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**Agilent Technologies**

# **Connector Care**

For

## **RF & Microwave Coaxial Connectors**



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PACKARD**

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# Contents

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<b>1. Introduction</b>	
Connectors . . . . .	1-1
Precision 7 mm Connectors . . . . .	1-2
Type-N Connectors . . . . .	1-2
Standard Type-N . . . . .	1-2
PSC-N . . . . .	1-2
75 $\Omega$ Type-N . . . . .	1-2
3.5 mm Connectors . . . . .	1-3
SMA . . . . .	1-3
Precision 3.5 mm . . . . .	1-3
PSC-3.5 mm . . . . .	1-3
NMD-3.5 mm . . . . .	1-3
2.4 mm Connectors . . . . .	1-4
The Three Grades . . . . .	1-4
Production Grade . . . . .	1-4
Instrument Grade . . . . .	1-4
Metrology Grade . . . . .	1-4
Precision 2.4 mm . . . . .	1-4
PSC-2.4 mm . . . . .	1-4
NMD-2.4 mm . . . . .	1-4
Electrostatic Discharge . . . . .	1-5
Static-Safe Work Station . . . . .	1-5
Static-Safe Practices . . . . .	1-5
Handling . . . . .	1-6
Storing . . . . .	1-6
<b>2. Visually Inspecting &amp; Cleaning Connectors</b>	
Visual Inspection Procedure . . . . .	2-2
1. Check for Obvious Defects . . . . .	2-2
2. Check for Particles, Scratches, and Dents . . . . .	2-2
Scratches . . . . .	2-3
Light Burnishing . . . . .	2-3
Deep Scratches . . . . .	2-3
Concentric Scratches . . . . .	2-3
Scratches Across the Mating Plane . . . . .	2-3
Dents . . . . .	2-4
Particles . . . . .	2-4
Metal and Metal By-product Particles . . . . .	2-4
Other Types of Particles . . . . .	2-4
Cleaning Connectors . . . . .	2-5
Periodically Check for Alcohol Contamination . . . . .	2-5
General Cleaning Procedure . . . . .	2-6



1. Use Compressed Air or Nitrogen . . . . .	2-6
2. Clean the Connector Threads . . . . .	2-6
3. Clean the Mating Plane Surfaces . . . . .	2-6
4. Clean the Interior Surfaces . . . . .	2-6
5. Dry the Connector . . . . .	2-7
6. Reinspect . . . . .	2-7
Precision 7 mm . . . . .	2-8
Center Collet in Place . . . . .	2-8
Fixed Connectors . . . . .	2-8
Center Collet Removed . . . . .	2-8
SMA, Precision 3.5 mm, & Precision 2.4 mm . . . .	2-9
 <b>3. Mechanically Inspecting &amp; Connecting Connectors</b>	
When to Gage Coaxial Connectors . . . . .	3-1
Connector Gages . . . . .	3-2
Types . . . . .	3-2
Accuracy . . . . .	3-2
Using a Centering Bead . . . . .	3-3
<b>General Gaging Procedure</b> . . . . .	3-4
Precision 7 mm . . . . .	3-8
Specifications . . . . .	3-8
Type-N . . . . .	3-10
Specifications . . . . .	3-10
Electrical Effects of Contact Separation . . . . .	3-13
Gaging Techniques . . . . .	3-14
Male Type-N . . . . .	3-14
Female Type-N . . . . .	3-16
SMA . . . . .	3-18
Specifications . . . . .	3-18
Dielectric Protrusion . . . . .	3-18
Out-of-Specification Male Pins . . . . .	3-18
Gaging Techniques . . . . .	3-20
Male SMA (Push-on Type Gage) . . . . .	3-20
Male SMA (Screw-on Type Gage) . . . . .	3-22
Female SMA (Push-on Type Gage) . . . . .	3-23
Female SMA (Screw-on Type Gage) . . . . .	3-24
Precision 3.5 mm . . . . .	3-25
Specifications . . . . .	3-25
Gaging Techniques . . . . .	3-26
Male 3.5 mm (Push-on Type Gage) . . . . .	3-26
Male 3.5 mm (Screw-on Type Gage) . . . . .	3-28
Female 3.5 mm (Push-on Type Gage) . . . . .	3-29
Female 3.5 mm (Screw-on Type Gage) . . . . .	3-30
2.4 mm . . . . .	3-31
Specifications . . . . .	3-31
Gaging Techniques . . . . .	3-32
Male 2.4 mm Connectors . . . . .	3-32
Female 2.4 mm Connectors . . . . .	3-33
Making Connections . . . . .	3-34
<b>General Connecting Procedure</b> . . . . .	3-34
Connecting . . . . .	3-34

Disconnecting . . . . .	3-39
Precision 7 mm . . . . .	3-40
Seating . . . . .	3-40
Type-N . . . . .	3-41
3.5 mm . . . . .	3-42
Mating a Precision 3.5 mm Connector to an SMA	
Connector . . . . .	3-42
Electrical Performance . . . . .	3-42
2.4 mm . . . . .	3-44
<b>A. Removing, Inspecting, &amp; Replacing Center Conductor Collets</b>	
Collet Types . . . . .	A-1
Slotted (page A-2) . . . . .	A-1
Slotless (page A-4) . . . . .	A-1
Slotted Collets . . . . .	A-2
Removing a Center Slotted Collet . . . . .	A-2
Inspecting a Slotted Collet . . . . .	A-2
Replacing a Slotted Collet . . . . .	A-3
Slotless Collets . . . . .	A-4
HP 85052B Option K11 . . . . .	A-4
HP 85054B Option K11 . . . . .	A-4
Repairing A Slotless Contact . . . . .	A-5
Inspecting A Damaged Slotless Contact . . . . .	A-6
Removing A Slotless Contact . . . . .	A-8
Step 1 . . . . .	A-8
Step 2 . . . . .	A-10
Step 3 . . . . .	A-12
Inspecting & Cleaning A Center Conductor . . . . .	A-15
Inspecting . . . . .	A-15
Cleaning . . . . .	A-15
Inserting an Inner Contact . . . . .	A-16
Testing a Slotless Contact . . . . .	A-18
<b>B. Accessories &amp; Cleaning Supplies</b>	
Adapters . . . . .	B-1
Precision 7 mm . . . . .	B-2
The HP 85130B Adapter Kit . . . . .	B-2
Directional Bridges . . . . .	B-2
Precision 3.5 mm . . . . .	B-2
Directional Bridges . . . . .	B-2
Precision 2.4 mm . . . . .	B-3
PSC 2.4 mm . . . . .	B-3
2.4 mm-to-2.4 mm Adapters . . . . .	B-3
3.5 mm-to-2.4 mm Adapters . . . . .	B-3

## Index

## Figures

---

1-1. Example of a Static-Safe Work Station . . . . .	1-5
2-1. Trimmed Toothpick Wrapped in a Single Layer of Lint-Free Cleaning Cloth . . . . .	2-7
2-2. Cleaning a 7 mm Connector with the Connector Collet in Place . . . . .	2-8
3-1. Typical Connector Gage . . . . .	3-3
3-2. Zeroing a Push-on Connector Gage . . . . .	3-5
3-3. Zeroing a Screw-on Connector Gage . . . . .	3-7
3-4. Precision 7 mm Connector Mechanical Specifications	3-9
3-5. Type-N Connector Mechanical Specifications . . .	3-11
3-6. The Approximate Effects of Contact Separation on the Reflection Coefficient of Type-N Connectors	3-13
3-7. Gaging a Type-N Male Connector . . . . .	3-15
3-8. Gaging a Type-N Female Connector Using a Push-on Type Gage . . . . .	3-17
3-9. SMA Connector Mechanical Specifications . . . .	3-19
3-10. Gaging an SMA Male Connector Using a Push-on Type Gage . . . . .	3-21
3-11. Gaging an SMA Male Connector Using a Screw-on Type Gage . . . . .	3-22
3-12. Gaging an SMA Female Connector Using a Push-on Type Gage . . . . .	3-23
3-13. Gaging an SMA Female Connector Using a Screw-on Type Gage . . . . .	3-24
3-14. 3.5 mm Connector Mechanical Specifications . . .	3-25
3-15. Gaging a 3.5 mm Male Connector Using a Push-on Type Gage . . . . .	3-27
3-16. Gaging a 3.5 mm Male Connector Using a Screw-on Type Gage . . . . .	3-28
3-17. Gaging a 3.5 mm Female Connector Using a Push-on Type Gage . . . . .	3-29
3-18. Gaging a 3.5 mm Female Connector Using a Screw-on Type Gage . . . . .	3-30
3-19. 2.4 mm Connector Mechanical Specifications . . .	3-31
3-20. Gaging a 2.4 mm Male Connector . . . . .	3-32
3-21. Gaging a 2.4 mm Female Connector . . . . .	3-33
3-22. Align the Connectors . . . . .	3-35
3-23. Make the Preliminary Connection Gently . . . .	3-35
3-24. Make the Final Connection With a Torque Wrench	3-37
3-25. Proper Torque Wrench Orientation . . . . .	3-37
3-26. Do not Push the Torque Wrench Straight Down .	3-37
3-27. Tighten Only to the Torque Wrench Break Point .	3-38

3-28. Do Not Pivot the Torque Wrench on Your Thumb	3-38
3-29. Seating a Precision 7 mm Connector . . . . .	3-40
3-30. A Precision 3.5 mm Connector Interface Compared to A Precision 3.5 mm-to-SMA Connector Interface . . . . .	3-43
3-31. Typical SWR of SMA and Precision 3.5 mm Coupled Junctions . . . . .	3-43
A-1. Using the Collet Removal Tool . . . . .	A-2
A-2. Inserting a Collet . . . . .	A-3
A-3. Gently Press the Collet into Place . . . . .	A-3
A-4. Finger Bent In or Crushed . . . . .	A-6
A-5. Broken Inner Contact . . . . .	A-7
A-6. Inner Contact Pushed Inside . . . . .	A-7
A-7. Damaged Center Conductor . . . . .	A-7
A-8. The Inner Contact and Center Conductor . . . . .	A-8
A-9. Inserting the Removal Tool . . . . .	A-9
A-10. Moving a Damaged Finger . . . . .	A-9
A-11. Freeing a Broken Contact Finger . . . . .	A-11
A-12. Removing a Broken Contact Finger . . . . .	A-11
A-13. Threading the Removal Tool into the Inner Contact	A-13
A-14. Removing the Inner Contact . . . . .	A-13
A-15. Damaged Center Conductor . . . . .	A-15
A-16. Holding the Inner Contact Properly . . . . .	A-16
A-17. Installing a New Inner Contact . . . . .	A-17
A-18. Inspecting the Installation . . . . .	A-17
A-19. Inserting the Testing Tool . . . . .	A-19
A-20. Testing the Retention Force of the Contact . . . . .	A-19
B-1. Typical Directivity Using Connector-Saver Adapters	B-2



**Tables**

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1-1. Connectors . . . . .	1-1
B-1. Cleaning Supplies and Accessories . . . . .	B-4

## Introduction

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**Note**

For a summary of general recommendations for coaxial connectors, see the Hewlett-Packard application note number 326, *Principles of Microwave Connector Care*, available from your local Hewlett-Packard representative.

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**Connectors****Table 1-1. Connectors**

Connector	Usable Frequency Range (GHz)
Precision 7 mm	DC to 20
Type-N	DC to 18
PSC-N	DC to 18
SMA	DC to 23
Precision 3.5 mm	DC to 34
PSC-3.5 mm	DC to 34
Precision 2.4 mm	DC to 50
PSC-2.4 mm	DC to 50

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## Precision 7 mm Connectors

Precision 7 mm connectors are air dielectric devices. A plastic bead inside the connector body supports the center conductor. These connectors provide the lowest SWR and the most repeatable connections of any 7 mm connector type. Durable, they are used in test and measurement applications that require a high degree of accuracy and repeatability.

Generally made of beryllium copper alloy plated with gold, these sexless connectors have replaceable inserts (collets). The collets provide contact between the center conductors, making spring-loaded butt contact when you tighten the connection.

Occasionally small mechanical differences that exist between precision 7 mm connectors made by different manufacturers can cause connection problems. Always mechanically inspect connectors to ensure they meet specifications.

---

## Type-N Connectors

Relatively inexpensive, general-purpose, sexed connectors, these rugged 7 mm connectors perform well in severe operating environments and in applications that require repeated connections.

**Standard Type-N** These connectors, made of brass, have slotted female connectors.

**PSC-N** As with other precision slotless female connectors, a PSC-N connector has no slots. This stainless steel connector provides better electrical performance, repeatability of connection, and durability than a standard type-N connector.

**75 $\Omega$  Type-N** A 75 $\Omega$  type-N connector has a smaller center conductor, male contact pin, and female contact hole than a 50 $\Omega$  connector. Because of this, if you mate a male 50 $\Omega$  connector with a female 75 $\Omega$  connector you either break the female contact fingers apart or permanently spread them.

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## 3.5 mm Connectors

**SMA** Sexed connectors, SMA (subminiature, type A) connectors have a solid plastic dielectric that separates the center and outer conductors. These are non-precision, low-cost 3.5 mm connectors.

These connectors do not work well in applications that require repeated connections; they wear out quickly. They work best as one-time-only connectors, or in applications that require very few reconnections.

**Precision 3.5 mm** Precision 3.5 mm connectors are sexed, air-dielectric connectors; air provides the insulating dielectric between the center and outer conductors. A plastic bead inside the connector body supports the center conductor.

Precision 3.5 mm connectors will mate with SMA connectors, and (unlike SMA connectors) are durable enough for repeated connections.

### **PSC-3.5 mm**

As with other precision slotless female connectors, a PSC-3.5 mm connector has no slots. This connector provides better electrical performance, repeatability of connection, and durability than a standard precision 3.5 mm connector.

### **NMD-3.5 mm**

Hewlett-Packard uses these rugged 3.5 mm connectors on cables, test port connectors, and on special adapters. These connectors have larger-than-standard coupling threads, providing an exceptionally strong coupling mechanism for measurement applications.

Female NMD connectors (used on the test set end of adapters and cables) *cannot* be connected to standard male 3.5 mm connectors.

Male NMD connectors (used on test sets (as test ports), and on the DUT end of adapters and cables) have *both* larger threads (to connect to female NMD connectors) *and* standard threads (to directly couple to a device under test).



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## 2.4 mm Connectors

### The Three Grades

#### Production Grade

Also defined as “economy,” this grade applies to connectors used in components, cabling and microstrip applications. This grade, usually used internal to instruments, has a slotted female center conductor.

#### Instrument Grade

These connectors, principally intended for use in precision test and measurement equipment, maintain high performance during many connect-disconnect cycles. This grade, usually used external to instruments, has a slotted female center conductor.

#### Metrology Grade

These connectors, used on measurement standards that require a high degree of dimensional precision, have direct traceability to national measurement standards through well-defined mechanical dimensions. This grade of connector has a slotless female center conductor.

### Precision 2.4 mm

These sexed connectors have air as the dielectric; air provides the insulating dielectric between the center and outer conductors. A plastic bead inside the connector body supports the center conductor.

#### PSC-2.4 mm

As with other precision slotless female connectors, a PSC-2.4 mm connector has no slots. This connector provides better electrical performance, repeatability of connection, and durability than a standard precision 2.4 mm connector.

#### NMD-2.4 mm

Hewlett-Packard uses these rugged 2.4 mm connectors on cables, test port connectors, and on special adapters. These connectors have larger-than-standard coupling threads, providing an exceptionally strong coupling mechanism for measurement applications.

Female NMD connectors (used on the test set end of adapters and cables) *cannot* be connected to standard male 2.4 mm connectors.

Male NMD connectors (used on test sets (as test ports), and on the DUT end of adapters and cables) have *both* larger threads (to connect to female NMD connectors), *and* standard threads (to directly couple to a device under test).

## Electrostatic Discharge

Protect against electrostatic discharge before cleaning or inspecting a connector attached to a static-sensitive circuit. Static electricity builds up on the body, on calibration components, and on devices under test, and can easily damage sensitive circuits when discharged by contact with a center conductor. A static discharge too small to feel can cause permanent damage.

### Static-Safe Work Station

Figure 1-1 illustrates a static-safe station using two types of ESD protection that you can use either together or separately (see Appendix B for ordering information):

- A conductive table mat and wrist-strap combination.
- A conductive floor mat and heel-strap combination.

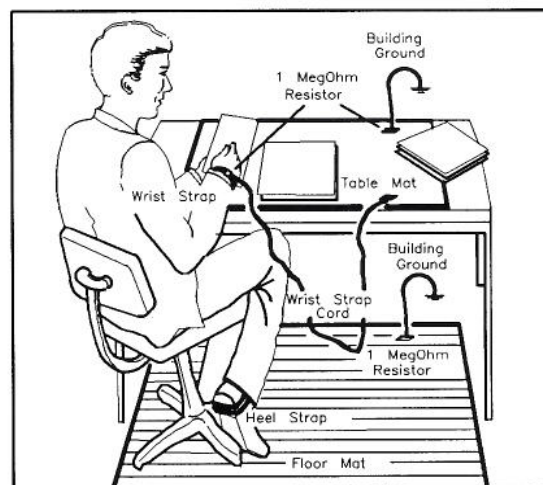


Figure 1-1. Example of a Static-Safe Work Station

### Static-Safe Practices

- Before cleaning, inspecting, or making a connection to a static-sensitive device or test port, ground yourself at a grounded device as far as possible from the test port.
- Discharge static electricity from a device before connecting it:

Touch the device briefly (through a resistor of at least  $2\text{ M}\Omega$ ) to either the outer shell of the test port, or another exposed ground. This discharges static electricity and protects test equipment circuitry.

---

## Handling

Handle connectors carefully, and inspect them before use:

1. Keep connectors clean.
2. Do not touch mating plane surfaces. Natural skin oils and microscopic particles of dirt (easily transferred to a connector interface) are difficult to remove.
3. Do not set connectors contact-end down on a hard surface. You can damage the plating and the mating plane surfaces if the interface comes in contact with a hard surface.

---

## Storing

When not using a device, store it in a way that gives it maximum protection:

1. Before storing a connector, extend the sleeve or connector nut. This protects the mating surfaces.
2. When you are not using a connector, use plastic end caps over the mating plane surfaces to keep them clean and protected.
3. Never store connectors loosely in a box, or drawer (the most common cause of connector damage during storage).

Store calibration devices, verification devices, and test fixtures in a foam-lined storage case.

4. Store cables in the same shape they have when you use them; do not either straighten a cable or flex it more tightly. Even flexible cables last longer if you flex them as little as possible.

## Visually Inspecting & Cleaning Connectors

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Because of the small size of some coaxial connectors, and because of very precise mechanical tolerances (on the order of a few hundreds of microinches in some cases), minor defects, damage, and dirt can significantly degrade repeatability and accuracy. In addition, a precision connector mating surface may have gold plating, making it susceptible to mechanical damage because of the softness of the metal. A dirty or damaged connector can destroy any connector mated to it.

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**Caution**

Never use a damaged connector.

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**Note**

You do not need to magnify a connector when you inspect it. In fact, inspecting a connector under magnification can mislead you. Defects and damage that you cannot see without magnification generally have no effect on the electrical or mechanical performance of a coaxial connector.

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## *Visual Inspection Procedure*

### **1. Check for Obvious Defects**

Before each connection, visually inspect all connectors. If necessary, clean the connectors each time you make a connection.

Look for obvious defects or damage (badly worn plating, deformed threads, or bent, broken, or misaligned center conductors). Connector nuts should move smoothly and have no burrs, loose metal particles, or rough spots.

Discard or send for repair any connector with an obvious defect.

### **2. Check for Particles, Scratches, and Dents**

Metal particles from the connectors threads can adhere to the mating plane surfaces when you disconnect a connector.

Check for:

- Flat contact between the connectors at all points on their mating plane surfaces.
- Deep scratches (see “Scratches”).
- Dents (see “Dents”).
- Dirt, or metal particles (see “Metal and Metal By-Product Particles”).
- Bent or rounded edges on the center and outer conductor mating plane surfaces.
- Any sign of damage due to excessive or uneven wear or misalignment.

If a connector shows deep scratches or dents, particles clinging to the mating plane surfaces, or uneven wear, clean it and inspect it again.

Determine the cause and extent of the damage before using a connector that has dents or scratches deep enough to displace metal on the connector mating plane surface.

---

## Scratches

On a gold plated connector, a scratch that goes through the gold plating to the metal underneath can cause trouble. The exposed bimetal surface accelerates corrosion and needs cleaning more often than an all-gold surface. Inspect the scratch carefully under magnification to see if it left a high spot of pushed-up metal on the mating plane surface. If so, do not use the connector; it will damage any connector you mate to it.

If you remove all metal displaced by a scratch, or it wears away (so that no high spots remain), the connector may work. Full, flat circular contact between the mating plane surfaces may not happen, but the connection may prove satisfactory for most purposes.

### Light Burnishing

Light burnishing (light scratches or shallow circular marks distributed uniformly over the mating plane surface) does not affect electrical or mechanical performance. Burnishing (caused by the normal, slight rotation of the mating planes against one another as you make a connection) and other small defects and cosmetic imperfections are normal.

### Deep Scratches

Individual, hard particles (metal particles or burrs left from machining) cause deep scratches. These particles slide across the mating plane surface and displace metal.

### Concentric Scratches

Deep scratches running concentrically (like the groove in a phonograph record) generally indicate that one or both of the connector mating plane surfaces were not perfectly clean, or that one of the connectors has a burr or high spot on its surface.

Long scratches running concentrically generally indicate too much rotation on a connector, or a connector nut that seizes during connection.

### Scratches Across the Mating Plane

Most often, deep scratches that run across the mating plane surface result from rough handling during connection, disconnection, or storage.

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## Dents

You usually find dents on the outside edge of a mating plane surface. Under magnification a dent looks like a small crater or valley, with metal pushed outward and upward from the point of impact.

Careless handling or assembly of a connector during manufacture can cause dents, but more often a dent results from dirt or metallic particles pressing into the mating plane surface. This can happen during connection or during storage. Even a work surface that looks clean can have particles on it large enough and hard enough to, with pressure, dent or scratch a connector. Sudden, sharp, metal-to-metal impact, (such as when a connector drops or has another metal part bumped against it) can also cause dents.

A connectors that has a dent anywhere on the mating plane surfaces will not make perfect contact, and the raised edges will dent any connector mated to it. Except for very slight damage, replace a dented connector.

---

## Particles

### **Metal and Metal By-product Particles**

Metal and metal by-product particles on connector mating plane surfaces often come from the connector nut threads. These very hard particles can scratch or dent a connector's gold plating. If you find these particles, completely clean the connector (see "Cleaning Connectors") then reinspect it.

### **Other Types of Particles**

You can also contaminate a connector with particle by setting the connector contact-end down on a work surface (even though the surface looks clean) or by touching the mating plane surfaces. You can usually remove particles left behind after cleaning by blowing the connector dry with clean, compressed air.

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## Cleaning Connectors

For a long, reliable connector life, carefully clean all connectors. Appendix B lists part numbers for recommended cleaning supplies.

### Periodically Check for Alcohol Contamination

1. Let a few drops of alcohol evaporate on a clean glass plate or microscope slide.
2. Examine the glass in reflected light. It should be perfectly clean and free of residue. If not, do not use the alcohol from that container.

To keep your main supply of alcohol free from contamination, pour a small amount into a clean container and use that as your cleaning supply. Safely discard any remaining alcohol in the small container and clean the container.

### Cautions



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If you must use a solvent, use *only* isopropyl alcohol.

Use the least amount of alcohol possible, and avoid wetting any plastic parts in the connectors.

On 3.5 mm (and smaller) connectors, openings are very small, interior surfaces difficult to reach, and generally a plastic dielectric bead supports the center conductor only at the inner end. You can easily bend or break the center conductor.

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## General Cleaning Procedure

### Warnings



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

**This procedure assumes you have taken the necessary ESD precautions.**

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#### 1. Use Compressed Air or Nitrogen

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

You can use any source of clean, dry, low-pressure compressed air or nitrogen that has an effective oil-vapor filter and liquid condensation trap placed just before the outlet hose. Ground the hose nozzle to prevent electrostatic discharge, and set the air pressure to a very low velocity (<60 psi). High-velocity air can cause electrostatic effects when directed into a connector.

#### 2. Clean the Connector Threads

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

- a. Apply a small amount of isopropyl alcohol to a foam swab or a lint-free cleaning cloth.
- b. Clean the connector threads.
- c. Let the alcohol evaporate, then blow the threads dry with a gentle stream of clean, low-pressure compressed air or nitrogen.

#### 3. Clean the Mating Plane Surfaces

- a. Apply a small amount of isopropyl alcohol to a new swab and clean the mating plane surfaces.

If the connector has a center conductor, use very short horizontal or vertical strokes (across the connector), and the least pressure possible, especially when cleaning a female connector (to avoid snagging the cleaning swab on the center conductor contact fingers). An illuminated magnifying glass helps.

#### 4. Clean the Interior Surfaces

In the following steps, use the proper size toothpick. The wooden handle of a foam swab, for example, is too large even if it fits into the connector.

- For 3.5 mm connectors, use a toothpick with a diameter no greater than 1.7 mm (0.070 in).
- For precision 2.4 mm connectors, use a toothpick with a diameter no greater than 1.2 mm (0.047 in).

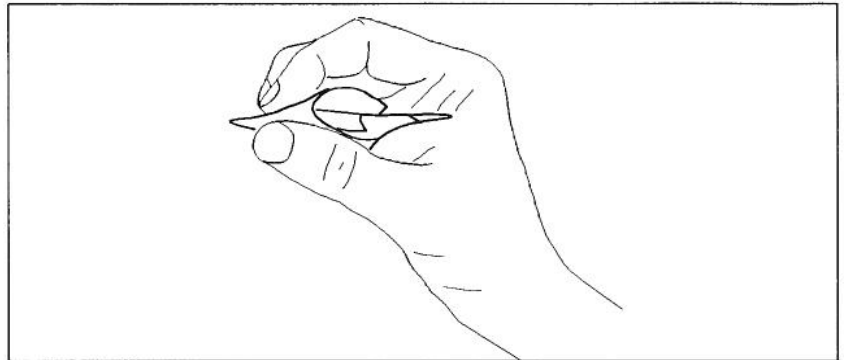
**Caution**

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Never use metal in place of a toothpick, it will scratch the plated surfaces.

---

- a. Cut off the sharp tip off a round, wooden toothpick.
- b. Wrap the trimmed toothpick with a single layer of lint-free cleaning cloth (see Figure 2-1).



**Figure 2-1.**  
**Trimmed Toothpick Wrapped in a Single Layer of Lint-Free Cleaning Cloth**

- c. Moisten the cloth with a small amount of isopropyl alcohol and carefully insert it into the connector. To clearly see the areas you wish to clean, use an illuminated magnifying glass or microscope.

**5. Dry the Connector**

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

**6. Reinspect**

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

---

## Precision 7 mm

### Center Collet in Place

You do not have to remove the center conductor collet to clean a precision 7 mm connector. With the center collet in place:

1. Put a lint-free cleaning cloth flat on a table.
2. Put a drop or two of isopropyl alcohol in the center of the cloth.
3. Retract the connector sleeve threads to expose the connector interface.
4. Gently press the contact end of the connector into the moistened cloth and turn the connector (Figure 2-2). The cloth scrubs away dirt on the connector interface without damaging the connector.
5. Blow the connector dry with a gentle stream of compressed air or nitrogen.
6. When not in use, keep the cloth in a plastic bag or box so that it does not collect dust or dirt.

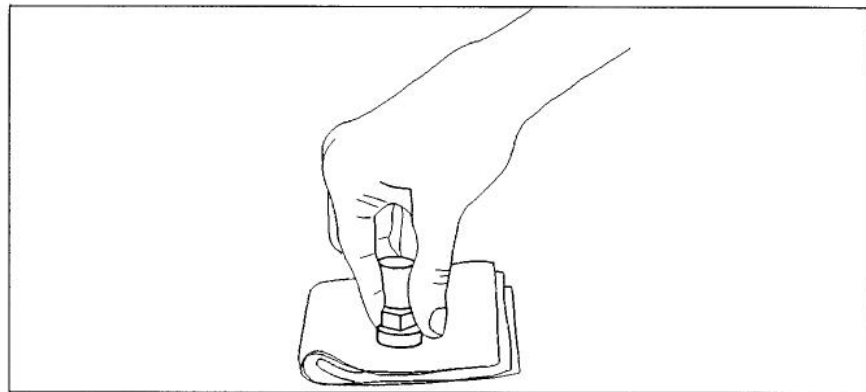
### Fixed Connectors

Use the following procedure to clean a fixed connector:

1. Fold a lint-free cleaning cloth several times.
2. Moisten the cloth with isopropyl alcohol.
3. Press the moistened cloth against the connector interface and turn the cloth to clean the connector.
4. Blow the connector dry with a gentle stream of compressed air or nitrogen.

### Center Collet Removed

Clean and inspect the interior surfaces any time you remove the center conductor collet. Use a wooden toothpick and lint-free cleaning cloth, as described in the general cleaning procedure.



**Figure 2-2.**  
**Cleaning a 7 mm Connector with the Connector Collet in Place**

---

**SMA,  
Precision 3.5 mm, &  
Precision 2.4 mm**

Because of their delicacy, small size, and intricate geometry, clean these connectors carefully. The center conductor contact pins, and especially the contact fingers on female connectors, can easily bend or break. In the precision connectors, a plastic dielectric bead supports the center conductor only at the inner end.

Use the general cleaning procedure.



## Mechanically Inspecting & Connecting Connectors

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Because coaxial connector mechanical tolerances can be very precise (on the order of a few hundreds of microinches), even a perfectly clean, unused connector can cause trouble if out of mechanical specification. Use a connector gage to mechanically inspect coaxial connectors.

---

### When to Gage Coaxial Connectors

Gage a connector:

- Before you use it for the first time.
- If either visual inspection or electrical performance suggests that the connector interface may be out of specification (due to wear or damage, for example).
- If someone else uses the device.
- If you use the device 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.

#### Note



Gage 2.4 mm, 3.5 mm, and SMA connectors relatively more often than other connectors, because the center pins can pull out of specification during disconnection.

---



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## Connector Gages

- Types** Each type of connector uses a different connector gage (Figure 3-1 shows a typical connector gage):
- There are push-on type gages and screw-on type gages.
  - Sexed connectors use either two gages (one male and one female), or (in the case of type-N connectors) a single gage with male and female adapter bushings.
  - Every connector gage requires a gage calibration block (to zero the gage).
  - Connector gages for precision 7 mm connectors also require an aligning pin and pin wrench to measure the center conductor depth of beadless airlines with the centering pin removed.

Appendix B lists connector gage kits containing the gages recommended for coaxial connectors. Also, many calibration kits include connector gages.

---

### Caution



*Use the proper gage for your connector (see Appendix B). Some gages have a very strong gage plunger spring that, if used on the wrong connector, can push the center conductor back through the connector, damaging the device itself. Other gages, if used improperly, can compress the center conductor collet in precision 7 mm connectors during a measurement, giving an inaccurate reading when you measure the collet protrusion.*

---

### Accuracy

Because of connector gage measurement uncertainties (typically one small division on the dial) and variations in measurement technique from user to user, connector setback dimensions are difficult to measure.

For example, if you use a gage with 0.0001-inch small divisions on the dial to measure a connector that has an actual setback of 0.0005 inches, you can get a gage reading from 0.0004 to 0.0006 inches, depending on the gage (due strictly to gage measurement uncertainty). Note that other variables (such as cleaning and gage technique) can increase this range of readings. Before you decide a connector fails specification, do the following:

1. Carefully clean the connector, the connector gage, and the gage block again.
2. Zero the gage again.
3. Repeat the measurement.

Dirt and contamination can be affected measurements in which differences of 0.0001 inch are significant.

4. After you measure the connector several times yourself, have another person measure the connector several times. This helps reduce uncertainties due to differences of technique and random variations in gage accuracy.
5. Keep records of the setback measurements for each device over time. Noticeable differences from one set of measurements to the next can indicate errors in measurement technique, or that a damaged connector needs replacing.

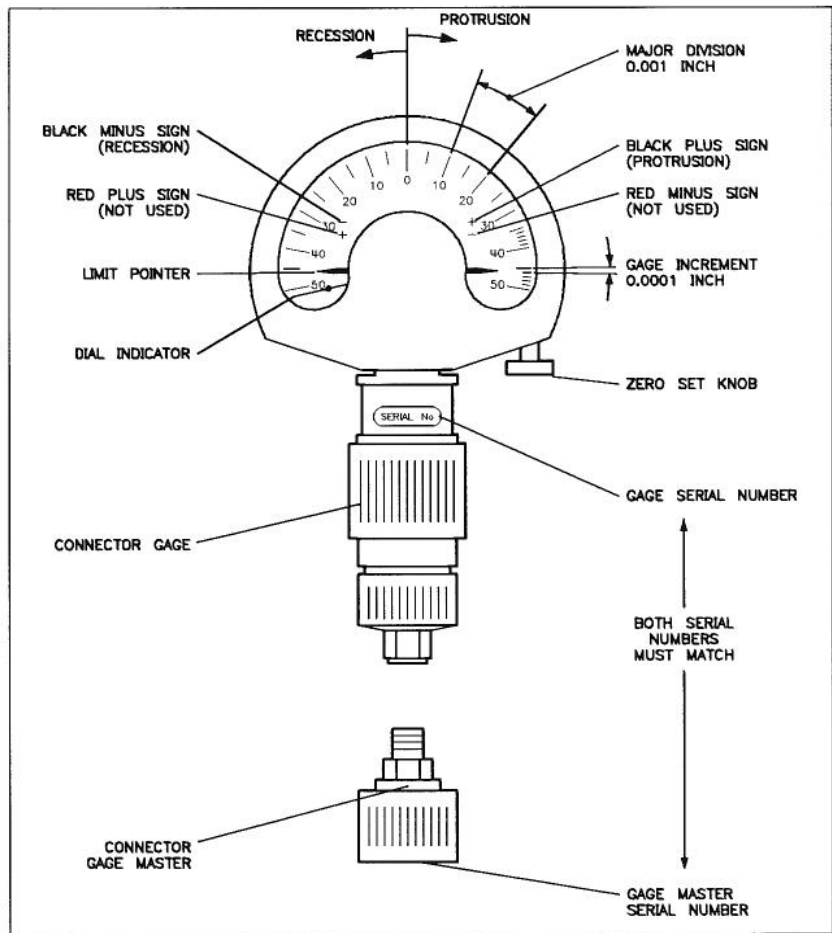


Figure 3-1. Typical Connector Gage

## Using a Centering Bead

Use a centering bead to keep a sliding load or airline beadless center conductor centered as you connect it to a gage. Always remove the centering bead before you connect the device to anything other than a gage. If you leave the bead on, the device will fail its electrical specifications.



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## General Gaging Procedure

### Caution



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Before you gage a connector, consult the mechanical specifications provided with that connector or device.

---

### Notes



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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 stresses to the gage plunger mechanism through the dial indicator housing).

When you measure a connector several times, use different orientations of the gage within the connector. Averaging several 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.

Because of the differences in the outer conductor of measured devices and the amount of pressure applied, screw on and press on type gages give slightly different readings.

---

1. Select the proper gage for your connector.
2. Inspect and clean the gage:
  - a. Inspect the connector gage and the gage calibration block carefully, exactly as you inspected the connector itself.
  - b. Clean or replace the gage and the gage calibration block if necessary.

Dirt on either the gage or the gage calibration block makes gage measurements inaccurate, and can damage a connector.

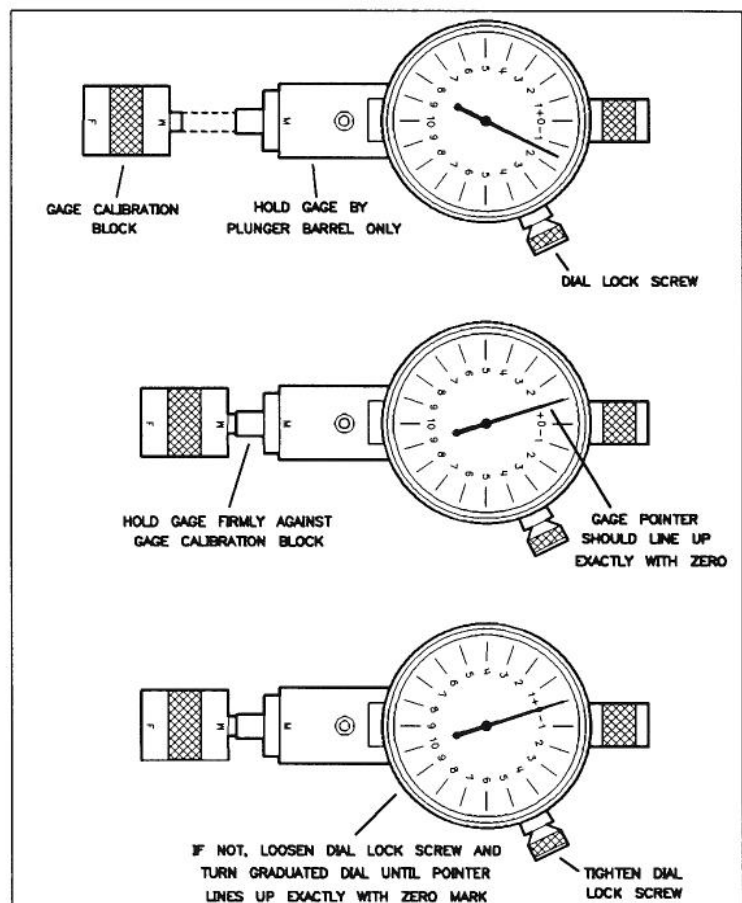
3. Zero the gage:

*Push-on Type* (see Figure 3-2):

- a. Hold the gage by the plunger barrel (not the dial housing or cap). This prevents gage reading errors caused by stresses to the gage plunger mechanism through the dial indicator housing.
  - i. For male connectors, slip the protruding end of the calibration block into the circular bushing on the connector gage.
  - ii. For precision 7 mm connectors, and female precision 3.5 mm connectors, use the flat end of the gage calibration block.
  - iii. For female type-N connectors, use the recessed end of the gage calibration block.

- b. Carefully bring the gage and gage block together. Apply only enough pressure to the gage and gage block to settle the dial indicator pointer at a reading.
- c. Gently rock the two surfaces together, to make sure that they have come together flatly.

The gage pointer should line up exactly with the zero mark on the gage. If not, inspect and clean the gage and gage calibration block again and repeat this process. If the gage pointer still does not line up with the zero mark on the gage, loosen the dial lock screw and turn the graduated dial until the gage pointer exactly lines up with zero. Then re-tighten the lock screw.



**Figure 3-2. Zeroing a Push-on Connector Gage**

*Screw-on Type* (see Figure 3-3):

- a. Holding the gage by the plunger barrel, screw on the calibration device just until you meet resistance.
- b. Use a torque wrench to tighten the connection.
- c. As you watch the gage pointer, gently tap the calibration device .

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

**Note**



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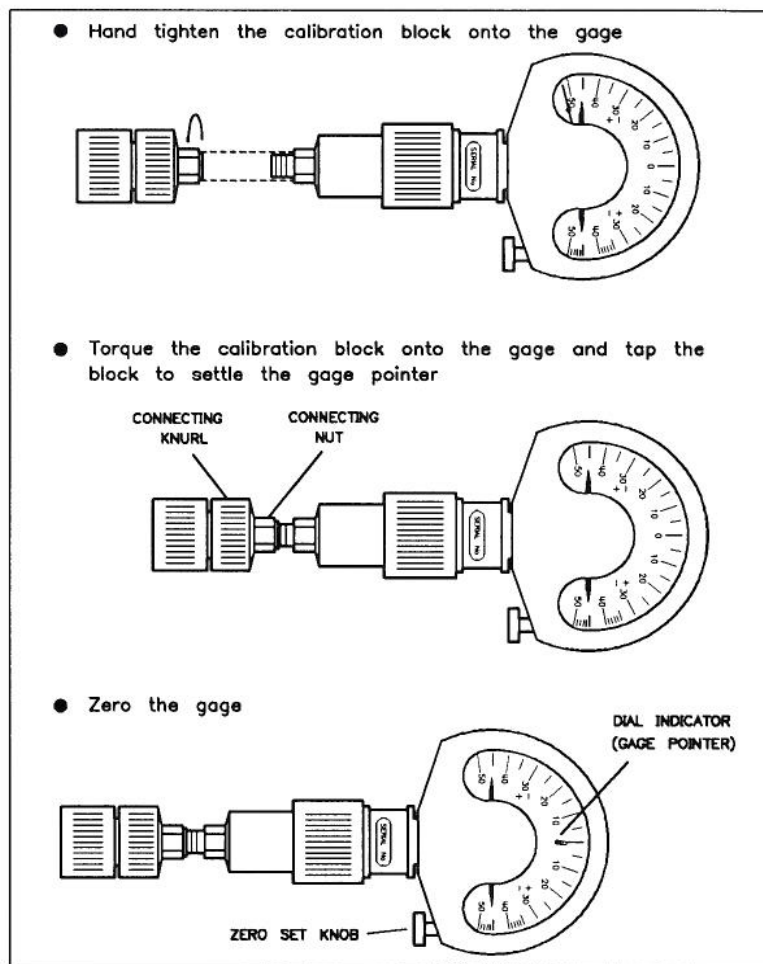
Check gages often to make sure that the zero setting has not changed. Generally, when the pointer on a recently zeroed gage does not line up exactly with the zero mark, the gage or calibration block needs cleaning. Clean both of these carefully and check the zero setting again.

---

4. Measure the connector.

Measure the recession of the center conductor behind the outer conductor mating plane exactly the same way you zeroed the gage, but *do not* reset the graduated dial.

5. For the best accuracy, measure the connector several times (rotating the gage relative to the connector between each measurement), and take an average of the readings.
6. To monitor connector wear, record the readings for each connector over time.



**Figure 3-3. Zeroing a Screw-on Connector Gage**



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## Precision 7 mm

In precision 7 mm connectors (Figure 3-4), replaceable inserts (collets) that make spring-loaded butt contact when you tighten the connection provide contact between the center conductors. The collets protrude slightly in front of the outer conductor mating plane when the connectors are apart. When the connection tightens, the collets compress into the same plane as the outer conductors.

### Specifications

Two mechanical specifications are generally given for precision 7 mm connectors:

1. A minimum and maximum allowable protrusion of the center conductor collet in front of the outer conductor mating plane with the collet in place.
  - a. Measure the collet protrusion.
  - b. If attached, remove the aligning pin from the connector gage.
  - c. Use the flat end of the gage calibration block.
2. The maximum recession of the center conductor behind the outer conductor mating plane with the center conductor collet removed.
  - a. Measure the center conductor recession.
  - b. The center conductor must not protrude beyond the outer conductor mating plane.
  - c. For an airline, attach the aligning pin to the connector gage and use the recessed end of the gage calibration block.

Also, the center conductor collet should immediately spring back if you compress it fully with a blunt plastic rod or with the rounded plastic handle of the collet removing tool.

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### Caution



With the center conductor collet removed, the center conductor may not protrude in front of the outer conductor mating plane, and sometimes must recede minimally. Consult the mechanical specifications provided with your connector or device.

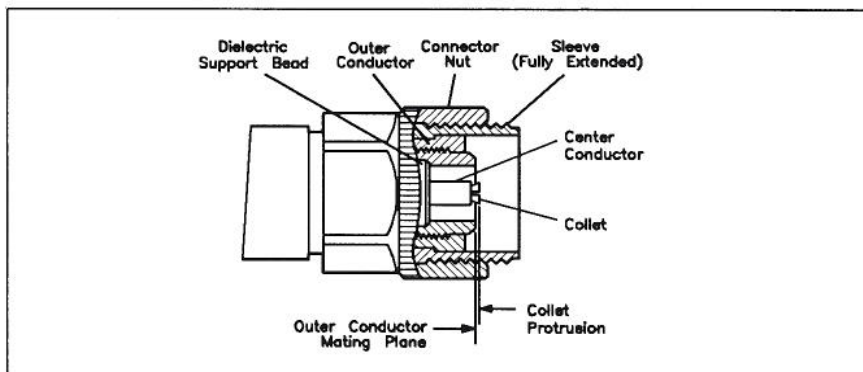
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### Note



Before you gage a precision 7 mm connector, fully extend the sleeve. This creates a cylinder into which the gage fits, minimizing the danger of the gage slipping sideways and damaging the connector.

---



**Figure 3-4. Precision 7 mm Connector Mechanical Specifications**

## Type-N

A type-N connector differs from other connector types in that its outer conductor mating plane is offset from the mating plane of the center conductor (Figure 3-5). The outer conductor sleeve in the male connector extends in front of the shoulder of the male contact pin. When you make a connection, this outer conductor sleeve fits into a recess in the female outer conductor behind the plane defined by the tip of the female contact fingers.

In a male type-N connector, the position of the shoulder of the male contact pin (not the position of the tip) defines the position of the center conductor. The male contact pin slides into the female contact fingers; the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin provide electrical contact.

### Specifications

Type-N connector critical mechanical specifications:

- A maximum protrusion of the female center conductor in front of the outer conductor mating plane.
- A minimum recession of the shoulder of the male contact pin behind the outer conductor mating plane (0.207 inches).
- A maximum recession of the shoulder of the male contact pin behind the outer conductor mating plane (0.210 inches).

In the Hewlett-Packard precision specification for type-N connectors, the male contact pin shoulder minimum allowable recession is 0.001 inches *less* than in the MIL-C-39012, Class II specification.

As type-N connectors wear, the protrusion of the female contact fingers generally increases, due to wear of the outer conductor mating plane inside the female connector. Check this periodically, because it decreases the total center conductor contact separation.

### Cautions



*Never* use a type-N connector if the possibility of interference between the shoulder of the male contact pin and the tip of the female contact fingers exists; *do not* mate type-N connectors if, when you make the connection, the separation between the tip of the female contact fingers and the shoulder of the male contact pin could measure less than zero.

If you use both 75 and 50 $\Omega$  type-N connectors, mark the 75 $\Omega$  connectors so that you never accidentally mate them with 50 $\Omega$  connectors. The center conductor, male contact pin, and female contact hole are smaller on 75 $\Omega$  connectors.

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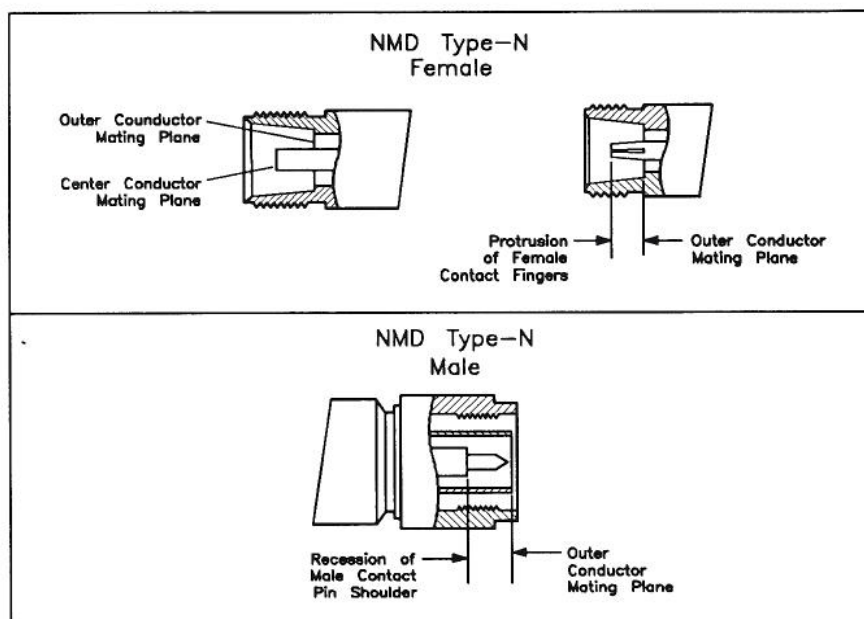


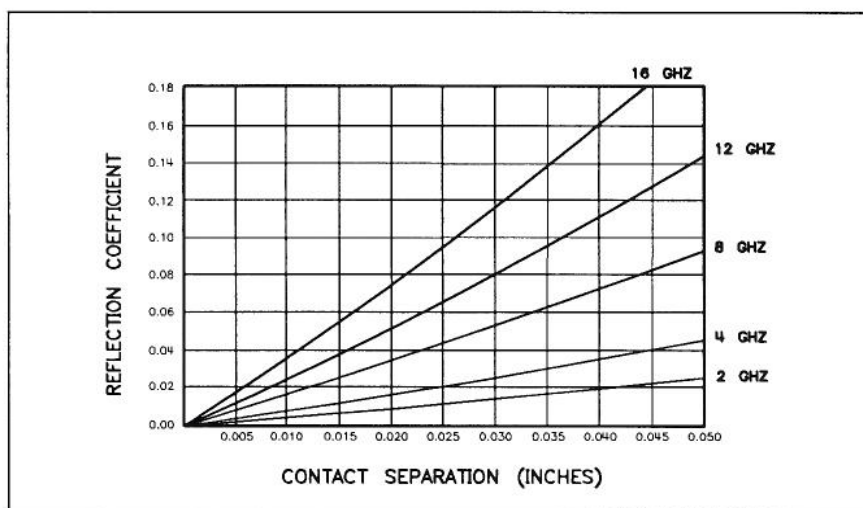
Figure 3-5. Type-N Connector Mechanical Specifications



**Type-N**

## Electrical Effects of Contact Separation

You may be able to use a type-N connector in an application where the total separation between the shoulder of the male contact pin and the tip of the female contact fingers exceeds the maximum implied by the mechanical specifications. Figure 3-6 shows the approximate effects of total contact separation on the reflection coefficient of standard (*not* PSC) type-N connections. At lower frequencies, the effects (even of fairly wide total contact separation) are small; at higher frequencies, contact separation becomes important.



**Figure 3-6.**  
The Approximate Effects of Contact Separation on the Reflection Coefficient of Type-N Connectors

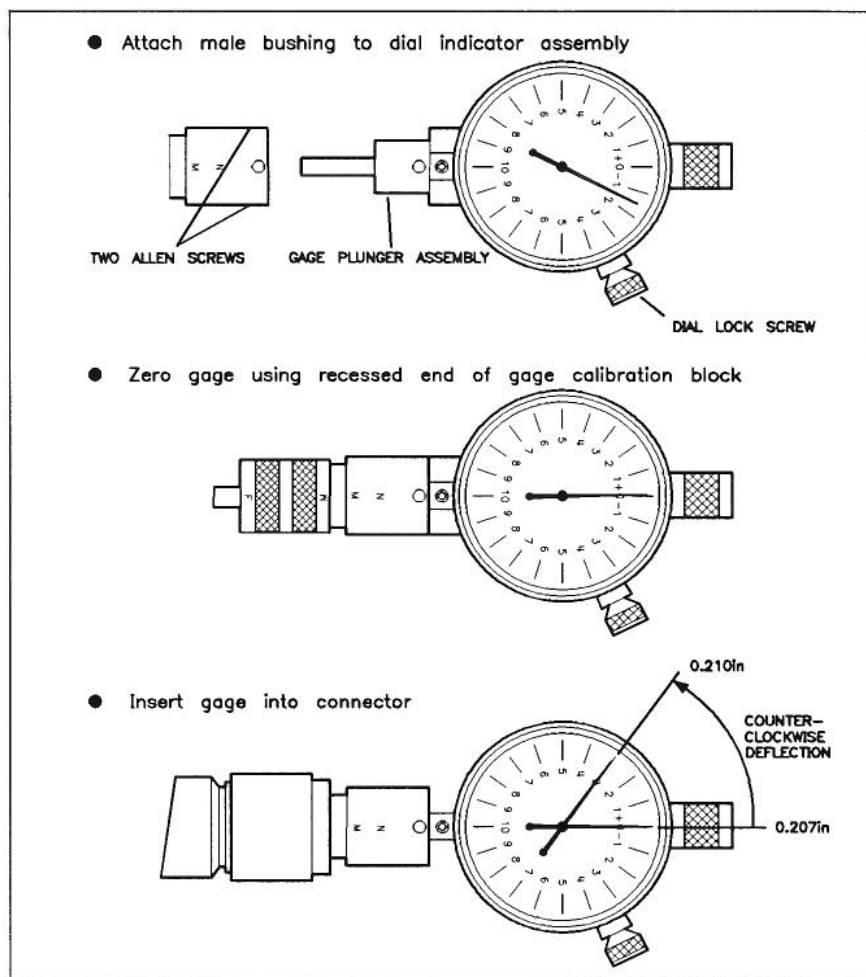
## **Gaging Techniques**

### **Male Type-N**

1. Refer to Figure 3-7.
2. Attach the bushing for male connectors to the dial indicator assembly.
3. Slip the bushing over the gage plunger assembly and fasten it with the two Allen screws in the bushing.

The male bushing has a flat outer end with a hole in it. Insert the gage plunger through the bushing so that with the bushing attached, the plunger protrudes from the bushing.

4. Using the recessed end of the gage calibration block, zero the gage as described in the general procedure at the beginning of this chapter.
5. Measure the connector:
  - a. Carefully center and insert the gage into the male connector; the flat outer part of the gage bushing rests on the outer conductor (the male contact pin slips into the hole in the gage plunger for this purpose).
  - b. Gently rock the connector gage within the connector to make sure the gage and the outer conductor mate flatly.
  - c. When the gage pointer settles consistently at a reading, read the gage indicator dial.

**Figure 3-7. Gaging a Type-N Male Connector**

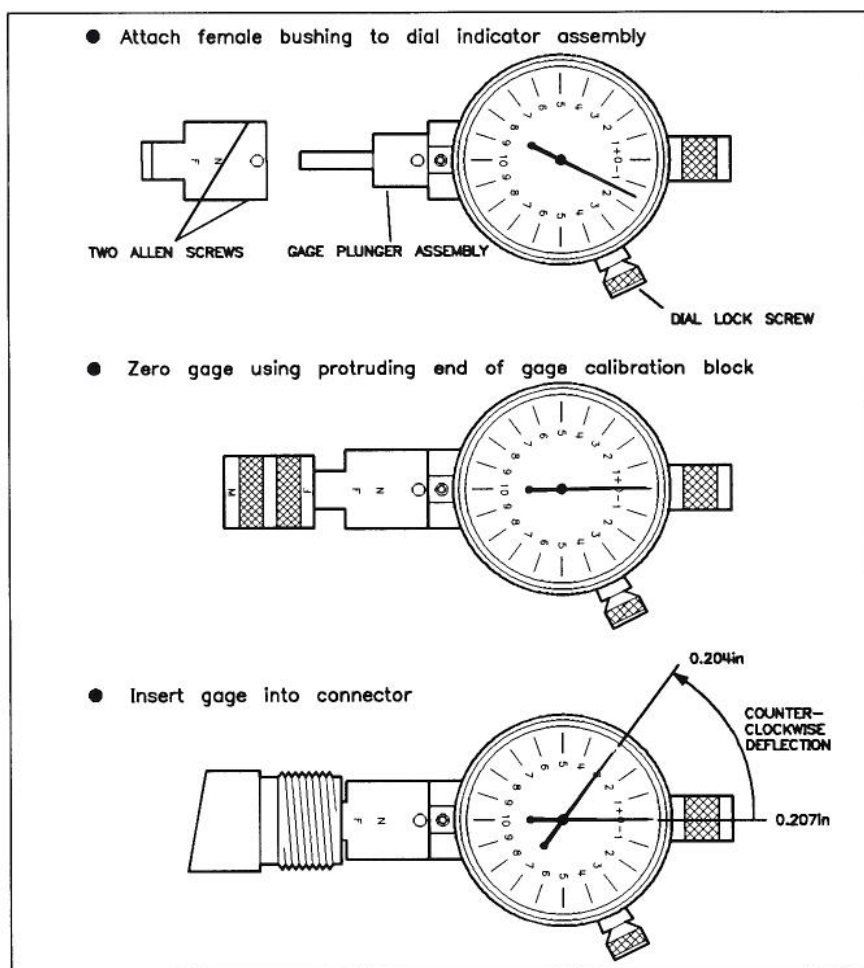
## Type-N

### Female Type-N

1. Refer to Figure 3-8.
2. Attach the bushing for female connectors to the dial indicator assembly. This bushing has a protruding circular sleeve.
3. Slip the bushing over the gage plunger assembly and fasten it with the two Allen screws in the bushing.
4. Insert the protruding end of the gage calibration block into the circular sleeve so it comes to rest on the gage plunger inside the female bushing.
5. Zero the gage as described in the general procedure at the beginning of this chapter.
6. Measure the connector:
  - a. Carefully center and insert the gage into the female connector; the female contact fingers in the connector slip inside the protruding circular sleeve on the gage.

The circular sleeve on the bushing should come to rest on the outer conductor mating plane inside the connector, behind the female contact fingers.
  - b. Gently rock the connector gage within the connector to make sure the gage and the outer conductor are together flatly.
  - c. When the gage pointer settles consistently at a reading, read the gage indicator dial.





**Figure 3-8.**  
**Gaging a Type-N Female Connector Using a Push-on Type Gage**

---

## SMA

SMA connectors are sexed connectors. The male contact pin slides into the female contact fingers; the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin provide electrical contact.

### Specifications

- A maximum and minimum recession of the shoulder of the male contact pin.
- A maximum and minimum recession of the tip of the female center conductor behind the outer conductor mating plane.

#### Dielectric Protrusion

Some SMA connector specifications allow protrusion of the solid plastic dielectric in front of the outer conductor mating plane (as much as 0.003 inches). This does not harm an SMA connector mated to another SMA connector, because some compression of the dielectric can occur, but protruding dielectric can force the rigid center conductor of a precision 3.5 mm connector back through the connector itself, damaging both the connector and the device to which you attach it.

#### Out-of-Specification Male Pins

Some SMA connectors have insecurely held male contact pins, making them easy to pull out of specification (especially with tight female connector contact fingers). Also, some SMA male pins are not true pins, but the cut-off ends of the center conductor in semi-rigid coaxial cable. In this case, misalignment and burrs are not unusual.

### Cautions



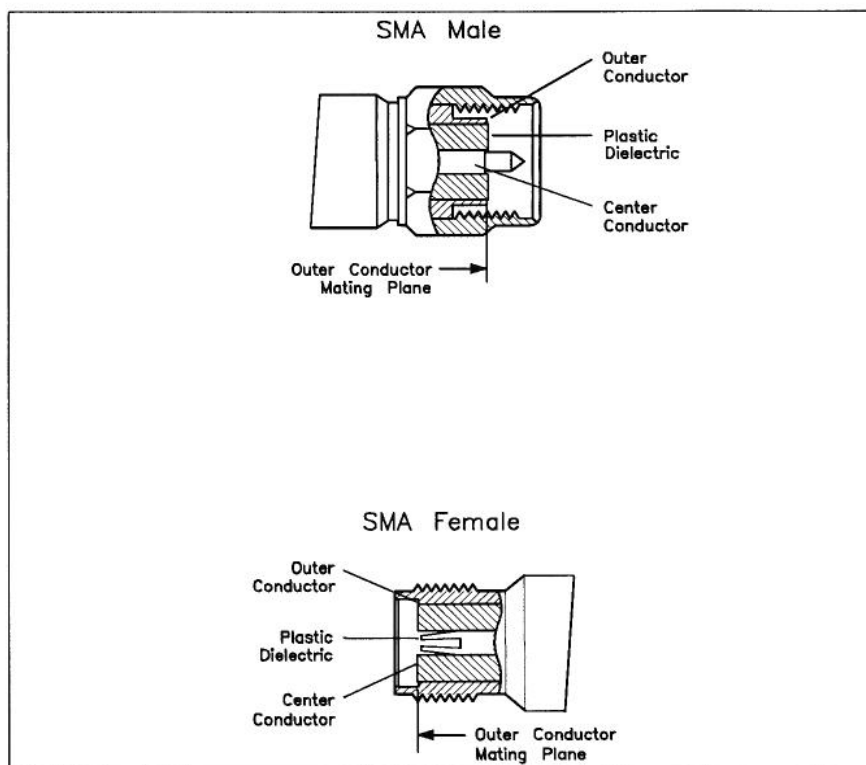
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Neither the shoulder of the male contact pin nor of the tip of the female contact fingers may protrude in front of the outer conductor mating plane, and sometimes must *recede* minimally. Consult the mechanical specifications provided with your connector or device.

Never mate a precision 3.5 mm connector to an SMA connector in which the solid plastic dielectric protrudes in front of the outer conductor mating plane.

Inspect all male SMA connectors for misalignment or burrs on the male contact pin. Discard any that are damaged.

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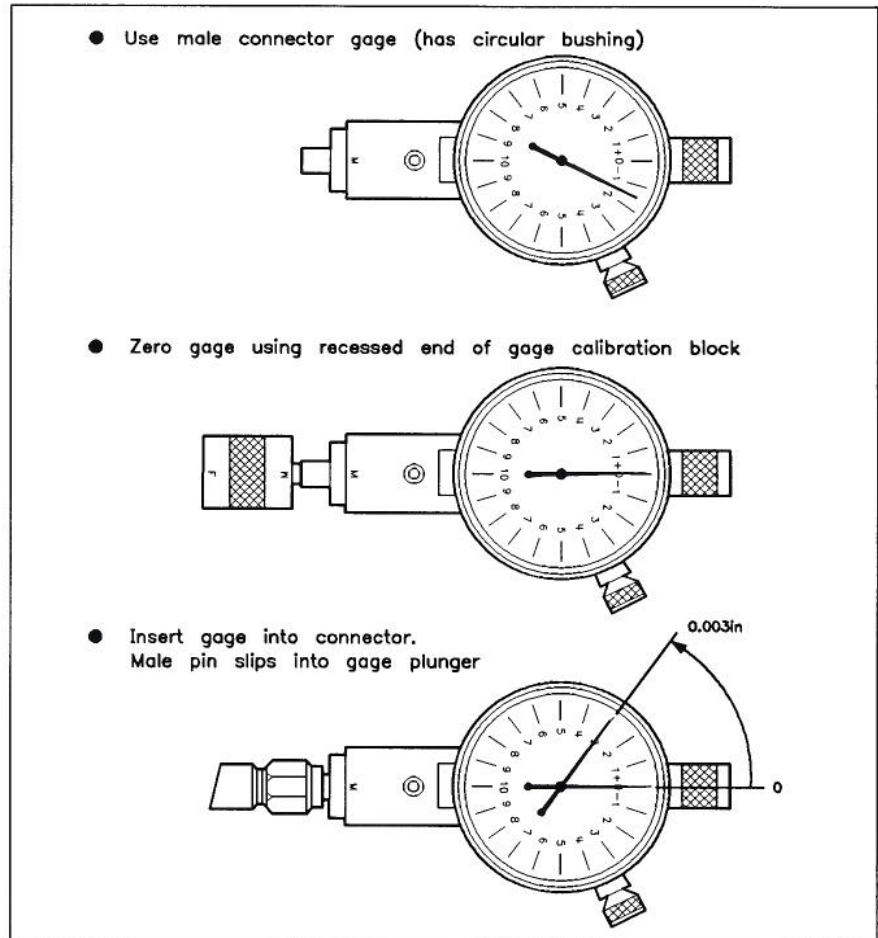


**Figure 3-9. SMA Connector Mechanical Specifications**

## **Gaging Techniques**

### **Male SMA (Push-on Type Gage)**

1. Refer to Figure 3-10. The male SMA connector gage (usually marked M) has a circular metal bushing surrounding the gage plunger.
2. Use the protruding end of the gage calibration block (also usually marked M).
3. Slip the calibration block into the outer bushing so that the bushing comes to rest on the outer, flat area of the calibration block. When you measure a connector, the gage outer bushing rests on the outer conductor mating plane inside the connector.
4. Zero the gage as described in the general procedure at the beginning of this chapter.
5. Measure the connector:
  - a. Carefully center and insert the gage into the male connector; the flat outer part of the gage bushing rests on the outer conductor (the male contact pin slips into the hole in the gage plunger for this purpose).
  - b. Gently rock the connector gage within the connector to make sure the gage and the outer conductor mate flatly.
  - c. When the gage pointer settles consistently at a reading, read the gage indicator dial.

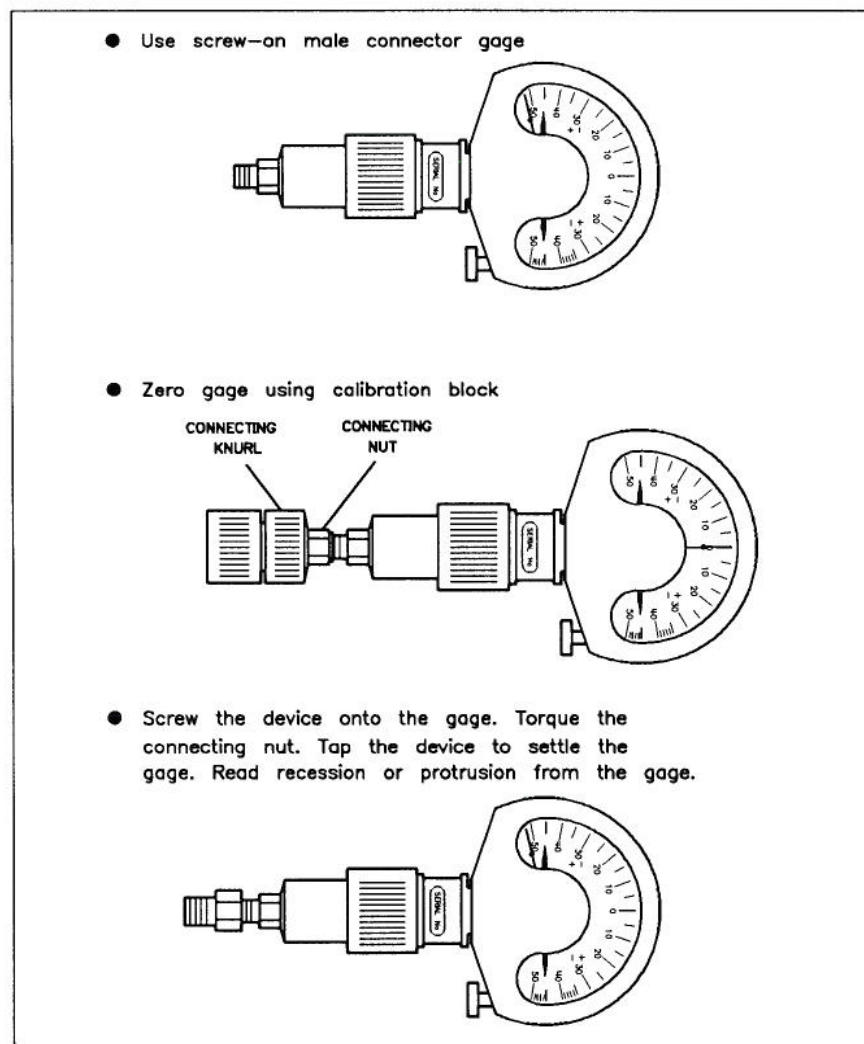


**Figure 3-10.**  
**Gaging an SMA Male Connector Using a Push-on Type Gage**



**Male SMA  
(Screw-on Type Gage)**

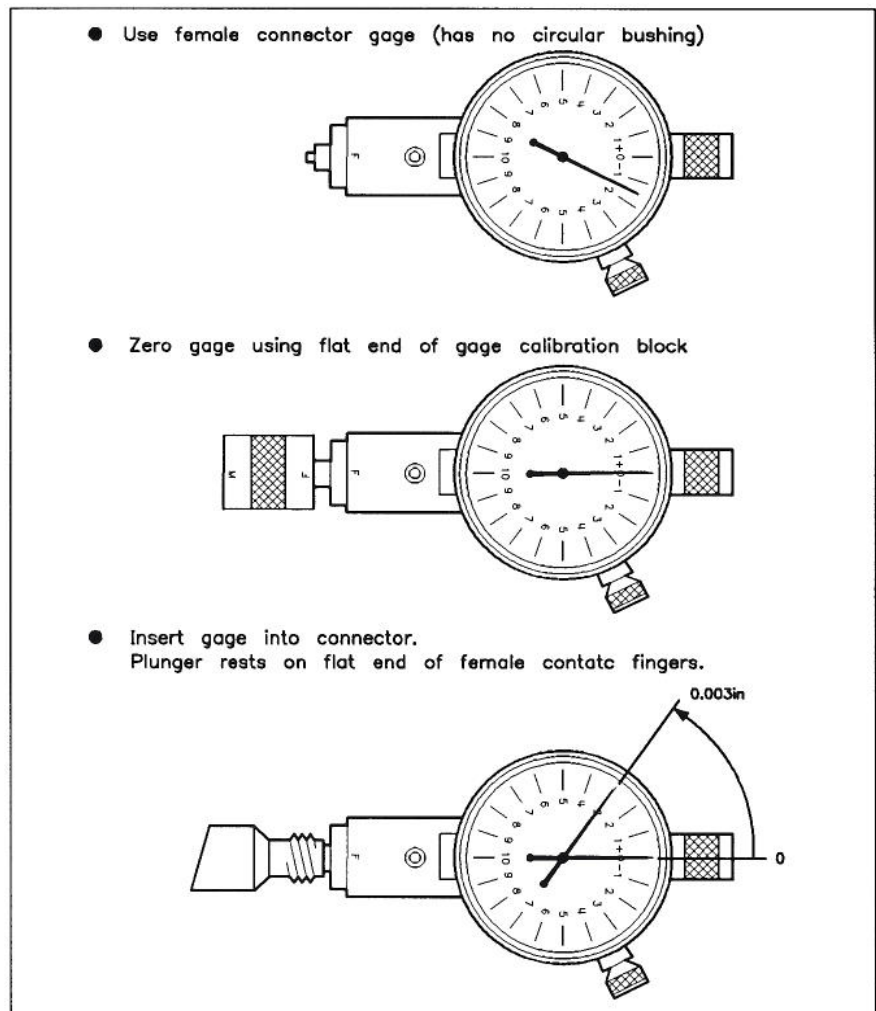
1. Refer to Figure 3-11.
2. Use the steps in the general procedure at the beginning of this chapter to zero the gage.
3. Hold the gage by the barrel only and screw it on the connector, connecting the knurl (do not turn the gage or the device) finger-tight.
4. Torque the connector onto the gage to 56 N-cm (5 in-lb).
5. Tap the connector with your finger to settle the gage.
6. Read the gage indicator dial.
7. For maximum accuracy, measure the connector several times and take an average of the readings.



**Figure 3-11.**  
**Gaging an SMA Male Connector Using a Screw-on Type Gage**

### Female SMA (Push-on Type Gage)

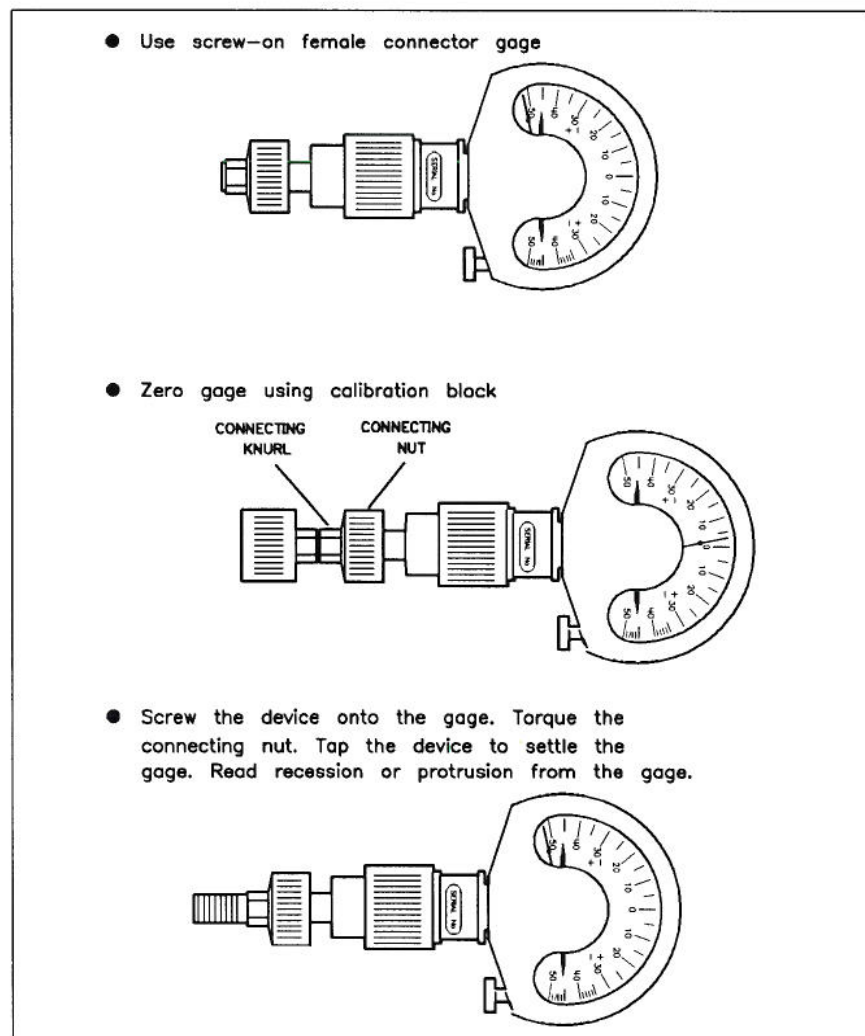
1. Refer to Figure 3-12. Locate the female SMA connector gage (usually marked F).
2. Using the flat end of the gage calibration block (also usually marked F), zero the gage as described in the general procedure at the beginning of this chapter.
3. Measure the connector:
  - a. Carefully center and insert the gage into the connector; the gage plunger rests on the outer end of the female contact fingers.
  - b. Gently rock the connector gage within the connector to make sure the gage and the outer conductor mate flatly.
  - c. When the gage pointer settles consistently at a reading, read the gage indicator dial.



**Figure 3-12.**  
**Gaging an SMA Female Connector Using a Push-on Type Gage**

**Female SMA  
(Screw-on Type Gage)**

1. Refer to Figure 3-13.
2. Use the steps in the general procedure at the beginning of this chapter to zero the gage.
3. Hold the gage by the barrel only and screw it on the connector, connecting the knurl (do not turn the gage or the device) finger-tight.
4. Torque the connector onto the gage to 56 N-cm (5 in-lb).
5. Tap the connector with your finger to settle the gage.
6. Read the gage indicator dial.
7. For maximum accuracy, measure the connector several times and take an average of the readings.



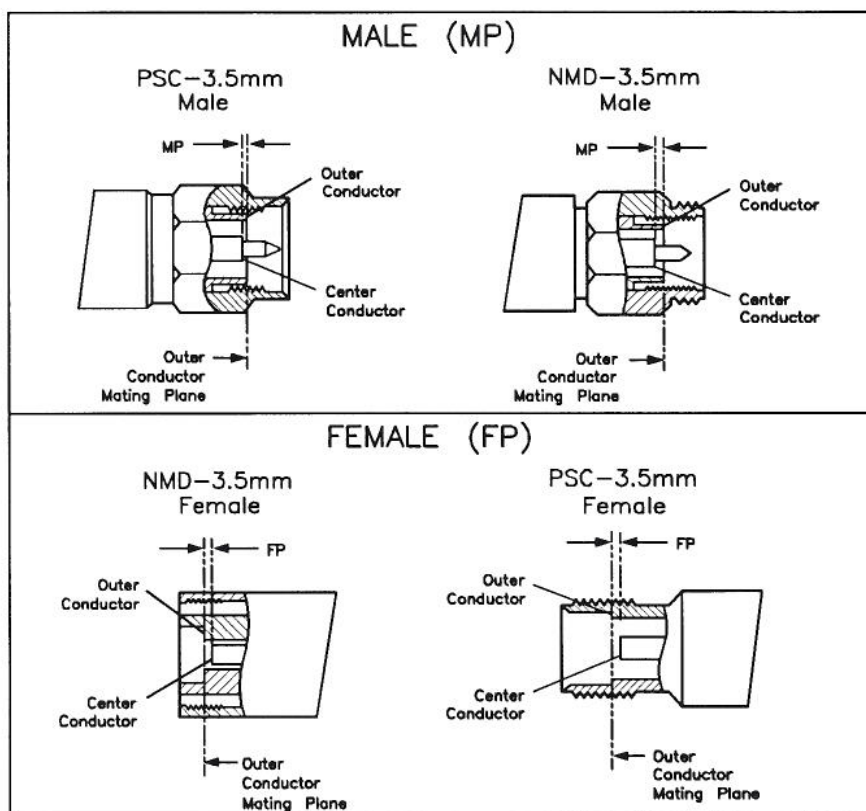
**Figure 3-13.**  
**Gaging an SMA Female Connector Using a Screw-on Type Gage**

## Precision 3.5 mm

Precision 3.5 mm connectors are sexed connectors. The male contact pin slides into the female contact fingers; the inside surfaces of the tip of the female contact fingers on the sides of the male contact pin provide electrical contact.

### Specifications

- A maximum and minimum recession of the shoulder of the male contact pin.
- A maximum and minimum recession of the tip of the female center conductor behind the outer conductor mating plane.



MP = male contact pin shoulder recession behind the outer conductor mating plane.

FP = recession of the end of female center pin behind the outer conductor mating plane.

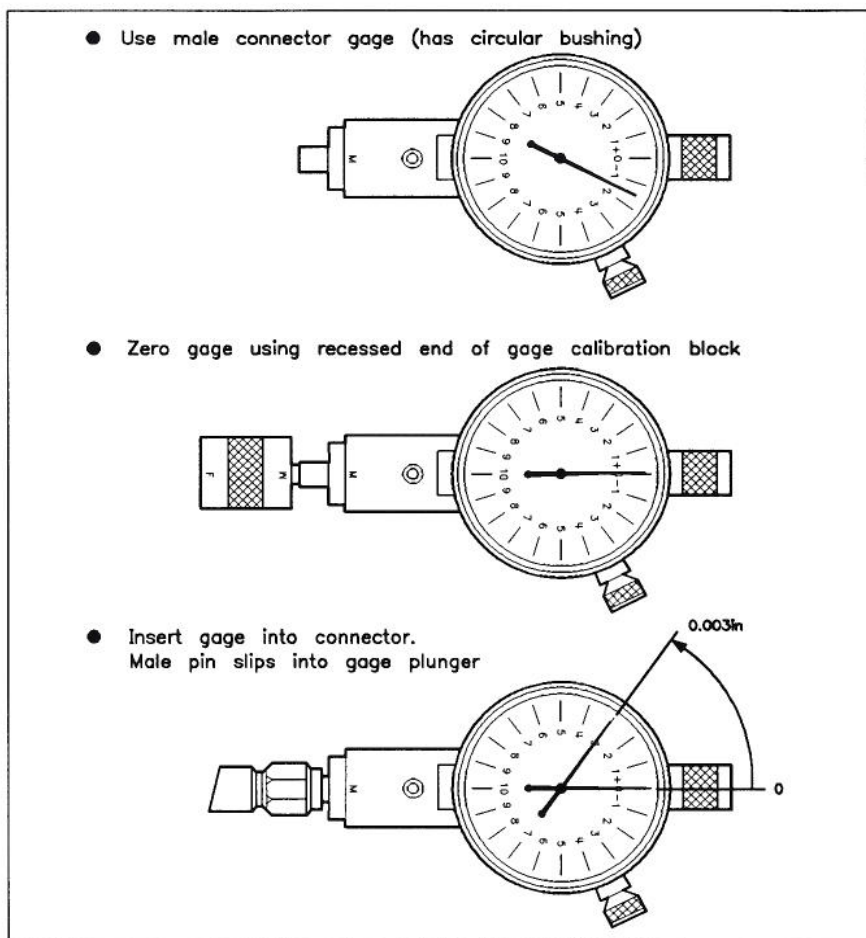
**Figure 3-14. 3.5 mm Connector Mechanical Specifications**

## Gaging Techniques

### Male 3.5 mm (Push-on Type Gage)

1. Refer to Figure 3-15. The male 3.5 mm connector gage (usually marked M) has a circular metal bushing surrounding the gage plunger.
2. Use the protruding end of the gage calibration block (also usually marked M).
3. Slip the calibration block into the outer bushing so that the bushing comes to rest on the outer, flat area of the calibration block. When you measure a connector, the gage outer bushing rests on the outer conductor mating plane inside the connector.
4. Zero the gage as described in the general procedure at the beginning of this chapter.
5. Measure the connector:
  - a. Carefully center and insert the gage into the male connector; the flat outer part of the gage bushing rests on the outer conductor (the male contact pin slips into the hole in the gage plunger for this purpose).
  - b. Gently rock the connector gage within the connector to make sure the gage and the outer conductor mate flatly.
  - c. When the gage pointer settles consistently at a reading, read the gage indicator dial.



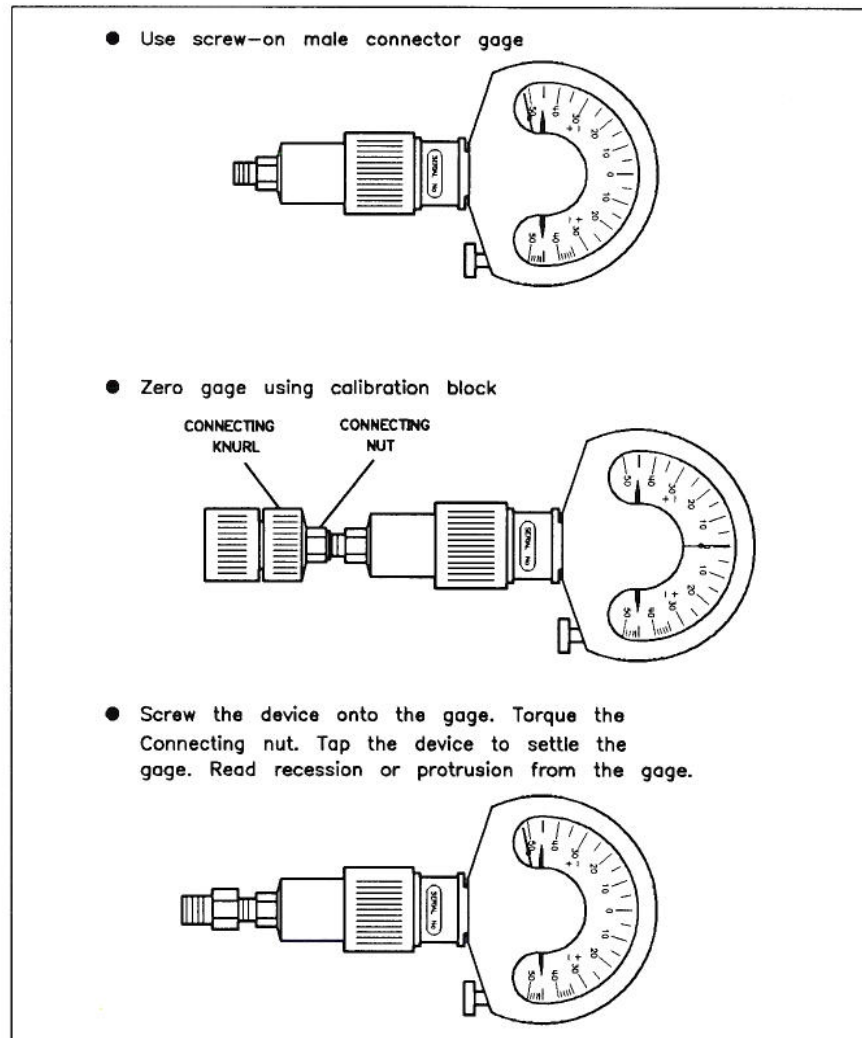


**Figure 3-15.**  
**Gaging a 3.5 mm Male Connector Using a Push-on Type Gage**

3.5 mm

**Male 3.5 mm  
(Screw-on Type Gage)**

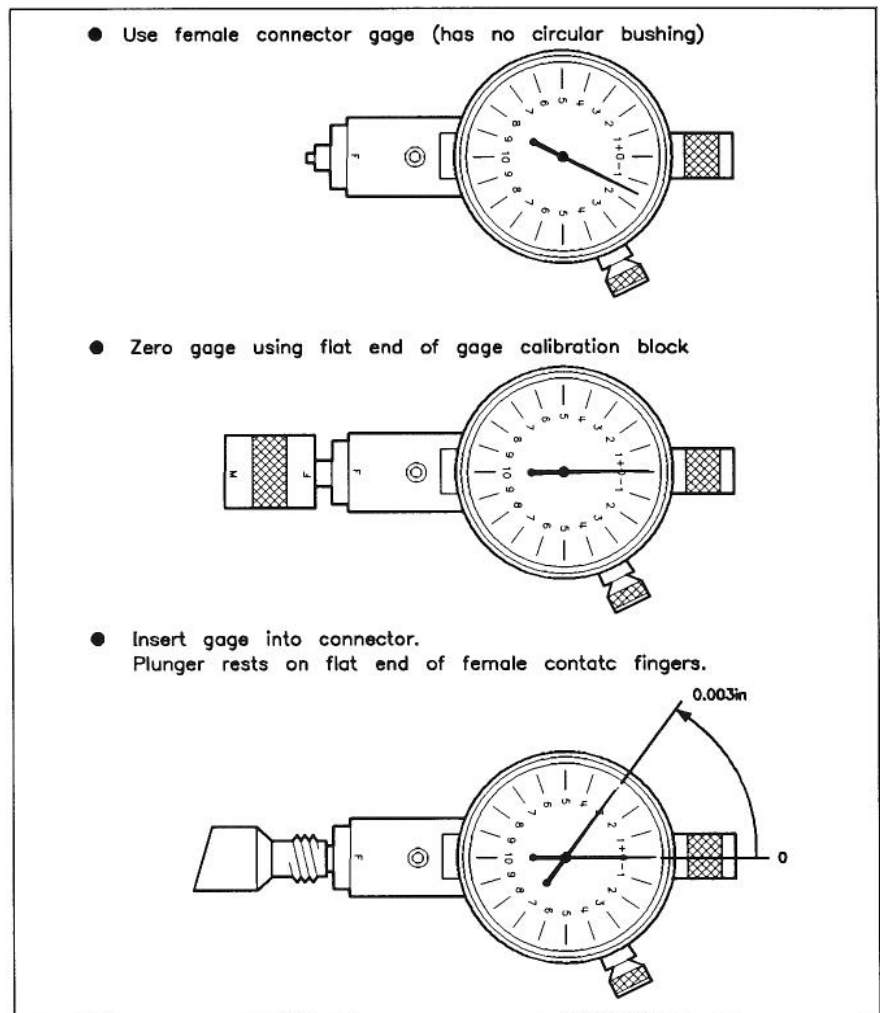
1. Refer to Figure 3-16.
2. Use the steps in the general procedure at the beginning of this chapter to zero the gage.
3. Hold the gage by the barrel only and screw it on the connector, connecting the knurl (do not turn the gage or the device) finger-tight.
4. Torque the connector onto the gage to 90 N-cm (8 in-lb).
5. Tap the connector with your finger to settle the gage.
6. Read the gage indicator dial.
7. For maximum accuracy, measure the connector several times and take an average of the readings.



**Figure 3-16.**  
**Gaging a 3.5 mm Male Connector Using a Screw-on Type Gage**

**Female 3.5 mm  
(Push-on Type Gage)**

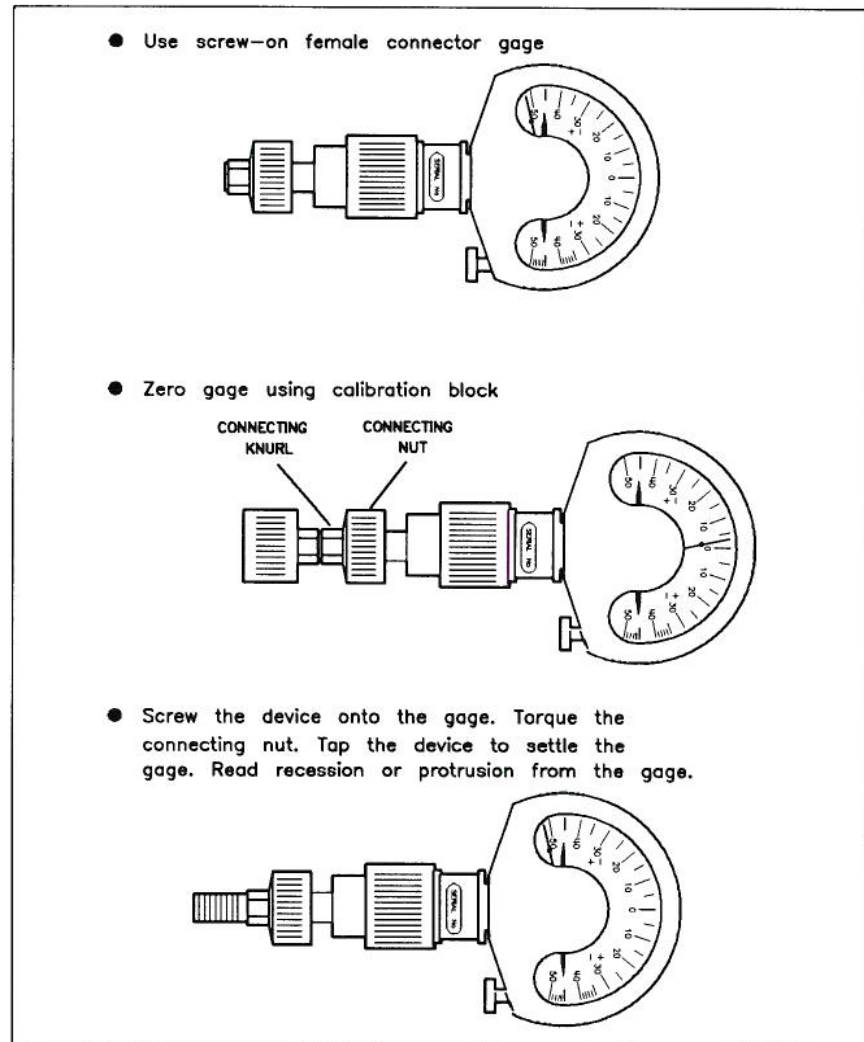
1. Refer to Figure 3-17. Find the female 3.5 mm connector gage (usually marked F).
2. Using the flat end of the gage calibration block (also usually marked F), zero the gage as described in the general procedure at the beginning of this chapter.
3. Measure the connector:
  - a. Carefully center and insert the gage into the connector; the gage plunger rests on the outer end of the female contact fingers.
  - b. Gently rock the connector gage within the connector to make sure the gage and the outer conductor mate flatly.
  - c. When the gage pointer settles consistently at a reading, read the gage indicator dial.



**Figure 3-17.**  
**Gaging a 3.5 mm Female Connector Using a Push-on Type Gage**

**Female 3.5 mm  
(Screw-on Type Gage)**

1. Refer to Figure 3-18.
2. Use the steps in the general procedure at the beginning of this chapter to zero the gage.
3. Hold the gage by the barrel only and screw it on the connector, connecting the knurl (do not turn the gage or the device) finger-tight.
4. Torque the connector onto the gage to 90 N-cm (8 in-lb).
5. Tap the connector with your finger to settle the gage.
6. Read the gage indicator dial.
7. For maximum accuracy, measure the connector several times and take an average of the readings.

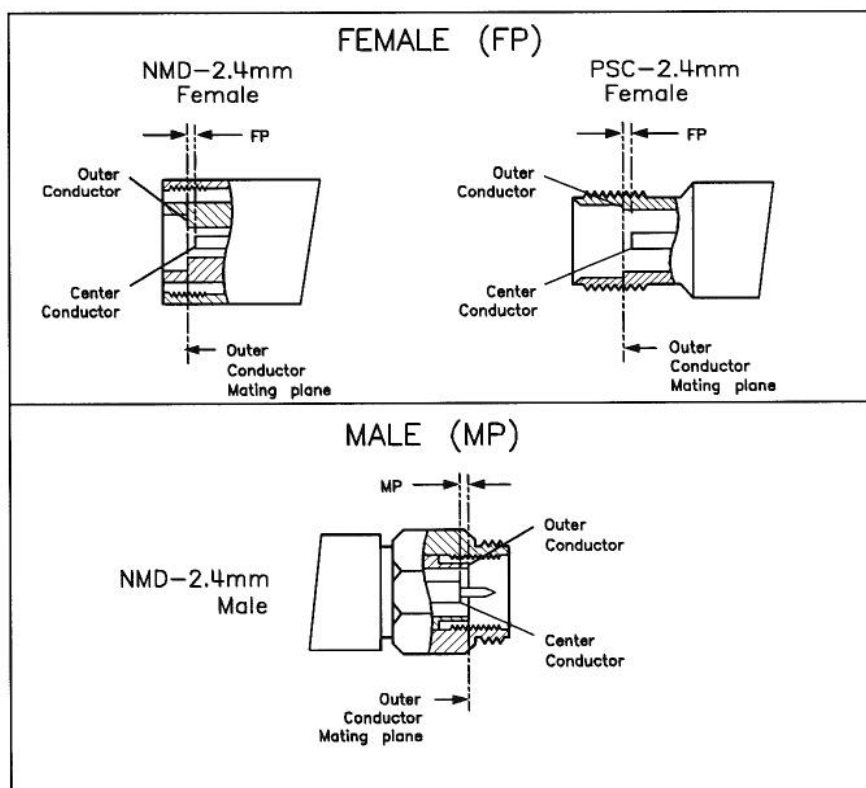


**Figure 3-18.**  
**Gaging a 3.5 mm Female Connector Using a Screw-on Type Gage**

## 2.4 mm

**Specifications**

- A maximum and a minimum recession of the shoulder of the male contact pin.
- A maximum and a minimum recession of the end of the female center conductor behind the outer conductor mating plane.
- Neither the shoulder of the male contact pin nor of the tip of the female contact fingers may protrude in front of the outer conductor mating plane, and sometimes must *recede* minimally. Consult the mechanical specifications provided with your connector or device.
- The maximum allowable recession depends on the connector and the device. Consult the mechanical specifications provided with the connector or the device itself.



MP = male contact pin shoulder recession behind the outer conductor mating plane.  
 FP = recession of the end of female center pin behind the outer conductor mating plane.

**Figure 3-19. 2.4 mm Connector Mechanical Specifications**



## Gaging Techniques

### Male 2.4 mm Connectors

1. Refer to Figure 3-20 Using the male calibration block, zero the gage as described in the general procedure at the beginning of this chapter.
2. Hold the gage by the barrel only and screw it on the connector, connecting the knurl (do not turn the gage or the device) finger-tight.
3. Torque the connector onto the gage to 90 N-cm (8 in-lb).
4. Tap the connector with your finger to settle the gage.
5. Read the gage indicator dial.
6. For maximum accuracy, measure the connector several times and take an average of the readings.

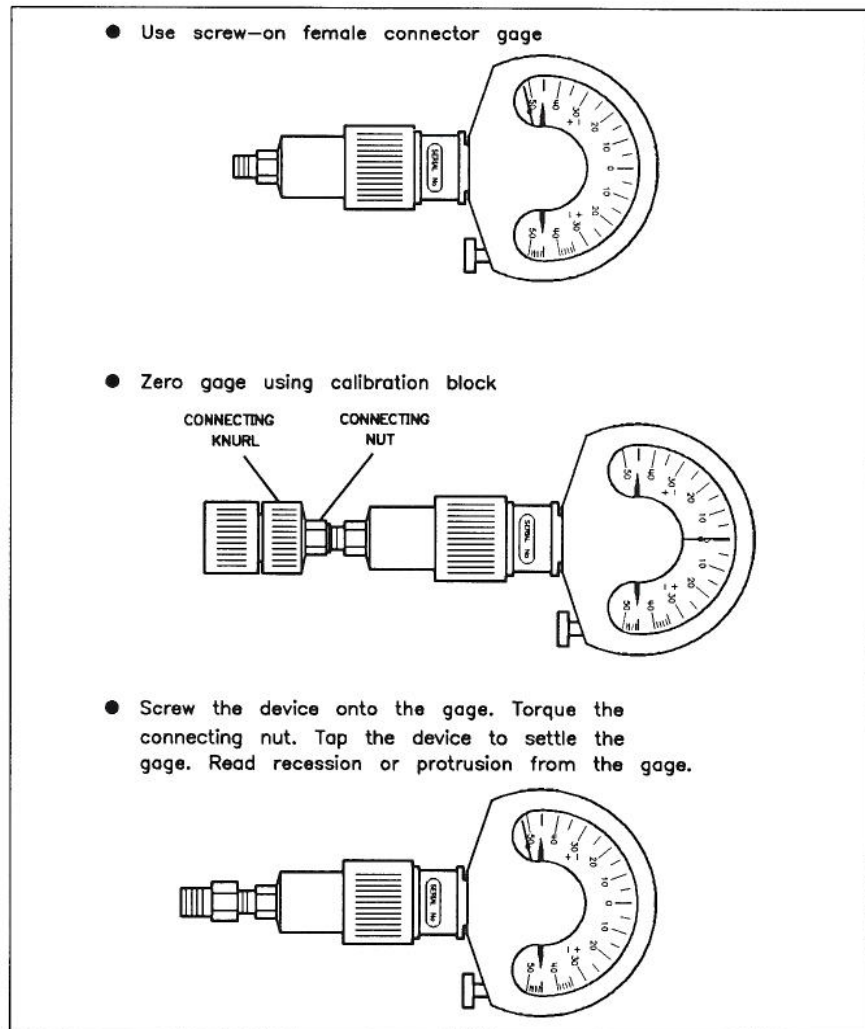
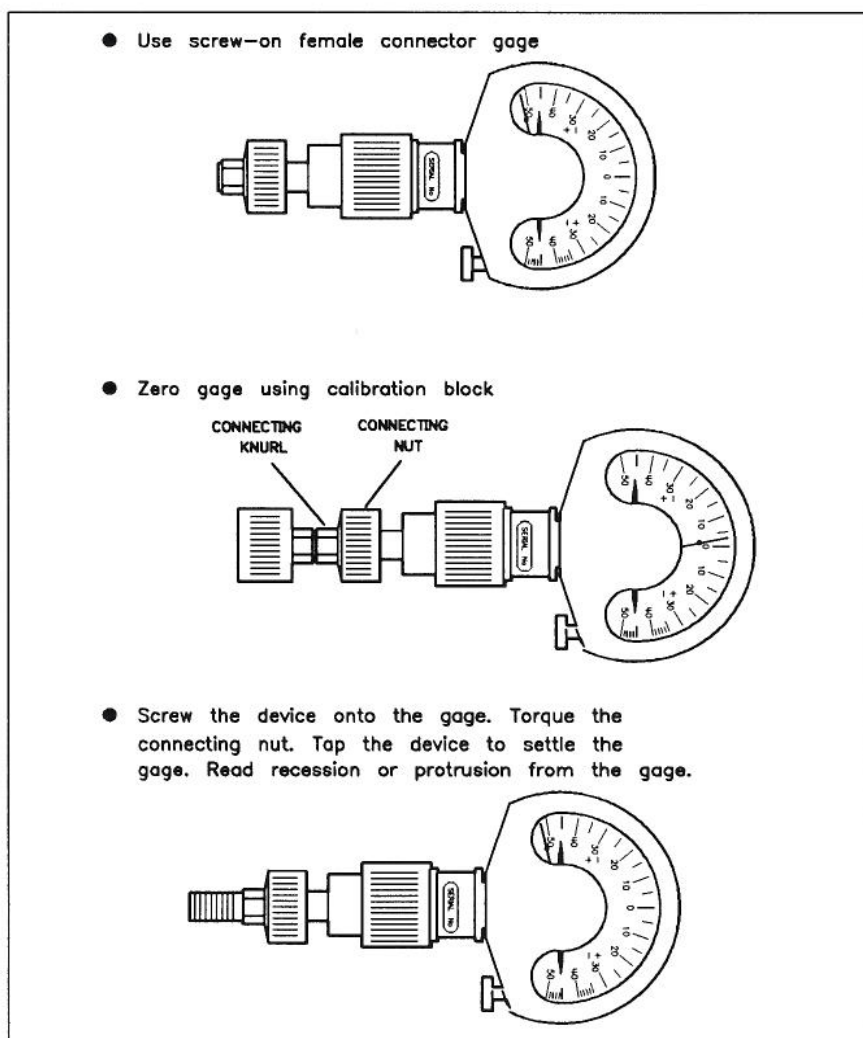


Figure 3-20. Gaging a 2.4 mm Male Connector

**Female 2.4 mm Connectors**

1. Refer to Figure 3-21 Using the female calibration block, zero the gage as described in the general procedure at the beginning of this chapter.
2. Hold the gage by the barrel only and screw it on the connector, connecting the knurl (do not turn the gage or the device) finger-tight.
3. Torque the connector onto the gage to 90 N-cm (8 in-lb).
4. Tap the connector with your finger to settle the gage.
5. Read the gage indicator dial.
6. For maximum accuracy, measure the connector several times and take an average of the readings.

**Figure 3-21. Gaging a 2.4 mm Female Connector**

---

## Making Connections

Good connections require a skilled operator. Because of instrument sensitivity and coaxial connector mechanical tolerances, slight errors in operator technique can significantly effect measurements and measurement uncertainties.

### Note



Before you make *any* connections, clean and inspect (visually and mechanically) all connectors.

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## General Connecting Procedure

### Connecting

The following procedure uses a 7 mm fixed load and a 7 mm test port connector, but the steps and principles are the same for all coaxial connector types. Read this general procedure, then read any information that applies specifically to your connector type.

### Caution

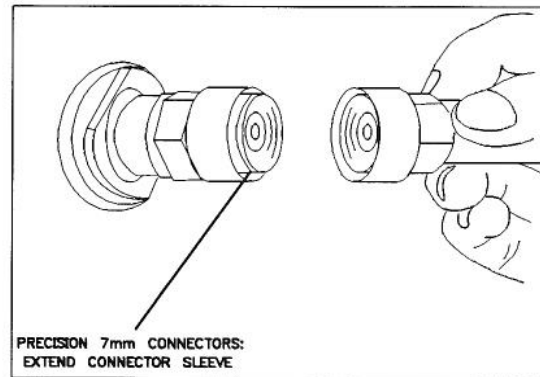


This procedure assumes that you have taken the necessary ESD precautions, and have *already* inspected (visually and mechanically) and cleaned the connectors.

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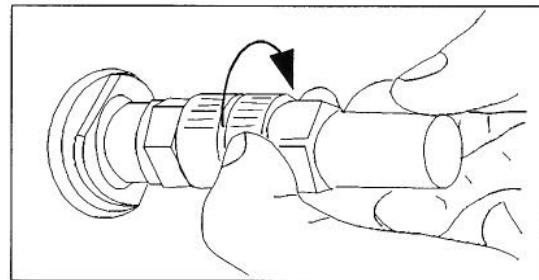
1. Carefully align the connectors (see Figure 3-22).
  - a. Fully extended the connector sleeve on one of the connectors and fully retract the sleeve on the other. The extended sleeve creates a cylinder into which the second connector fits. If one of the connectors is fixed (as on a test port) fully extend *that* connector sleeve (spin its knurled connector nut to make sure the threads are fully extended). Fully retract the connector sleeve on the other connector.
  - b. As you bring one connector up to the other, and as you make the actual connection, be sure the connectors align perfectly. If not, stop and begin again.

On sexed connectors, the male connector center pin must slip concentrically into the contact fingers of the female connector.



**Figure 3-22. Align the Connectors**

2. Push the connectors straight together. *Do not* twist or screw them together. As the center conductors mate, you may feel a slight resistance.
3. Engage the connector nut over the threads on the second connector. Turn *only* the connector nut. Let the connector nut pull the two connectors straight together (see Figure 3-23).



**Figure 3-23. Make the Preliminary Connection Gently**

**Caution**



Do *not* twist one connector into the other (like changing a light bulb). This happens if you turn the device body rather than the connector nut.

In a preliminary connection, the mating plane surfaces make uniform, light contact. Do not overtighten this connection.

At this point you want a connection in which the outer conductors make gentle contact at all points on both mating surfaces. This requires very light finger pressure (no more than 2 inch-pounds of torque).

4. Relieve any side pressure on the connection from long or heavy devices or cables. This assures consistent torque in the following steps.

5. Use a torque wrench to make the final connection (Figure 3-24).

Using a torque wrench prevents overtightening (and possible connector damage). It also guarantees that all connections are equally tight each time.

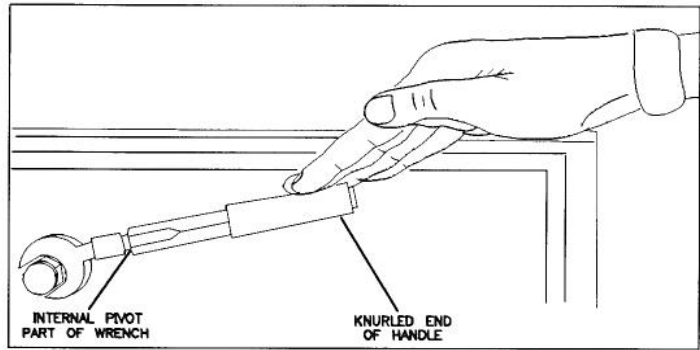
- a. Prevent the rotation of anything other than the connector nut you wish to tighten. Do this by hand for a fixed connector (as on a test port). Otherwise, use an open-end wrench to keep the body of the connector from turning.
- b. Hold the torque wrench lightly.

Hold the torque wrench at the same point near the end of the handle each time you use it. Always use the wrench in the proper orientation (see Figure 3-25), and when possible, hold the wrench horizontally as you begin tightening the connection.

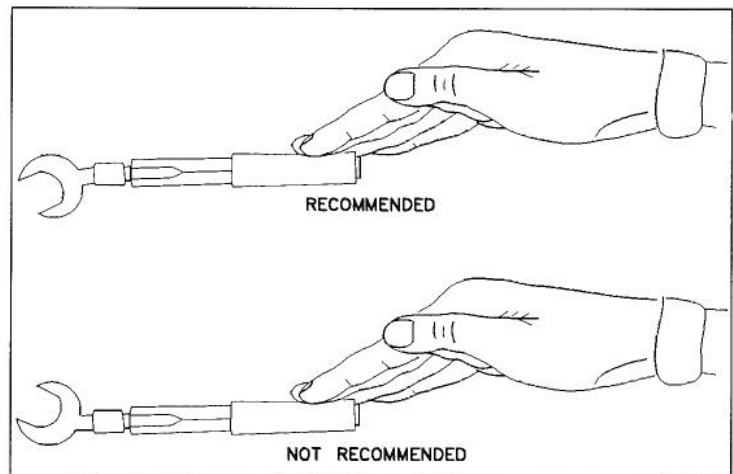
- c. Apply force at the *end* of the torque wrench, perpendicular to the wrench, in a plane parallel to the outer conductor mating planes. This applies torque to the connection *through* the wrench.

Do not hold the wrench so tightly that you push the handle straight down along its length rather than pivoting it (Figure 3-26). If you do, you apply an unlimited amount of torque.

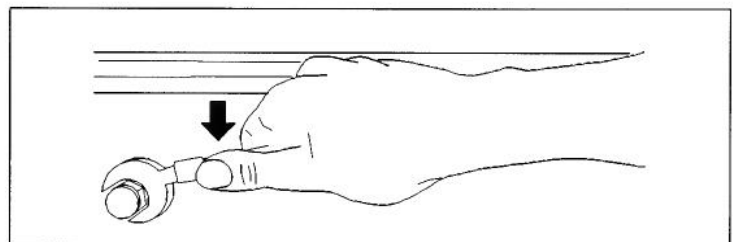




**Figure 3-24. Make the Final Connection With a Torque Wrench**



**Figure 3-25. Proper Torque Wrench Orientation**



**Figure 3-26. Do not Push the Torque Wrench Straight Down**

- d. Tighten the connection just to the torque wrench “break” point (the wrench handle gives way at its internal pivot point. See Figure 3-27). *Do not* tighten the connection further.

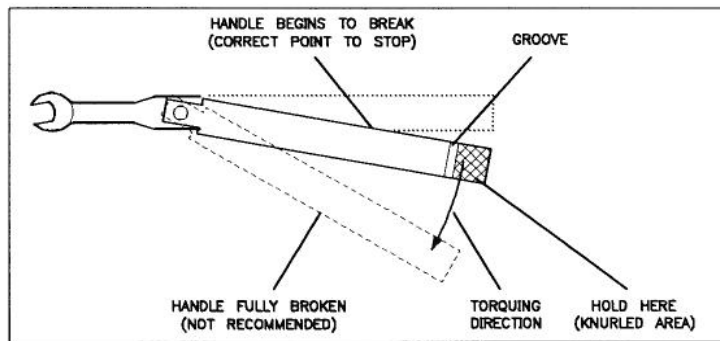
## cautions



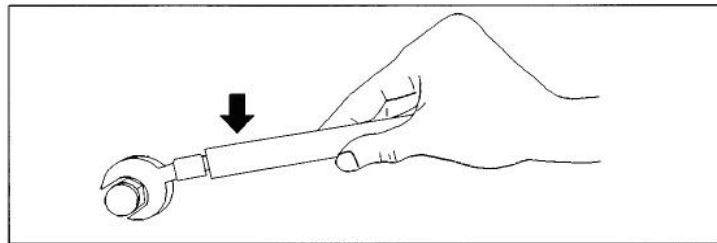
You don’t have to “fully break” the handle of the torque wrench to reach the specified torque, and doing so can cause the handle to kick back and loosen the connection.

*Do not* pivot the wrench handle on your thumb or other fingers (Figure 3-28). If you do, 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.



**Figure 3-27. Tighten Only to the Torque Wrench Break Point**



**Figure 3-28. Do Not Pivot the Torque Wrench on Your Thumb**

## Disconnecting

### Note



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

---

1. Firmly grasp the device body (to prevent it from turning).
2. Loosen the connector nut that you tightened to make the connection.

If necessary, use the torque wrench or an open-end wrench to start the disconnection, but leave the connection finger tight.

3. Complete the disconnection by hand, turning only the connector nut.
4. For sexed connectors, pull the connectors straight apart.

### Caution



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*Do not* twist the connection or you may damage the center conductors or the interior component parts to which the connectors attach. You can also scrape the plating off the male contact pin, or (rarely) slightly unscrew the male or female contact pin from its interior mounting, taking it out of specification.

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## Precision 7 mm

### Seating

The general procedure in this chapter describes how to connect a precision 7 mm connector. In certain applications, however, an additional step may prove helpful. Use the following procedure only for the most demanding measurement applications, and only with gold-plated precision 7 mm connectors.

1. After making the preliminary connection (using light finger pressure), hold the connector nut stationary with one hand. With the other hand, gently turn *the body of the connecting device* 5 to 15 degrees opposite the direction of tightening (Figure 3-29). You should feel smooth, uniform movement, without resistance.

You may feel a sudden, slight “breaking loose” of the connection when you rotate the connected device. This happens as the mating plane surfaces or the connector nut threads move into correct alignment, and it slightly loosens the connector nut.

2. If the connector nut loosens, tighten it slightly and repeat the rotation. You should feel smooth, uniform motion, without resistance.
3. Use a torque wrench to make the final connection (136 N-cm (12 in-lb)).

---

### Caution



Because this technique does wear the gold plating on the mating plane surfaces, use seating only in the most demanding measurement applications. Never use this seating technique as a substitute for careful cleaning and complete mechanical inspection.

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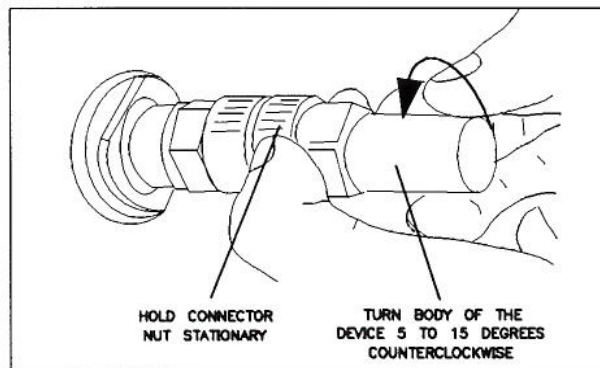


Figure 3-29. Seating a Precision 7 mm Connector

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**Type-N**

For proper torque, finger-tighten a type-N connector (these connectors do not have wrench flats).

If you wish, you can use a torque wrench with a special non-slip end (136 N-cm (12 in-lb)).

*Never* rotate the mating plane surfaces against each other.



## 3.5 mm

### **Mating a Precision 3.5 mm Connector to an SMA Connector**

For proper torque, finger-tighten this type of connector.

Using the following procedure *very carefully*, you can mate a precision 3.5 mm connector to an SMA connector (Figure 3-30). The two connectors have slightly different dimensions and mechanical characteristics. Mating a precision 3.5 mm connector to an SMA connector also affects electrical performance (see “Electrical Performance”).

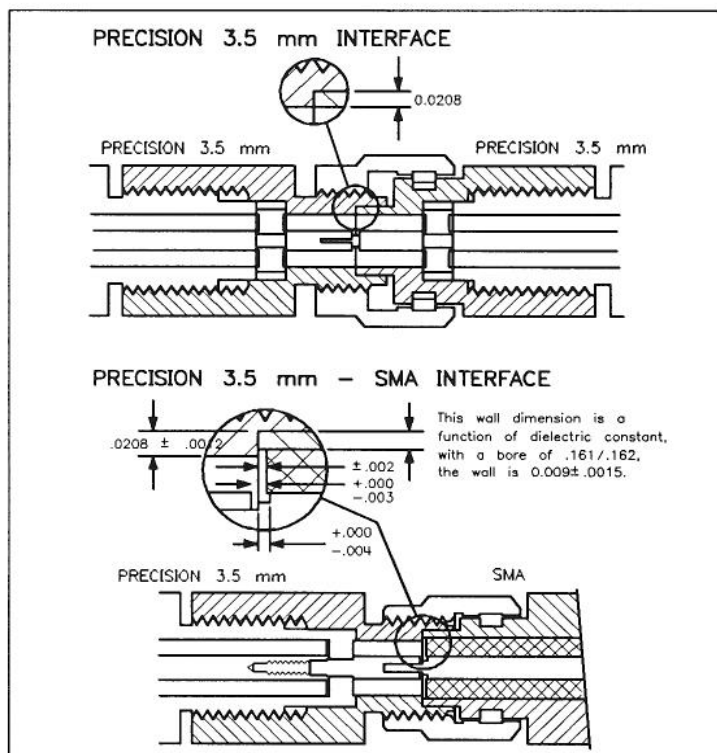
1. Gage both connectors. The SMA connector must meet the precision 3.5 mm connector setback specifications. If not, it will damage the 3.5 mm connector.
2. Carefully align the connectors.
3. Push the two connectors straight together, with the male contact pin precisely concentric with the female.
4. Do not twist either connector or device.
5. Turn only the outer male connector nut.
6. Use a torque wrench for the final connection (56 N-cm (5 lb-in)).

If you must make more than a few connections, use a 3.5 mm-to-3.5 mm adapter to protect the 3.5 mm connector (see Appendix B).

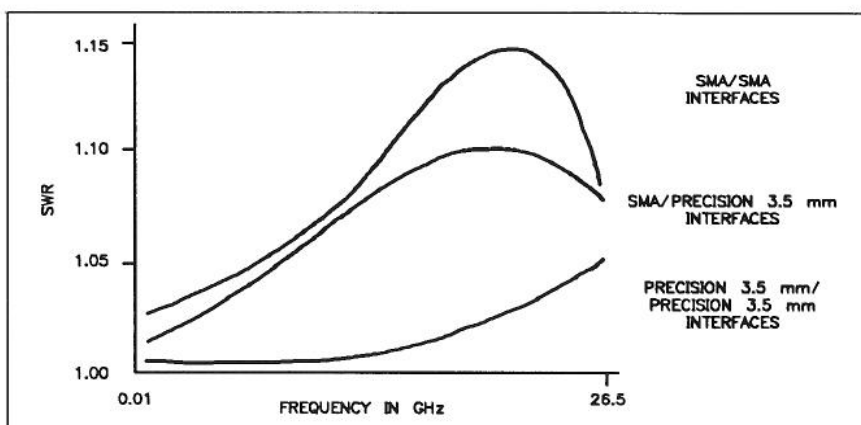
### **Electrical Performance**

The junction of two precision 3.5 mm connectors provides superior electrical performance compared to either the junction of two SMA connectors, or an SMA connector mated to a precision 3.5 mm connector (see Figure 3-31).

When you mate an SMA connector with a precision 3.5 mm connector, the connection has a typical mismatch (SWR) of 1.10 at 2 GHz (less than that of two SMA connectors, but much greater than that of two precision 3.5 mm connectors).



**Figure 3-30.**  
**A Precision 3.5 mm Connector Interface Compared to**  
**A Precision 3.5 mm-to-SMA Connector Interface**



**Figure 3-31.**  
**Typical SWR of SMA and Precision 3.5 mm Coupled Junctions**

2.4 mm

**2.4 mm**

For proper torque, finger-tighten this type of connector.

## Removing, Inspecting, & Replacing Center Conductor Collets

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### Collet Types

#### Slotted (page A-2)

This appendix covers two types of slotted 7 mm collets:

- 4-slot collets.
- 6-slot collets.

The more durable 6-slot collets provide more repeatable connections. Never replace a 6-slot collet with a 4-slot collet. You can reuse either type, but inspect them carefully before you do.

#### Slotless (page A-4)

This appendix covers two types of slotless collets:

- 3.5 mm slotless collets.
- 7 mm slotless collets.

## Slotted Collets

### Removing a Center Slotted Collet

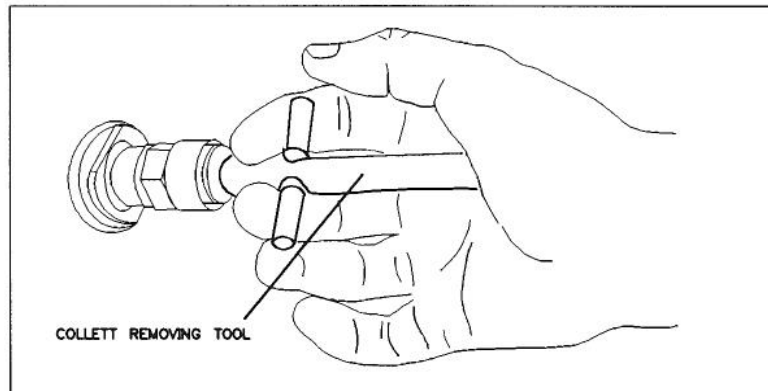
Use this procedure to remove a slotted center conductor collet for any of the following reasons:

- You wish to gage the connector with the collet removed.
  - You find a damaged collet.
  - The collet protrusion measures out of specification.
1. Wear a grounded wrist strap, and ground yourself as far as possible from the test port.
  2. To open the interior collet removal jaws fully, pull back the handle of the collet removing tool.
  3. With the handle pulled back, carefully insert the tool completely into the connector, inside the outer conductor, until it comes to rest lightly on the interior support bead (Figure A-1).
  4. Release the handle and remove the tool (and collet) from the connector.

#### Note



Removing the collet should not damage it. If it does, replace the collet and the collet removing tool.



**Figure A-1. Using the Collet Removal Tool**

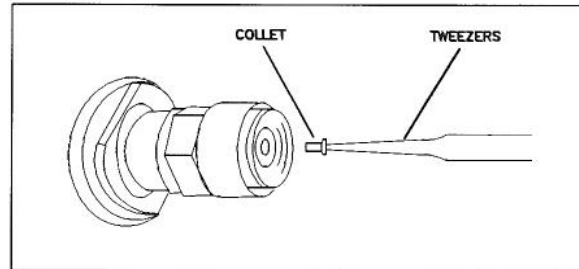
### Inspecting a Slotted Collet

- Look for edge or surface damage.
- Look for any signs of bent or twisted spring contacts. If necessary, replace both the collet and the collet removing tool.



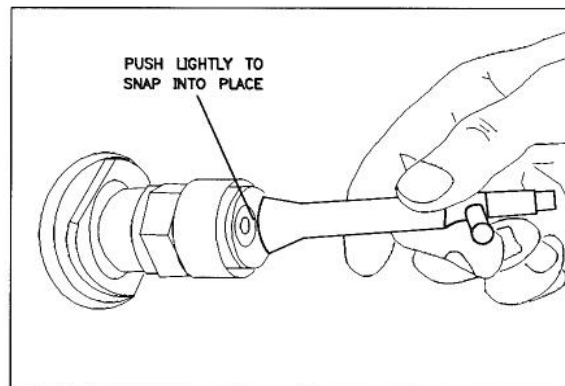
### Replacing a Slotted Collet

1. Wear a grounded wrist strap, and ground yourself as far as possible from the test port. .
2. With tweezers, pick up the collet by the slotted end.
3. Carefully insert the collet (narrow end first) into the connector center conductor (Figure A-2).



**Figure A-2. Inserting a Collet**

4. Using a blunt plastic rod (or the rounded plastic handle of the collet removing tool) press the collet gently until it snaps into place (Figure A-3).



**Figure A-3. Gently Press the Collet into Place**

### Slotless Collets

When properly used, a precision slotless connector should have the same lifespan as a standard slotted connector. Hewlett-Packard designed the precision slotless contacts to mate with all connectors within a connector series *when those connectors meet published interface dimensions*. Mating a connector that *does not* meet published specifications can damage a precision slotless connector. For this reason, ensure that any device you connect measures within its specifications.

The following procedure calls for items contained in HP 85052B option K11 and 85054B option K11 slotless contact repair kits:

- Alcohol.
- Foam swabs.
- Tweezers.
- Inner contact removal tool.
- Inner contact insertion tool.
- Inner contact testing tool.
- Testing weight.
- Replacement inner contacts.

#### HP 85052B Option K11

Use the 3.5 mm slotless contact repair kit to repair the female contacts on all HP PSC-3.5 mm connectors except for the precision slotless contacts on the air lines in the HP 85052C 3.5 mm precision calibration kit. If damaged, these contacts must be repaired at the factory.

#### HP 85054B Option K11

Use the type-N slotless contact repair kit to repair the female contacts on all HP type-N precision slotless connectors.

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## Repairing A Slotless Contact

If you suspect a problem with the slotless contact, make a visual inspection to check for damage. As you use a connector, dirt and metal particles can accumulate in and around the slotless contact. In extreme cases this accumulation can render the contact non-functional. Often, simply cleaning the contact fixes the problem.

This section provides procedures on how to clean both the inner contact and the center conductor, how to reinstall the inner contact, how to test for functionality, and, if necessary, how to replace the inner contact.

Repairing a damaged slotless contact comprises six-steps:

1. Gage the connector.
2. Under  $\geq x10$  magnification, inspect the connector to determine the damage.
3. Remove the damaged inner contact.
4. Inspect the center conductor. If undamaged, clean it.
5. Install the replacement inner contact.
6. Test the slotless contact.

## Slotless

### Inspecting A Damaged Slotless Contact

Inspect the contact under  $\geq x10$  magnification to define the problem. Usually you can make the repair without disassembling the device to which the precision slotless contact is attached.

Inspect the slotless contact to see if any of the following conditions exist:

- The inner contact has one or more fingers bent inward or crushed, preventing proper contact to the male pin (see Figure A-4).

If so, go to step 1 of "Removing A Slotless Contact".

- The inner contact has one or more fingers broken (see Figure A-5).

If so, go to step 2 of "Removing A Slotless Contact".

- The inner contact is pushed inside the center conductor and does not make contact with the mating connector's male pin (see Figure A-6).

If so, go to step 3 of "Removing A Slotless Contact".

- The end of the center conductor appears dented or scraped near where it touches the inner contact (see Figure A-7).

If so, the slotless contact may be damaged beyond the capabilities of this repair kit, and the device must be repaired or replaced by Hewlett-Packard.

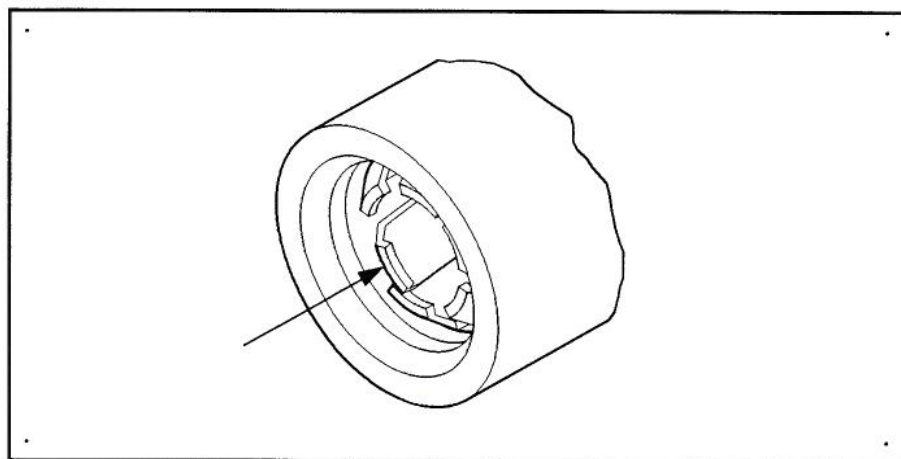
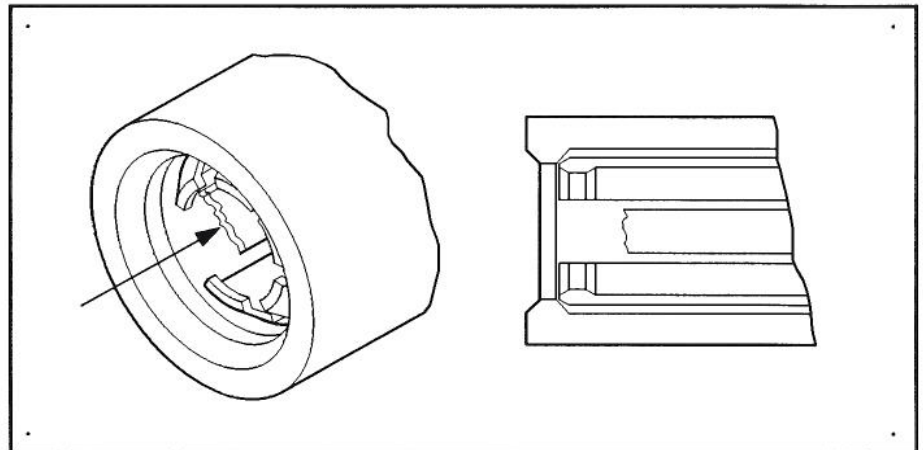
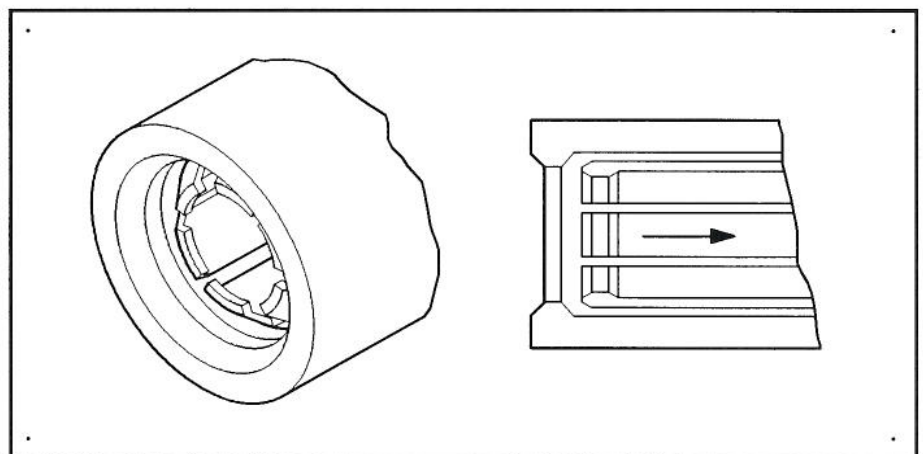


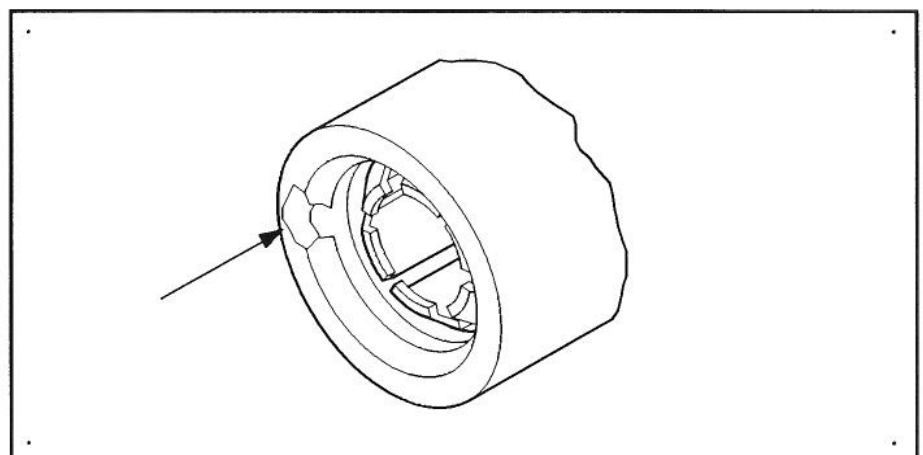
Figure A-4. Finger Bent In or Crushed



**Figure A-5. Broken Inner Contact**



**Figure A-6. Inner Contact Pushed Inside**



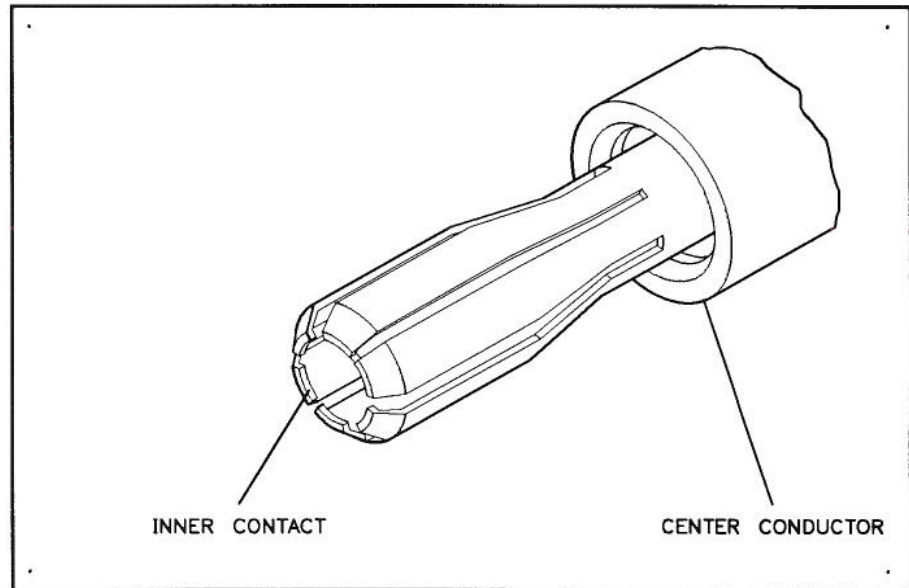
**Figure A-7. Damaged Center Conductor**



## Removing A Slotless Contact

### Step 1

If one or more of the inner contact's fingers are bent inward or crushed, you must straighten or remove those fingers before you remove the entire inner contact. Figure A-8 shows both the inner contact and the center conductor.

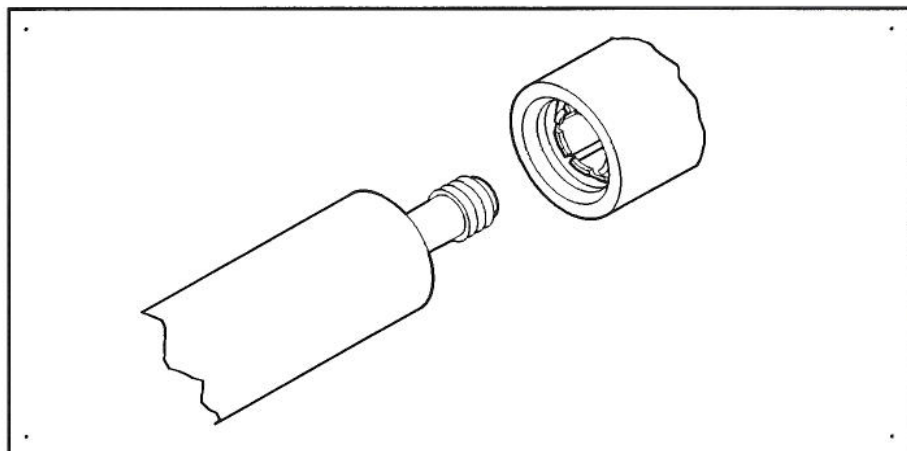


**Figure A-8. The Inner Contact and Center Conductor**

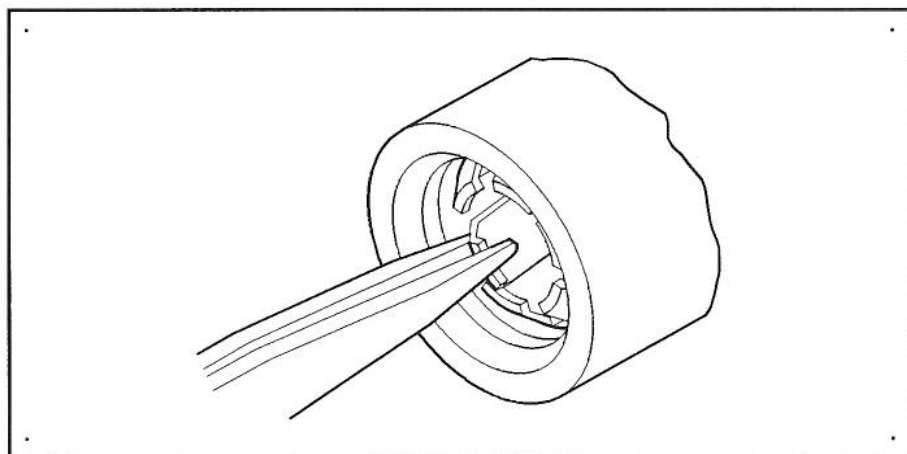
- a. Under magnification, *carefully* try to insert the removal tool (see Figure A-9).
- b. If the damaged fingers prevent you from inserting the tool, use tweezers to either move aside or remove the damaged fingers (see Figure A-10).

Be *extremely cautious* to avoid damaging the center conductor, which houses the inner contact. Do not touch the tweezers to anything but the damaged inner contact. Do not, under any circumstances, use anything to squeeze or clamp on to the center conductor that might cause damage.

- c. After you move or remove the damaged inner contact fingers and can insert the inner contact removal tool, go to step 3.



**Figure A-9. Inserting the Removal Tool**



**Figure A-10. Moving a Damaged Finger**

**Step 2**

If one or more of the inner contact's fingers are broken, you must remove that finger before you remove the entire inner contact:

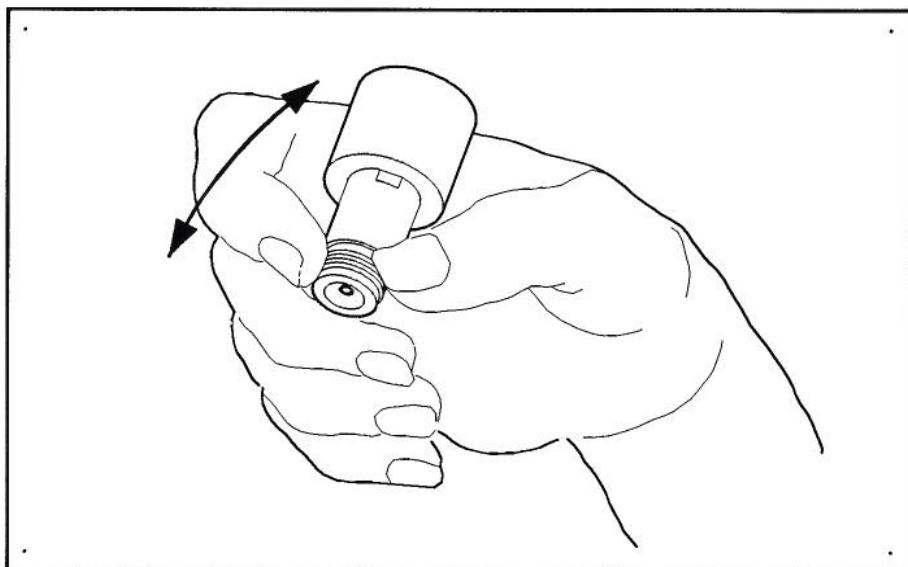
- a. Under magnification, look down inside the inner contact and locate the broken finger or fingers.

The fingers may have already fallen out. If so, continue with step 3.

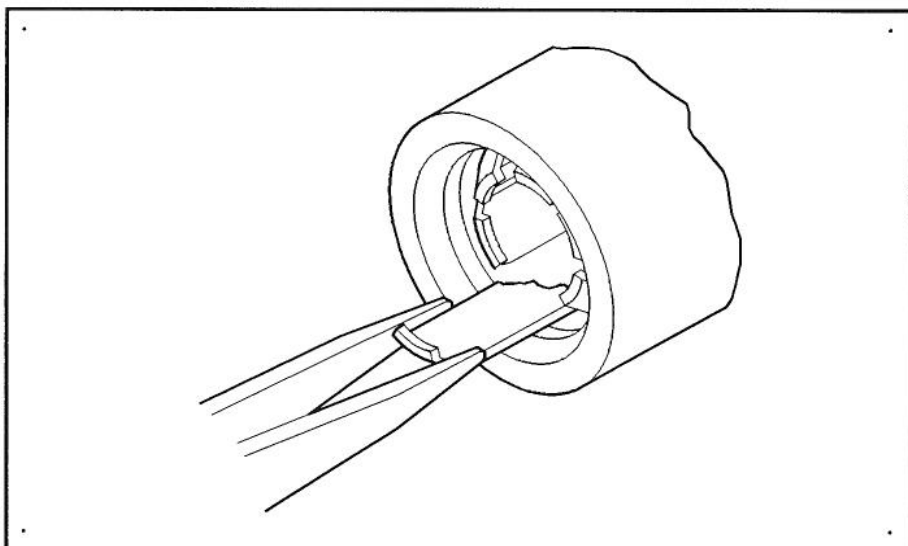
- b. If you can see the broken fingers inside the inner contact, turn the device upside down and gently tap on it (see Figure A-11).

Using this gentle tapping, try to force the broken fingers to drop out or at least move forward far enough so that you can remove them with the tweezers (see Figure A-12). Do not, under any circumstances, use anything other than gentle tapping.

- c. After you remove the broken inner contact fingers and can carefully insert the inner contact removal tool, go to step 3.



**Figure A-11. Freeing a Broken Contact Finger**



**Figure A-12. Removing a Broken Contact Finger**

### Step 3

If the inner contact is pushed inward and no longer makes contact with the mating connector's male pin, you must remove and replace the inner contact:

- a. Under magnification, insert the removal tool into the damaged contact far enough so that it touches the bottom of the inside of the inner contact.
- b. Turn the tool clockwise to engage the tool coupling thread with the thread on the inside of the contact (see Figure A-13).
- c. Occasionally the inner contact spins with the tool, preventing the tool from engaging. If this happens, apply a small amount axial pressure to the tool and continue to turn it clockwise.
- d. Once you engage the tool by 2 turns, you can remove the inner contact. Pull the tool and inner contact straight out away from the center conductor (see Figure A-14).

### Caution

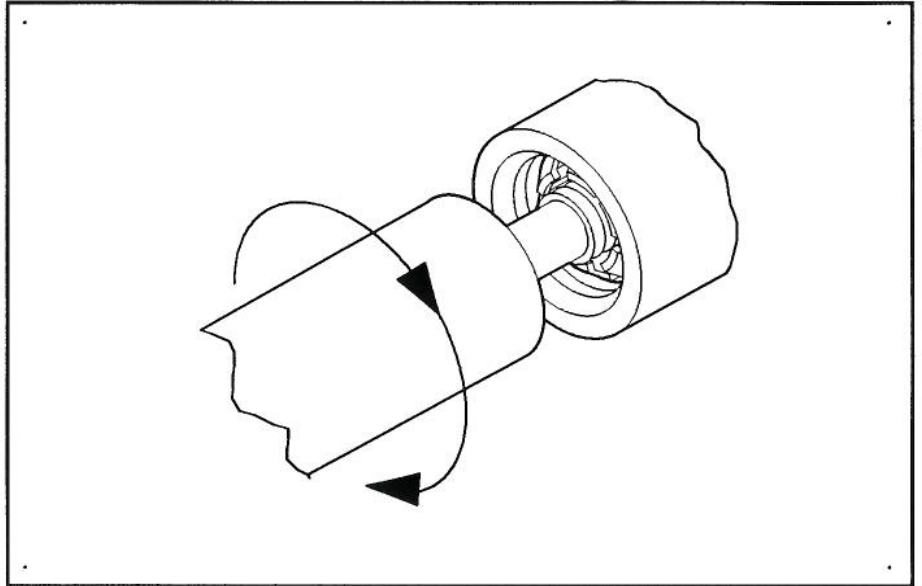


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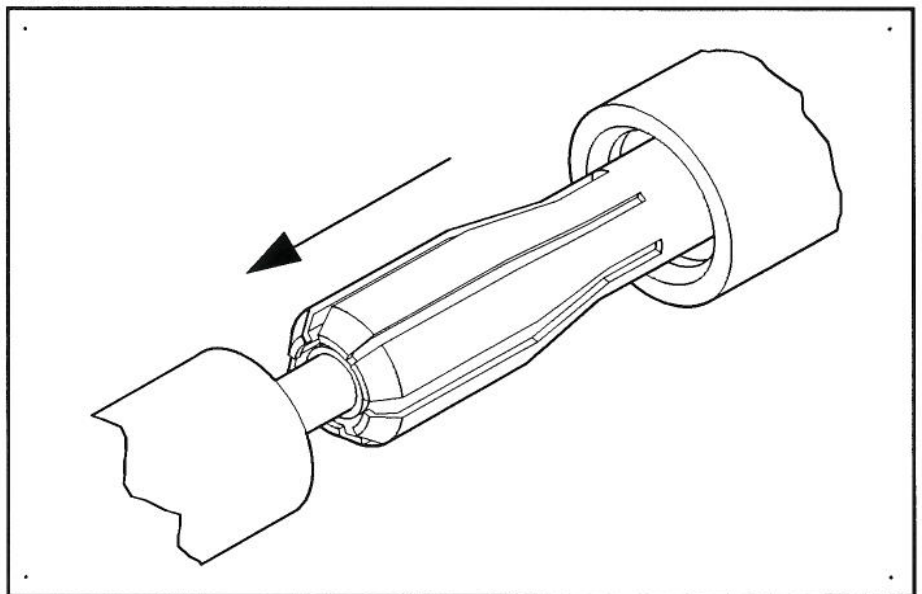
Do not damage the center conductor as you remove the inner contact.

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- e. Unthread the broken inner contact from the removal tool and discard the contact; it cannot be repaired or reused.



**Figure A-13.**  
**Threading the Removal Tool into**  
**the Inner Contact**



**Figure A-14. Removing the Inner Contact**

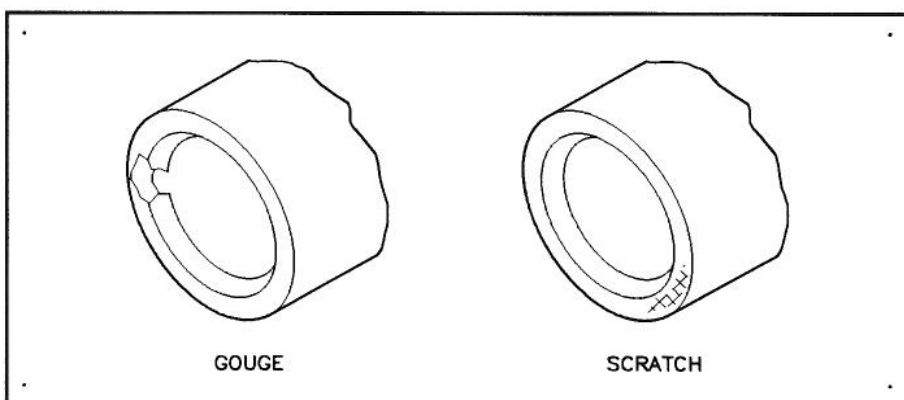


**Slotless**

## Inspecting & Cleaning A Center Conductor

### Inspecting

1. Under magnification, inspect the center conductor for damage.
2. Refer to Figure A-15. Is the center conductor gouged? Does it have any imperfection that would interfere with the insertion of a new inner contact? If so, you must return the device to Hewlett-Packard for repair; you cannot repair a center conductor with either kit.
3. If the center conductor is undamaged, or if the damage is too light to affect device performance, clean the center conductor.



**Figure A-15. Damaged Center Conductor**

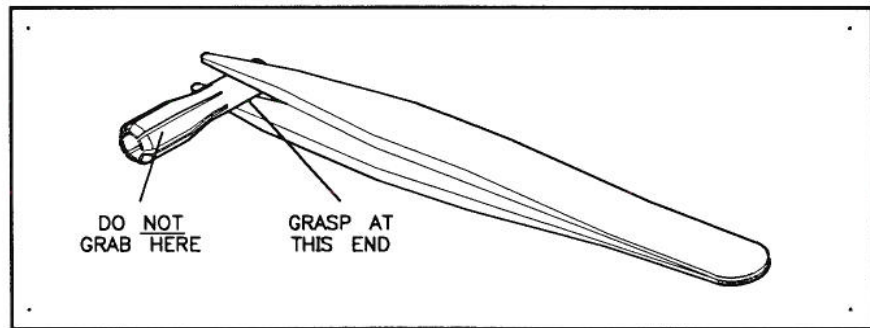
### Cleaning

1. Under magnification, look for loose dirt or metal particles.
2. Using foam swabs and isopropyl alcohol, clean the center conductor.
3. Using a source of dry air or nitrogen, blow out the hole in the center conductor; be sure that all the alcohol evaporates.
4. Now you can insert a new inner contact into the clean center conductor.

## Inserting an Inner Contact

When you install a replacement inner contact, be careful handling the replacement parts. These parts are fragile until they are inside the center conductor; do not squeeze or misuse them in any way.

1. Using tweezers, carefully pick up a new inner contact by its small-diameter end (away from the fingers, see Figure A-16). Do not use excessive pressure. Holding the contact by the fingers will damage it.



**Figure A-16. Holding the Inner Contact Properly**

2. Under magnification, carefully insert the insertion tool into the new inner contact until it hits bottom. Do not use the removal tool (with the threaded end) to insert the inner contact, or you may damage the new inner contact.
3. Let go of the contact with tweezers and slowly insert the contact into the center conductor (see Figure A-17). As you install the contact, its fingers compress and the force required to insert it first increases and then decreases. When the insertion force begins to decrease, do not push too hard or you may damage the new inner contact or center conductor.
4. At the point that the contact snaps into place, stop pushing.
5. Carefully withdraw the insertion tool from the inner contact.
6. Under magnification, visually inspect the assembly and make sure the inner contact is properly installed (see Figure A-18).

### Caution



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*Never* apply either lubricant or adhesive to an inner contact.

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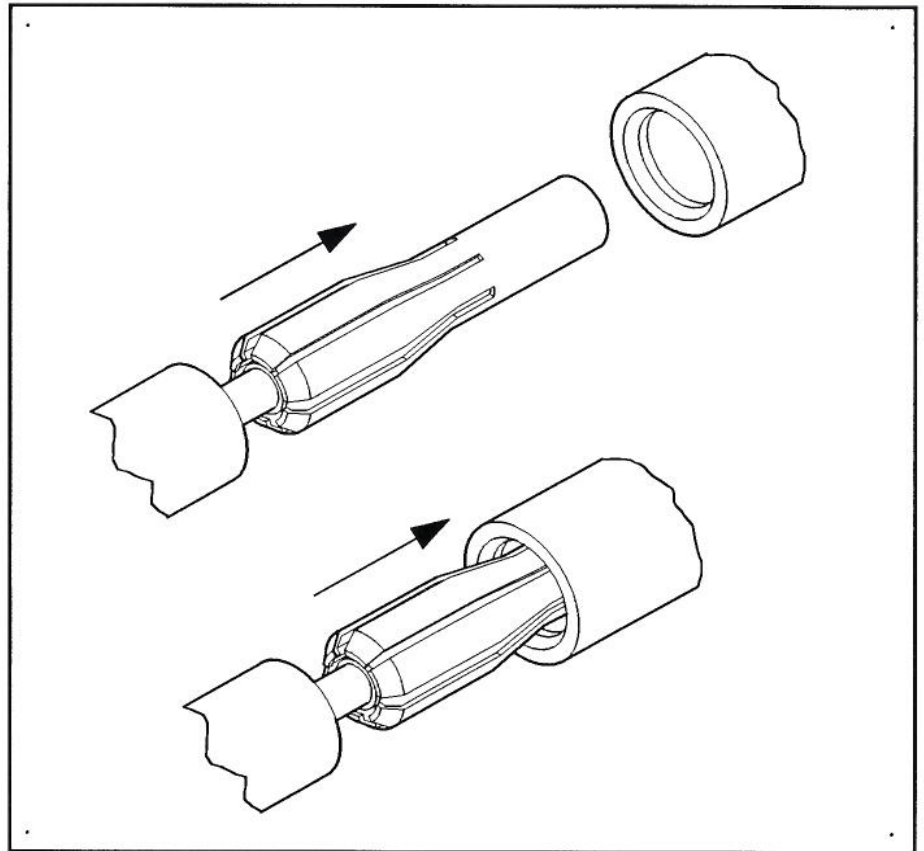


Figure A-17. Installing a New Inner Contact

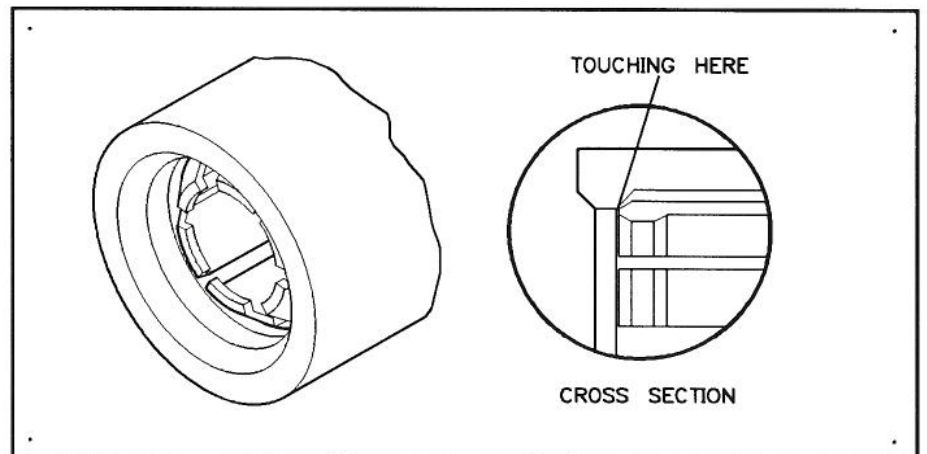


Figure A-18. Inspecting the Installation

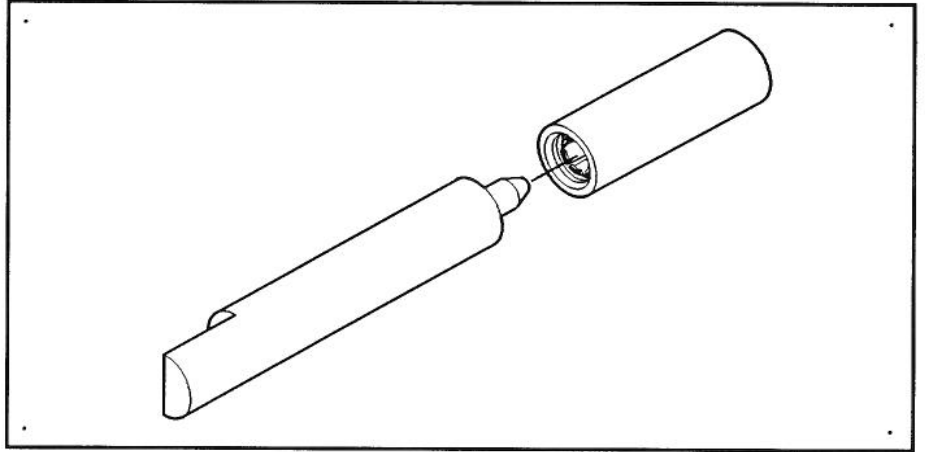
**Testing a  
Slotless Contact**

After you install a new inner contact, you must test it using the tools provided in the repair kit.

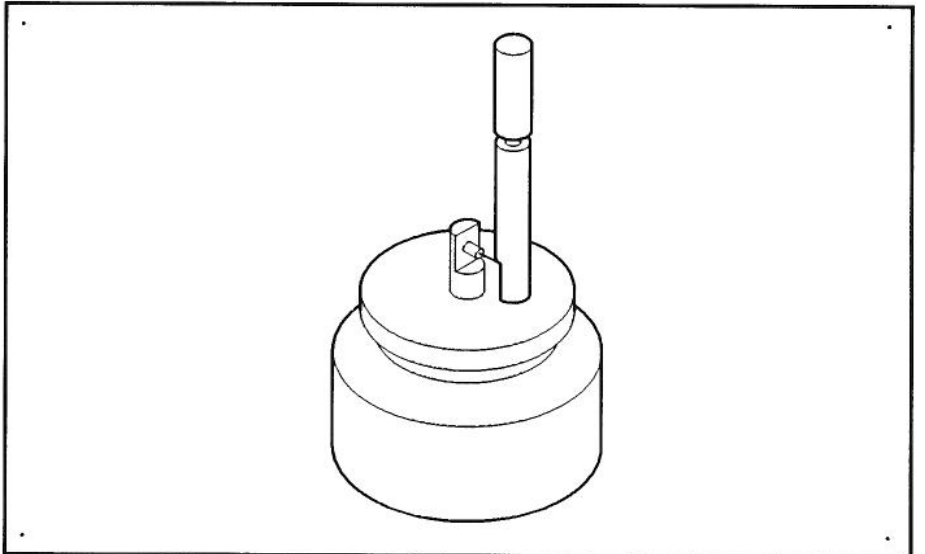
1. Using a foam swab and alcohol, clean the testing tool.
2. Under magnification, carefully install the testing tool in the slotless contact assembly (see Figure A-19).
3. Repeat step 2 two more times.
4. Inspect the inner contact. If the fingers are damaged, remove and replace the inner contact.
5. Insert the testing tool.
6. With the testing tool inserted, turn the device upside down so that the testing tool hangs by the grip of the slotless contact.
7. Hook the testing weight to the testing tool.

If the contact has the proper minimum retention force, it does not lose its grip.

8. Remove the testing weight.
9. Remove the testing tool.
10. Visually inspect the slotless contact.
11. If you see any dirt or metal particles, clean the contact using alcohol and foam swabs.
12. The clean, precision slotless connector is ready for use.



**Figure A-19. Inserting the Testing Tool**



**Figure A-20. Testing the Retention Force of the Contact**





## **Accessories & Cleaning Supplies**

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### **Adapters**

Table B-1 lists many of the adapters available from Hewlett-Packard. Use adapters for the following reasons:

- To reduce wear on an expensive or difficult to replace connector.
- To change the connector interface.
- When you measure a coaxial device that has an SMA connector.

SMA connectors are:

- ☐ Not precision mechanical devices.
- ☐ Not designed for repeated connections.
- ☐ Quickly worn out.
- ☐ Easily out of specification.
- ☐ Potentially destructive (because of the previous characteristics).

### Precision 7 mm

#### The HP 85130B Adapter Kit

This adapter kit interfaces NMD-3.5 mm tests ports to 7 mm devices.

#### Directional Bridges

If you measure devices with SMA connectors at frequencies from 0.01 to 18 GHz, and can tolerate a slight loss in directivity, use a 7 mm directional bridge and 7 mm-to-3.5 mm adapters. The larger 7 mm connector is more durable than a 3.5 mm connector, and the adapters protect the bridge connectors.

Figure B-1 shows the typical directivity of HP 85021/27 directional bridges with and without connector-saver adapters.

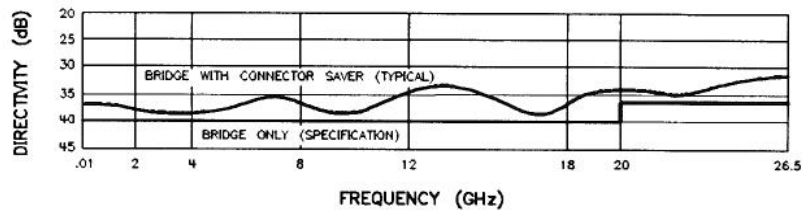


Figure B-1. Typical Directivity Using Connector-Saver Adapters

---

### Precision 3.5 mm

#### Directional Bridges

If you measure devices with SMA connectors at frequencies from 0.01 to 26.5 GHz, and can tolerate a slight loss in directivity, use a 3.5 mm directional bridge and 3.5 mm-to-3.5 mm adapters. The adapters protect the bridge connectors.

Figure B-1 shows the typical directivity of HP 85021/27 directional bridges with and without connector-saver adapters.

---

## Precision 2.4 mm

### PSC 2.4 mm

#### 2.4 mm-to-2.4 mm Adapters

Use high-quality precision adapters, sometimes called “connector savers,” when you make more than a few connections. This protects the port connector from wear and accidental damage, and you need replace only a worn adapter.

Table B-1 lists 2.4 mm-to-2.4 mm adapters.

#### 3.5 mm-to-2.4 mm Adapters

Using 3.5 mm-to-2.4 mm adapters (listed in Table B-1), you can connect a device or cable that has a precision slotless 2.4 mm connectors to a device or cable that has a precision 3.5 mm connector.

You can order other PSC-2.4 mm adapters, this section describes only the most frequently used.

## Part Numbers

**Table B-1. Cleaning Supplies and Accessories**

Item	HP Part or Model Number	Item	HP Part or Model Number
<b>Cleaning Supplies</b>			
Compressed Air	8500-5262	PSC-N <sub>(f)</sub> to PSC-N <sub>(f)</sub>	85054-60037
99.5% Isopropyl Alcohol (8 oz)	8500-0559	PSC-N <sub>(m)</sub> to NMD-3.5 mm	85054-60030
99.5% Isopropyl Alcohol (30 ml)	8500-05344	PSC-N <sub>(f)</sub> to NMD-3.5 mm	85054-60029
Foam Swabs (500)	9300-1270		
Alcohol Wipes	92193N	SMA <sub>(m)</sub> to SMA <sub>(m)</sub>	1250-1159
Lint-free Cleaning Cloth	9310-4242	SMA <sub>(f)</sub> to SMA <sub>(f)</sub>	1250-1158
<b>Adapters</b>		3.5 mm <sub>(m)</sub> to 3.5 mm <sub>(m)</sub>	1250-1748
7 mm to 7 mm	85050-60005	3.5 mm <sub>(m)</sub> to 3.5 mm <sub>(f)</sub>	1250-1750
7 mm to type-N <sub>(m)</sub>	11525A	3.5 mm <sub>(f)</sub> to 3.5 mm <sub>(f)</sub>	1250-1749
7 mm to type-N <sub>(f)</sub>	11524A	3.5 mm <sub>(m)</sub> to 2.4 mm <sub>(m)</sub>	11901A
7 mm to PSC-N	85054-60031	3.5 mm <sub>(m)</sub> to 2.4 mm <sub>(f)</sub>	11901C
7 mm to SMA <sub>(m)</sub>	11533A	3.5 mm <sub>(f)</sub> to 2.4 mm <sub>(f)</sub>	11901B
7 mm to SMA <sub>(f)</sub>	11534A	3.5 mm <sub>(f)</sub> to 2.4 mm <sub>(m)</sub>	11901D
7 mm to 3.5 mm <sub>(m)</sub>	1250-1746	3.5 mm <sub>(m)</sub> to NMD-3.5 mm <sub>(f)</sub>	85130-60006
7 mm to 3.5 mm <sub>(f)</sub>	1250-1747		
7 mm to NMD-3.5 mm	85130-60003	NMD-3.5 mm <sub>(f)</sub> to PSC-3.5 mm <sub>(f)</sub>	85130-60005
7 mm to 2.4 mm <sub>(m)</sub>	11902A	NMD-3.5 mm <sub>(m)</sub> to NMD-2.4 mm <sub>(f)</sub>	85130-60010
7 mm to 2.4 mm <sub>(f)</sub>	11902B		
7 mm to NMD-2.4 mm <sub>(f)</sub>	85130-60014	PSC-3.5 mm <sub>(f)</sub> to NMD-2.4 mm <sub>(f)</sub>	85130-60011
Type-N <sub>(m)</sub> to Type-N <sub>(m)</sub>	1250-0778	2.4 mm <sub>(m)</sub> to 2.4 mm <sub>(m)</sub>	11900A
Type-N <sub>(f)</sub> to Type-N <sub>(f)</sub>	1250-0777	2.4 mm <sub>(m)</sub> to 2.4 mm <sub>(f)</sub>	11900C
Type-N <sub>(m)</sub> to SMA <sub>(m)</sub>	1250-1636	2.4 mm <sub>(f)</sub> to 2.4 mm <sub>(f)</sub>	11900B
Type-N <sub>(f)</sub> to SMA <sub>(m)</sub>	1250-1562		
Type-N <sub>(f)</sub> to SMA <sub>(f)</sub>	1250-1772	NMD-2.4 mm <sub>(f)</sub> to NMD-2.4 mm <sub>(m)</sub>	85130-60015
Type-N <sub>(m)</sub> to 3.5 mm <sub>(m)</sub>	1250-1743	NMD-2.4 mm <sub>(f)</sub> to PSC-2.4 mm <sub>(f)</sub>	85130-60016
Type-N <sub>(m)</sub> to 3.5 mm <sub>(f)</sub>	1250-1744		
Type-N <sub>(f)</sub> to 3.5 mm <sub>(f)</sub>	1250-1745		
Type-N <sub>(m)</sub> to 2.4 mm <sub>(m)</sub>	11903A	<b>Bridge Connector-Savers</b>	
Type-N <sub>(m)</sub> to 2.4 mm <sub>(f)</sub>	11903D	3.5 mm <sub>(m)</sub> to 3.5 mm <sub>(m)</sub>	85027-60002
Type-N <sub>(f)</sub> to 2.4 mm <sub>(f)</sub>	11903B	3.5 mm <sub>(m)</sub> to 3.5 mm <sub>(f)</sub>	85027-60003
Type-N <sub>(f)</sub> to 2.4 mm <sub>(m)</sub>	11903C		

## B-4 Accessories & Supplies

Table B-1. Cleaning Supplies and Accessories (continued)

Item	HP Part or Model Number	Item	HP Part or Model Number
<b>Connector Gage Kits</b>		<b>Open-End Wrenches</b>	
7 mm	85050-80012	7 mm	8710-1761
Type-N	85054-60049	1/4-in	8720-0014
SMA <sub>(m)</sub>	11752C Opt 001	3/4-in	8720-0011
SMA <sub>(f)</sub>	11752C Opt 002	5/16-in	8720-0015
3.5 mm	11752D	11/32-in	8720-0018
3.5 mm <sub>(m)</sub>	11752DZ		
3.5 mm <sub>(f)</sub>	11752DY	<b>Spanner Wrench</b>	
2.4 mm	11752E	NMD-2.4 mm or NMD-3.5 mm	08513-20014
2.4 mm <sub>(m)</sub>	11752EZ		
2.4 mm <sub>(f)</sub>	11752EY	<b>Miscellaneous Items</b>	
		Collet Extractor Tool	5060-80012
<b>Connector Centering Beads</b>		3.5 mm Slotless Contact Repair Kit	85052B Opt K11
Type-N	85054-80028	7 mm Slotless Contact Repair Kit	85054B Opt K11
3.5 mm	85052-20057	6-Slot Collet	85050-20001
2.4 mm	85056-20001	Coaxial & Waveguide Measurement Accessories Catalog	5954-6401
		Support Materials Organization Materials Handling and Packaging Guide	5181-1930
<b>Protective End Caps</b>		2.4 mm Adapters and Calibration Accessories Operating Note	11900-9003
7 mm	1401-0123	Grounding Wrist Strap	9300-1367
Type-N <sub>(m)</sub>	1401-0124	5 ft Wrist-Strap to Table-Mat Grounding Cord	9300-1980
Type-N <sub>(f)</sub>	1401-0225	2 x 4 ft Conductive Table Mat & 15 ft Ground Wire	9300-0797
SMA <sub>(m)</sub> , 3.5 mm <sub>(m)</sub> , and 2.4 mm <sub>(m)</sub>	1401-0208	EDS Heel Strap	9300-1169
SMA <sub>(f)</sub> , 3.5 mm <sub>(f)</sub> , and 2.4 mm <sub>(f)</sub>	1401-00202	Hard-Surface Conductive Floor Mat 4 x 5 ft	92175A
NMD-3.5 mm and NMD-2.4 mm	1401-0214	3 x 4 ft	92175C
		Soft-Surface Conductive Floor Mat 4 x 8 ft	92175B
<b>Torque Wrenches</b>			
3/4-in 136 N-cm (12 in-lb)	8710-1766		
5/16-in 56 N-cm (5 in-lb)	8710-1582		
5/16-in 90 N-cm (8 in-lb)	8710-1765		
20 mm 90 N-cm (8 in-lb)	8710-1764		





# Index

---

## 2

2.4 mm connector  
  adapters, B-2  
  cleaning, 2-9  
  connecting, 3-44  
  description, 1-3  
  frequency range, 1-1  
  gaging techniques, 3-4, 3-32-33  
  grades, 1-3  
  mechanical inspection, 3-31  
  part numbers, B-4  
  toothpick diameter, 2-6  
  visual inspection, 2-2

## 3

3.5 mm connector  
  adapters, B-2, B-3  
  cleaning, 2-9  
  collet, A-1  
  connecting, 3-42  
  connecting to SMA, 3-42  
  description, 1-2  
  frequency range, 1-1  
  gaging techniques, 3-4, 3-26-30  
  junction performance, 3-42  
  mechanical inspection, 3-25  
  toothpick diameter, 2-6  
  visual inspection, 2-2

## 7

7 mm connector  
  adapters, B-2  
  cleaning, 2-7  
  collet, A-1  
  connecting, 3-40  
  description, 1-2  
  frequency range, 1-1  
  gaging techniques, 3-4  
  mechanical inspection, 3-8  
  visual inspection, 2-2

## A

accessories, B-4  
accuracy, connector gage, 3-2  
adapter

2.4 mm, B-2

3.5 mm, B-2, B-3

7 mm, B-2

kit, B-2

part numbers, B-4

types, B-1

air, compressed. *See* compressed air

alcohol

  contamination, 2-5

  part numbers, B-4

  use, 2-6

  wipes, B-4

## B

bead. *See* centering bead

bridge

  adapters, B-4

  connector savers, B-2, B-4

burnishing, 2-3

by-product particles, 2-4

## C

cap. *See* end cap

center conductor

  cleaning, A-15

  inspecting, A-15

centering bead

  part numbers, B-4

  use, 3-3

checking alcohol, 2-5

cleaning connectors, 2-5

cleaning supplies, B-4

collet

  connector, A-1

  extractor tool, B-4

  inserting, A-16

  inspecting, A-2, A-6

  part numbers, B-4

  removing, A-2, A-4, A-8

  repairing, A-5

  replacement, A-1

  replacement kit, A-4

  replacing, A-2

  slotless, A-1, A-4

  slotted, A-1

  testing, A-18

- types, A-1
- compressed air
  - part number, B-4
  - use, 2-6, 2-7
- conductive mat. *See* mat
- conductor. *See* center conductor
- connector. *See* specific connector type
  - centering bead, 3-3, B-4
  - cleaning, 2-5
  - collet, A-1, B-4. *See also* collet
  - connecting, 3-34
  - disconnecting, 3-39
  - end cap, B-4. *See also* end cap
  - frequency range, 1-1
  - gage. *See* gage
  - gage part numbers, B-4
  - gaging, 3-4
  - general recommendations, 1-1
  - grade, 1-3
  - handling, 1-6
  - mechanical inspection, 3-1
  - replacement kit, B-4
  - savers, B-4
  - storing, 1-6
  - type, 1-1
  - visual inspection, 2-1, 2-2
  - when to gage, 3-1
- connector collet. *See* collet
- connector end cap. *See* end cap
- connector gage. *See* gage
- contact separation, effects of, 3-13

## D

- dents, 2-3
- description
  - 2.4 mm, 1-3
  - 3.5 mm, 1-2
  - 75 $\Omega$  type-N, 1-2
  - 7 mm, 1-2
  - NMD-2.4 mm, 1-4
  - NMD-3.5 mm, 1-3
  - PSC-2.4 mm, 1-4
  - PSC-3.5 mm, 1-3
  - PSC-N, 1-2
  - SMA, 1-3
  - standard type-N, 1-2
  - type-N, 1-2
- dielectric protrusion, 3-18
- discharge, electrostatic. *See* ESD
- documents, part number, B-4

## E

- effects of contact separation, 3-13
- electrostatic discharge. *See* ESD
- end cap
  - part number, B-4
  - use, 1-6
- ESD, 1-5
- extractor tool
  - part number, B-4
  - use, A-2

## F

- floor mat. *See* mat|
  - use, 1-5
- foam swabs, B-4
- frequency range, 1-1

## G

- gage
  - accuracy, 3-2
  - part numbers, B-4
  - type, 3-2
  - types, 3-2
  - use, 3-4
  - when to, 3-1
- gaging techniques. *See* specific connector type
- grade, 2.4 mm connector, 1-3
- grounding
  - heel strap. *See* heel strap
  - mat. *See* mat
  - wrist strap. *See* wrist strap

## H

- handling connector, 1-6
- heel strap
  - part numbers, B-4
  - use, 1-5

## I

- inner contact, inserting, A-16
- inserting inner contact, A-16
- inspection
  - mechanical, 3-1
  - visual, 2-1
- instrument grade connector, 1-3
- isopropyl. *See* alcohol

## M

- male pin, SMA, 3-18
- mat
  - part number, B-4
  - use, 1-5
- materials handling and packaging guide, B-4
- measurement accessories catalog, B-4

metal particles, 2-4  
metrology grade connector, 1-3

## N

NMD-2.4 mm connector  
  description, 1-4  
  visual inspection, 2-2  
NMD-3.5 mm connector  
  connecting, 3-42  
  description, 1-3  
  visual inspection, 2-2

## O

open-end wrench. *See* wrench  
operating note, part number, B-4

## P

particles, 2-4  
part numbers, B-4  
precision 7 mm. *See* 7 mm  
precision slotless connector. *See* PSC  
production grade connector, 1-3  
protrusion, dielectric, 3-18  
PSC-2.4 mm connector  
  description, 1-4  
  frequency range, 1-1  
  gaging techniques, 3-4  
  visual inspection, 2-2  
PSC-3.5 mm connector  
  description, 1-3  
  frequency range, 1-1  
  gaging techniques, 3-4  
  visual inspection, 2-2  
PSC-N connector  
  description, 1-2  
  frequency range, 1-1  
  visual inspection, 2-2  
PSC-N mm connector  
  gaging techniques, 3-4  
publications, part number, B-4

## R

range, frequency, 1-1  
repair, collet, A-1  
replacement kit, collet, A-4  
replacement parts, B-4  
replacing, collet, A-1

## S

savers  
  bridge, B-4  
  connector, B-4  
scratches, 2-2, 2-3

separation, contact, 3-13  
slotless collet. *See* collet  
slotted collet. *See* collet  
SMA connector  
  cleaning, 2-9  
  connecting to 3.5 mm, 3-42  
  description, 1-3  
  dielectric protrusion, 3-18  
  frequency range, 1-1  
  gaging techniques, 3-4, 3-20–25  
  junction performance, 3-42  
  male pin, 3-18  
  mechanical inspection, 3-18  
spanner wrench. *See* wrench  
standard type-N connector  
  description, 1-2  
static-safe  
  practices, 1-5  
  work station, 1-5  
storing connector, 1-6  
strap, part numbers, B-4  
swab. *See* foam swabs

## T

table mat. *See* mat  
  use, 1-5  
techniques, gaging. *See* specific connector type  
tool. *See* extractor tool  
toothpick, use, 2-6  
torque wrench, 3-36–38. *See also* wrench  
type  
  connector, 1-2  
  gage, 3-2  
type-n connector  
  gaging techniques, 3-4  
type-N connector  
  75 $\Omega$ , 1-2  
  connecting, 3-41  
  contact separation, 3-13  
  description, 1-2  
  frequency range, 1-1  
  gaging techniques, 3-14–17  
  mechanical inspection, 3-10  
  visual inspection, 2-2

## V

visual inspection, 2-1

## W

wrench, part numbers, B-4  
wrist strap  
  part number, B-4  
  use, 1-5



## Hewlett-Packard Sales and Service Offices

### IN THE UNITED STATES

#### California

Hewlett-Packard Co.  
1421 South Manhattan Ave.  
P.O. Box 4230  
Fullerton, CA 92631  
(714) 999-6700

Hewlett-Packard Co.  
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Mountain View, CA 94039  
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Hewlett-Packard Co.  
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(201) 265-5000

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Hewlett-Packard Co.  
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(214) 231-6101

### IN AUSTRALIA

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

### IN CANADA

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

### IN FRANCE

Hewlett-Packard France  
F-91947 Les Ulis Cedex  
Orsay  
(6) 907-78-25

### IN GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH  
Vertriebszentrale Frankfurt  
Berner Strasse 117  
Postfach 560 140  
D-6000 Frankfurt 56  
(0611) 50-04-1

### IN GREAT BRITAIN

Hewlett-Packard Ltd.  
King Street Lane  
Winnersh, Wokingham  
Berkshire RG11 5AR  
0734 784774

### IN OTHER EUROPEAN COUNTRIES

Hewlett-Packard (Schweiz) AG  
Allmend 2  
CH-8967 Widen (Zurich)  
(0041) 57 31 21 11

### IN JAPAN

Yokogawa-Hewlett-Packard Ltd.  
29-21 Takaido-Higashi, 3 Chome  
Suginami-ku Tokyo 168  
(03) 331-6111

### IN PEOPLE'S REPUBLIC OF CHINA

China Hewlett-Packard, Ltd.  
P.O. Box 9610, Beijing  
4th Floor, 2nd Watch Factory  
Main Bldg.  
Shuang Yu Shu, Bei San Huan Rd.  
Beijing, PRC  
256-6888

### IN SINGAPORE

Hewlett-Packard Singapore  
Pte. Ltd.  
1150 Depot Road  
Singapore 0410  
273 7388  
Telex HPSGSO RS34209  
Fax (65) 2788990

### IN TAIWAN

Hewlett-Packard Taiwan  
8th Floor, Hewlett-Packard  
Building  
337 Fu Hsing North Road  
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(02) 712-0404

### IN ALL OTHER LOCATIONS

Hewlett-Packard Inter-Americas  
3495 Deer Creek Rd.  
Palo Alto, California 94304



