.579	162.211	-4.0954	0.037		6.575	50.0	7.80	0	50.50	Coax	(F) Open
3	Short	2.419	-21.1901	-0.8034	0.0095		8.149	50.0	7.7	0	50.50	Coax	(M) Short 3
4	Open	29.27	360.024	-8.3672	0.0758		6.575	50.0	8.0	0	50.50	Coax	(M) Open
5	Short	0.2885	40.2472	-0.9816	0.0057		8.149	50.0	7.93	0	999	Coax	(F) Short 3
6	Open	31.043	274.897	-6.6250	0.0539		6.575	50.0	8.0	0	999	Coax	(F) Open
7	Short	4.3065	-156.379	1.9852	-0.0081		8.149	50.0	7.9	0	999	Coax	(M) Short 3
8	Open	28.40	543.356	-11.754	0.0793		6.575	50.0	8.0	0	999	Coax	(M) Open
9	Load					Fixed	0	50.0	0	0	50.50	Coax	50 GHz Load
10	Load					Fixed	0	50.0	0	0	999	Coax	Load
11	Thru						0	50.0	0	0	999	Coax	Thru
12	Short	4.4217	-174.59	2.2083	-0.0084		4.313	50.0	8.0	49.90	999	Coax	(F) Short 1
13	Short	-14.4155	484.395	-5.0055	0.0164		6.064	50.0	8.51	65.0	999	Coax	(F) Short 2
14	Short	1.14	24.8423	-0.9462	0.006		8.149	50.0	8.0	49.90	999	Coax	(F) Short 3
15	Short	3.6474	-113.206	1.1075	-0.0027		9.984	50.0	8.2	49.90	75.1	Coax	(F) Short 4
16	Short	-0.9209	107.672	-1.553	0.0057		4.313	50.0	8.0	49.90	999	Coax	(M) Short 1
17	Short	11.2987	-384.343	3.251	-0.009		6.064	50.0	8.55	65.0	999	Coax	(M) Shrot 2
18	Short	8.2341	-305.298	3.7762	-0.015		8.149	50.0	8.0	49.90	999	Coax	(M) Short 3
19	Short	45.099	-1988.66	27.99	-0.1258		9.984	50.0	8.23	49.90	75.1	Coax	(M) Short 4
20	Thru						42.50	50.0	7.90	0	999	Coax	Adapter
21	Load					Fixed	99999	50.0	0	0	50.50	Coax	50 GHz Load

1. Open, short, load, or arbitrary impedance.
2. Load or arbitrary impedance only.
3. For waveguide, lower frequency is same as Fco.
4. The connector sex designations of the calibration standards refer to the sex of the test port. For example, (F) Open is the female test port open.

Table 8-6 Standard Definitions for the HP 8510 Network Analyzer

Calibration Kit Label: 1.00mmA.1B
Disk File Name: CK_1MMA1B[1]

STANDARD[2]		C0 X10 $^{-15}$ F	C1 X10 $^{-27}$ F/Hz	C2 X10 $^{-36}$ F/Hz ^{2}	C3 X10 $^{-45}$ F/Hz ^{3}								
NO	TYPE	L0 X10 $^{-12}$ H	L1 X10 $^{-24}$ H/Hz	L2 X10^{-33} H/Hz ^{2}	L3 X10^{-42} H/Hz ^{3}	Fixed[3] or Sliding	OFFSET Delay ps	OFFSET Zo Ω	LOSS GΩ/ s	FREQ[4] (GHz) MIN	FREQ[4] (GHz) MAX	COAX or WG	STANDARD LABEL[5]
1	Short	0.2885	40.2472	-0.9816	0.0057		8.149	50.0	7.93	0	999	Coax	(F) Short 3
2	Open	31.043	274.897	-6.6250	0.0539		6.575	50.0	8.0	0	999	Coax	(F) Open
3	Short	4.3065	-156.379	1.9852	-0.0081		8.149	50.0	7.9	0	999	Coax	(M)F Short 3
4	Open	28.400	543.356	-11.754	0.0793		6.575	50.0	8.0	0	999	Coax	(M) Open
5													
6													
7													
8													
9													
10	Load					Fixed	0	50.0	0	0	999	Coax	Load BB[6]
11	Thru						0	50.0	0	0	999	Coax	Thru
12	Short	0	0	0	0		4.3165	50.0	8.0	0	999	Coax	(F) Short 1
16	Short	0	0	0	0		4.3165	50.0	8.0	0	999	Coax	(M) Short 1
17													
18													
19													
20	Thru						42.50	50.0	7.90	0	999	Coax	Adapter
21	Load					Fixed	99999	50.0	0	0	999	Coax	Load BB[6]

1. This file is used for “quick” calibrations and performance specifications are not guaranteed.
2. Open, short, load, or arbitrary impedance.
3. Load or arbitrary impedance only.
4. For waveguide, lower frequency is same as Fco.
5. The connector sex designations of the calibration standards refer to the sex of the test port. For example, (F) Open is the female test port open.
6. The broadband load, is a combination of the lossy delay line plus the 50 GHz load.

Table 8-7 Standard Definitions Blank Form

Calibration Kit Label: _1.00mmA.1A_
Disk File Name: CK_1MMA1A

STANDARD[1]		C0 X10 $^{-15}$ F	C1 X10 $^{-27}$ F/Hz	C2 X10 $^{-36}$ F/Hz ^{2}	C3 X10 $^{-45}$ F/Hz ^{3}								
NO	TYPE	L0 X10 $^{-12}$ H	L1 X10 $^{-24}$ H/Hz	L2 X10^{-33} H/Hz ^{2}	L3 X10^{-42} H/Hz ^{3}	Fixed[2] or Sliding	OFFSET Delay ps	OFFSET Zo Ω	LOSS GΩ/ s	FREQ[3] (GHz) MIN	FREQ[3] (GHz) MAX	COAX or WG	STANDARD LABEL[4]
1	Short												(F) Short 3
2	Open												(F) Open
3	Short												(M) Short 3
4	Open												(M) Open
5	Short												(F) Short 3
6	Open												(F) Open
7	Short												(M) Short 3
8	Open												(M) Open
9	Load												Load LB
10	Load												Load BB
11	Thru												Thru
12	Short												(F) Short 1
13	Short												(F) Short 2
14	Short												(F) Short 3
15	Short												(F) Short 4
16	Short												(M) Short 1
17	Short												(M) Short 2
18	Short												(M) Short 3
19	Short												(M) Short 4
20	Thru												Adapter
21	Load												Load

1. Open, short, load, or arbitrary impedance.

2. Load or arbitrary impedance only.

3. For waveguide, lower frequency is same as Fco.

4. The number refers the number of rings around the device.

Table 8-8 Standard Definitions Blank form

Calibration Kit Label: _1.00MMA.1B__
Disk File Name: CK_1MMA1B[1]

STANDARD[2] NO	TYPE	C0 X10 $^{-15}$ F	C1 X10 $^{-27}$ F/Hz	C2 X10 $^{-36}$ F/Hz ^{2}	C3 X10 $^{-45}$ F/Hz ^{3}	Fixed[3] or Sliding	OFFSET Delay ps	Zo Ω	LOSS GΩ/s	FREQ[4] (GHz) MIN	MAX	COAX or WG	STANDARD LABEL[5]
		L0 X10 $^{-12}$ H	L1 X10 $^{-24}$ H/Hz	L2 X10^{-33} H/Hz ^{2}	L3 X10^{-42} H/Hz ^{3}								
1	Short												(F) Short 3
2	Open												(F) Open
3	Short												(M) Short 3
4	Open												(M) Open
5													
6													
7													
8													
9													
10	Load												Load BB[6]
11	Thru												Thru
12	Short												(F) Short 1
13													
14													
15													
16	Short												(M) Short 1
17													
18													
19													
20	Thru												Adapter
21	Load												Load

1. This file is used for “quick” calibrations and performance specifications are not guaranteed.
2. Open, short, load, or arbitrary impedance.
3. Load or arbitrary impedance only.
4. For waveguide, lower frequency is same as Fco.
5. The number refers the number of rings around the device.
6. The broadband load, is a combination of the lossy delay line plus the 50 GHz load.

Index