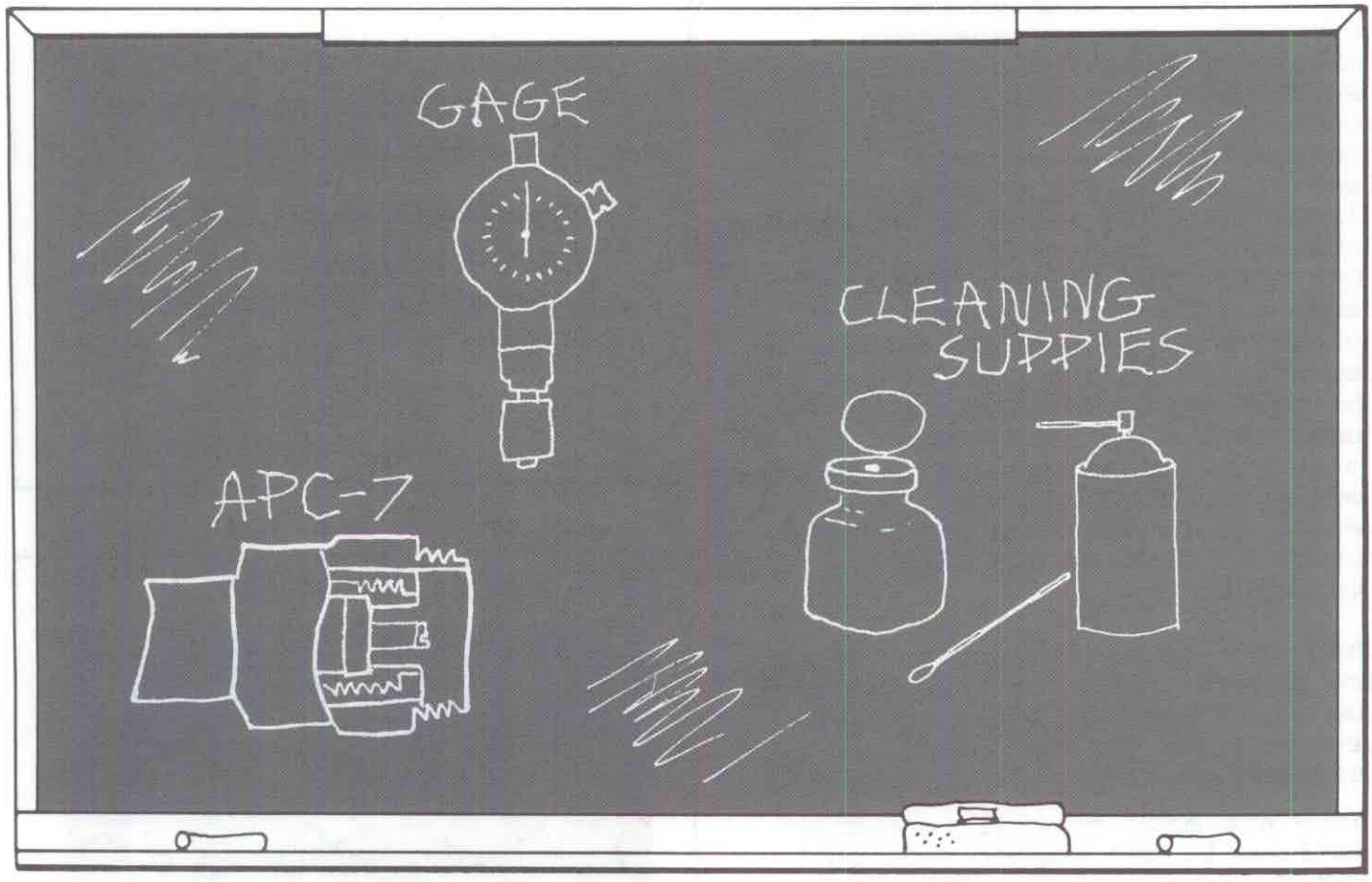
Microwave Connector Care



We have reviewed the fundamentals of scalar measurements and the effects of source match, detector match, and directivity on our measurement error. All these errors are directly influenced by the quality of the microwave connection. Let's discuss proper microwave connector care techniques to make better measurements.

This section is an overview of connector care techniques. For more detailed information, refer to the Microwave Connector Care Manual (HP part no. 08510-90064) or HP Application Note 326, which summarizes the key considerations in connector care.
The condition of the connectors and the quality of connections in the measurement system (adapters cables, bridges, detectors, etc.) can dramatically affect the accuracy of scalar reflection and transmission measurements. Connection quality determines directivity and match which in turn determine measurement accuracy. Poor connector maintenance can cause a connector to wear more quickly than it should, causing a degradation in the performance of the test equipment and the device under test. In fact, poor connection techniques often lead to severe connector damage. The result is frustrating and costly rework of devices and test equipment.

This section of the seminar shows how proper connector care can help you avoid some of these potential problems and get the best performance from your connectors.

There are many coaxial connector families in use today, such as Type-N, 7 mm, 3.5 mm, SMA, BNC, and TNC. Most families have several different versions available. The principles of connector care apply to every connector family. In this presentation, emphasis is placed on the Precision 7 mm and 3.5 mm connectors, as well as SMA.

MICROWAVE CONNECTOR CARE

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CONNECTOR QUALITY DETERMINES

- Measurement Accuracy
- Connector Longevity
- Amount of Repair and Rework Required
- Device Performance

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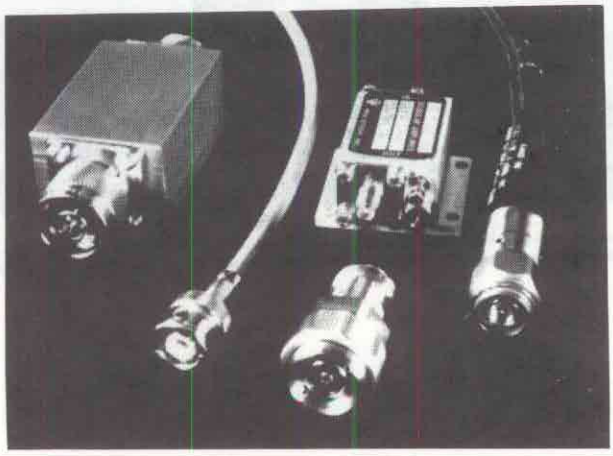
EXISTING CONNECTOR TYPES



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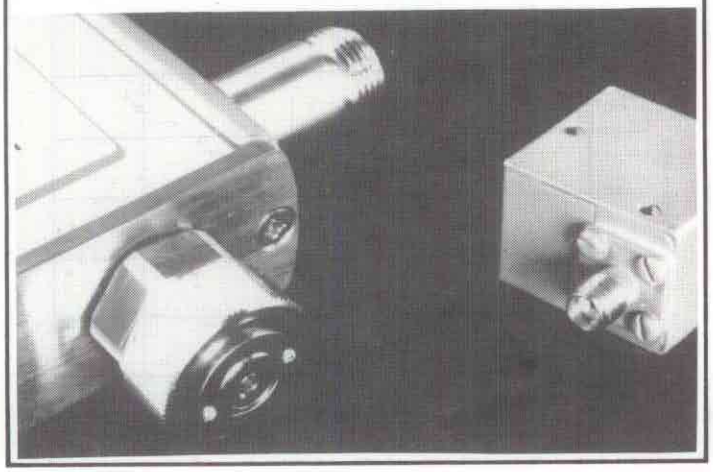
EXAMPLE MEASUREMENT



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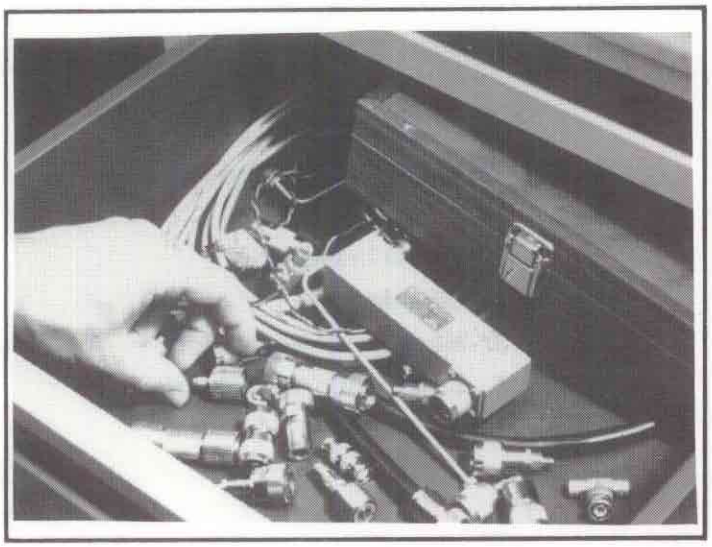
Let's take a look at a measurement example. Suppose we have a brand new directional bridge with a Precision 7 mm test port, and we want to make a reflection measurement on an SMA female device whose connector has been verified to be within its specification. The first thing we need is an adapter.



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We reach into the drawer and pick out the correct adapter, connect up the adapter and proceed with the measurement, right?

NOT SO FAST! What do you know about the condition of that adapter? Chances are, not much. If you just connect the adapter you run the risk of creating many problems for yourself.

(Adapters should not be stored loose in this type of drawer. Always store them in a foam-lined storage case, and always make sure the protective plastic end caps are placed over the ends of the connector.)

ADAPTER COULD

- **Cause Bad Measurement (Poor Directivity, Match)**
- **Destroy Bridge Connector**
  (Repair Cost = approx. $550)
  (Replacement Bridge Cost = $2500)
- **Destroy Device Connector**
  (Repair, Rework)

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First, the adapter may have poor match electrically. This causes a degradation in directivity as we have already discussed. Second, if the adapter is out-of-spec mechanically, it may cause permanent damage to the directional bridge with just one connection by pushing the bridge center conductor back into the bridge. Third, the 3.5 mm side of the adapter may be out-of-spec. When connected to the device under test, the device connector could be damaged.

Shown here is an example of bridge directivity shown before and after one connection to a faulty adapter. The result is more measurement error due to lower directivity. What happened in this case was that the connector center pin was pushed in, causing permanent damage to the bead which supports it. This damage caused the center conductor recession to increase by just 0.002 inches, not a visible change, but one that caused significant degradation in performance.

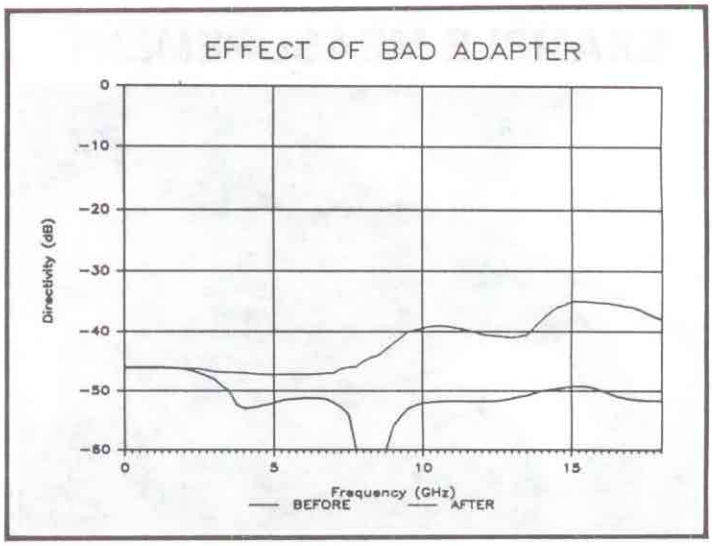
Problems such as the previous example can be avoided only through proper connector care. Shown here are the four basic steps.

Before every connection, connectors should be inspected. Make sure you are grounded to prevent electrostatic damage to the system. Concentrating on the mating surface, check for loose particles, contamination, and corrosion. Check the mating plane for bent or rounded surfaces. Check the connector threads for excessive wear.

Never use a connector that does not look good. A dirty or damaged connector can damage every other connector with which it is mated.

With the 7 mm connector, another visual inspection is also required: the collet test. Not only should the collet be checked for bent or twisted spring contacts, it should also be checked for spring. Press the collet gently with a blunt plastic or wooden rod. When released, the collet should spring back immediately. If there is any problem with the collet, it can be easily removed and replaced.

Two types of center collets exist: 4-slot collets and 6-slot precision collets. The two types are interchangeable, and the 6-slot type is recommended for maximum durability and repeatability of connections.



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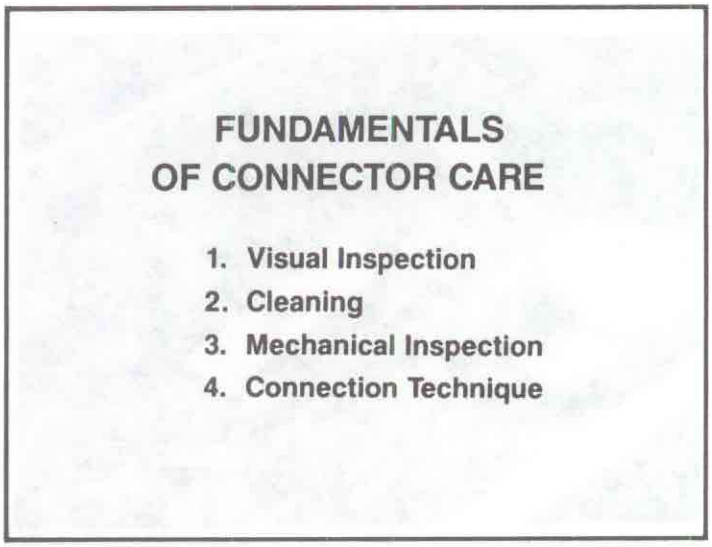

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CLEANING

1. Try Compressed Air First

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When visual inspection shows particles or contaminants on the connector, the connector must be cleaned. First, try a quick blast of clean, dry "compressed air" to blow away dust or other loose particles.

CLEANING

2. Use a Solvent If Necessary

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It may be necessary to clean dirty connectors with a solvent. HP recommends pure liquid Freon for this purpose. Apply to the connector using a cotton swab. Never spray freon directly on the connector, since that will damage the bead inside the connector. Isopropanol can also be used for extremely dirty connectors.

MECHANICAL INSPECTION

- Gage Test Ports and Adapters Periodically
- Gage All Devices Under Test

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The third step to proper connector care is mechanical inspection using a connector gage. Gaging the device to be tested is always highly recommended, particularly SMA devices. A survey carried out by incoming inspection of a California manufacturer showed that over 40% of the components supplied with SMA connectors did not meet their mechanical interface specification.

Also, a weekly check of the bridge test port and adapters is a good practice. Never connect an adapter unless its characteristics are known.

Connector gaging is a two-step process, first the gage is zeroed using a calibration block, then the connector is measured. Detailed instructions on connector gaging are contained in the HP Microwave Connector Care Manual.

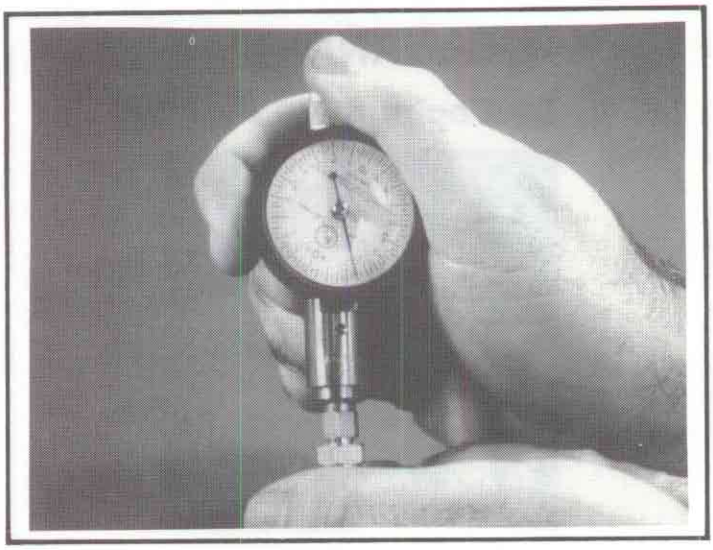
Let's take a look at some example connector specifications.

With the 7 mm connector, the critical dimension for gaging is the distance from the outer conductor mating plane to the center conductor shoulder. Gaging is complicated in the 7 mm case by the collet. For a complete job, one must gage twice, first with the collet removed and then with the collet in place.

The allowable ranges are shown here. Note that with the collet removed no protrusion is allowed. Sometimes, a minimum recession is required. With the collet in place at least 0.002 inches protrusion is required to keep spring tension when mating. Otherwise, the collet must be replaced.

Another example is the 3.5 mm connector. Again, the recession of the center conductor from the outer conductor mating plane is the critical dimension.

With 3.5 mm connectors, no protrusion of the shoulder of the male contact pin or the tip of the female contact fingers is allowed under any conditions. Protrusion is the major cause of connector damage, particularly when mating with SMA connectors. Some SMA connectors may have such a loose tolerance on protrusion, that they can damage a 3.5 mm connector, even though the SMA connector meets its specification. SMA should always be gaged to within the 3.5 mm specification for recession. Recession is tightly specified on HP bridges and standards, but it may be as high as 0.020 inches with loosely toleranced SMA connectors. In this case, no damage will occur, but measurement accuracy and repeatability may be questionable.



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TYPICAL RANGES 7mm

Center Collet Removed

	Recession
Standards	+0.0000 to −0.0005 in
Test Port	−0.0002 to −0.0008 in

Center Collet in Place

	Protrusion
All Connectors	+0.002 to +0.015 in

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TYPICAL RANGES 3.5mm

	Recession
Standards	+0.0000 to −0.003 in
Test Port	−0.0002 to −0.0022 in
Devices Under Test	+0.0000 to −0.003 in (typical)

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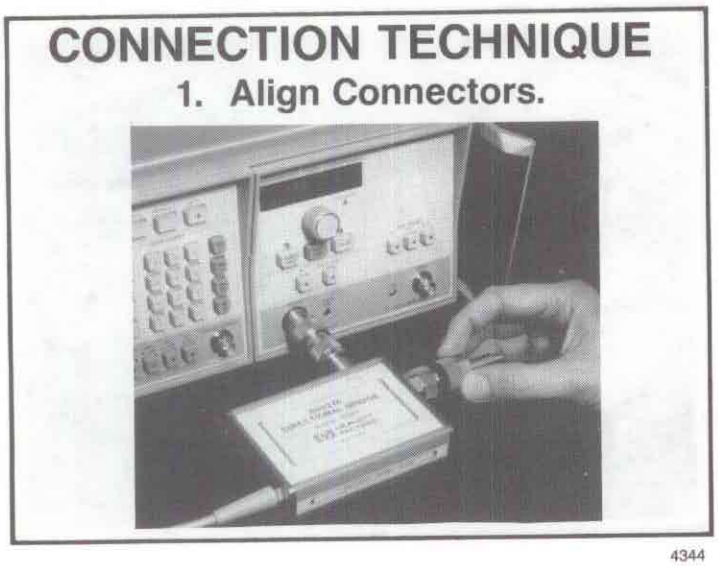

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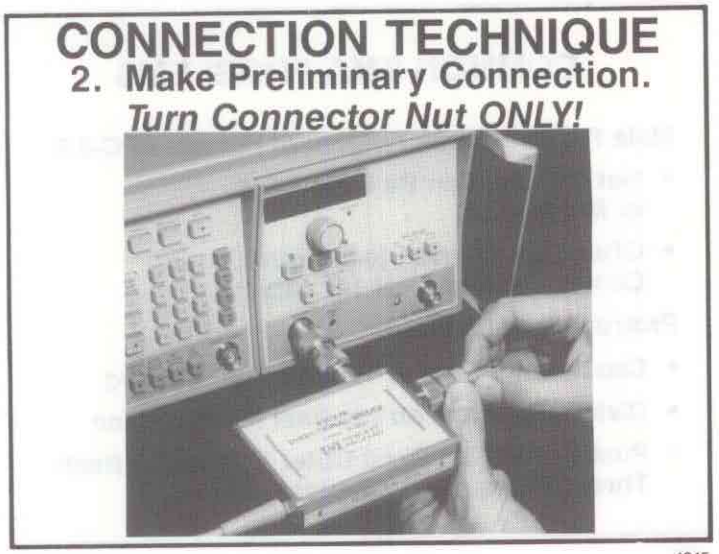
The last part of microwave connector care is proper connection technique. The technique is a three step process. First, align the connectors axially. This is particularly important in the case of sexed connectors, such as 3.5 mm to avoid bending or breaking the contact pins. The center pin on the male connector must fit concentrically into the contact fingers of the female connector, and this requires great care in aligning the two connectors before and as they are mated.



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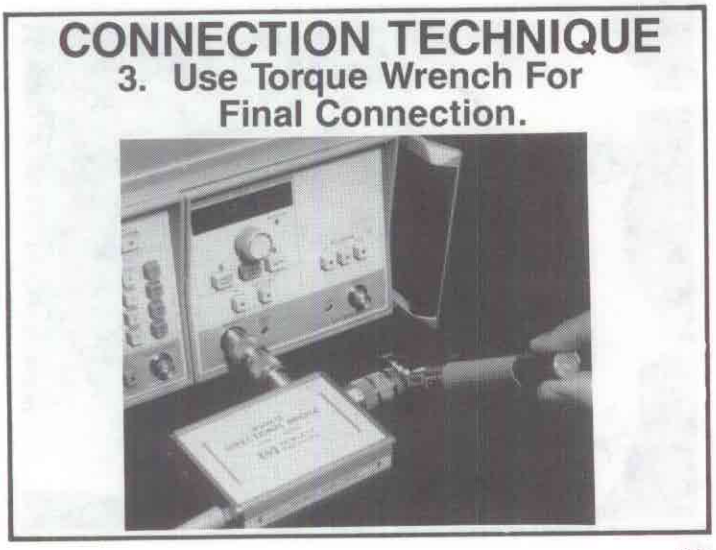
Then turn the connector nut lightly with your fingers to make a preliminary connection. Whenever tightening the connector, be sure to turn the connector nut only, not the connector body. Rotating the connector body, while often easier to do, can damage the center conductors by twisting the fingers of the female center conductor.



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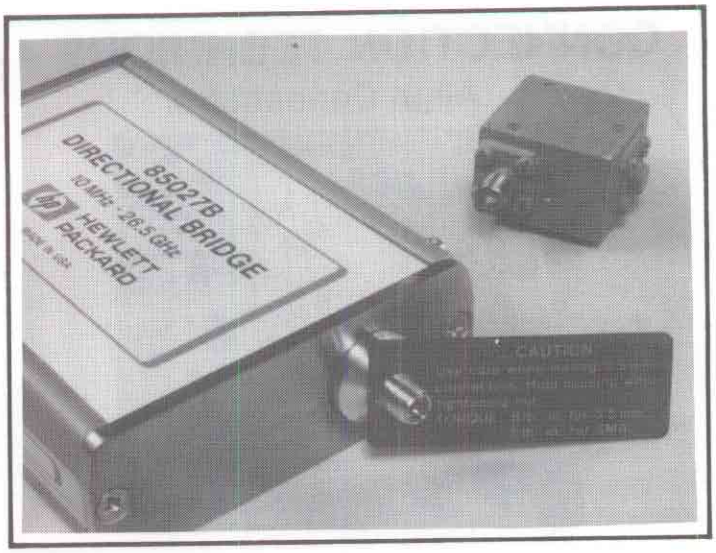
Use a torque wrench for the final connection. Tighten the connection only until the wrench's break point is reached, when the handle gives way at its internal pivot point. Do not tighten the connection further.

Note that for Type-N connectors, no torque wrench can be used, since connections are made by hand.

Extra caution is required when measuring SMA devices, particularly when using APC-3.5 test equipment. Shown here is the HP 85027B directional bridge (APC-3.5) and an SMA device.



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SMA is not a precision connector and is subject to a number of problems. The male pin may not be secure, and as a result can be easily pulled out or misaligned. The male pin can also often have "burrs" or irregularities that have resulted from cutting RG-141 cable, for example. Whenever a male pin has one of these problems, it can easily damage the delicate fingers of the female APC-3.5 connector.

Another common problem with SMA devices is the protrusion of the dielectric past the outer conductor mating plane. This protrusion can occur slowly with simple aging, and is particularly aggravated by temperature cycling. When mated to an APC-3.5 connector, an SMA connector with a protruded dielectric can push the APC-3.5 rigid outer conductor back through the device or test port.

COMMON SMA PROBLEMS

Male Pin Can Break Fingers of Female APC-3.5

- **Not Secure, Can Be Pulled Out or Misaligned**
- **Often Has "Burrs" (e.g. From Cutting Center Conductor of 141 cable)**

Protrusion of Dielectric

- **Caused by Aging or Temperature Cycling**
- **Dielectric Can Protrude Past Mating Plane**
- **Pushes APC-3.5 Rigid Outer Conductor Back Through Device or Adapter**

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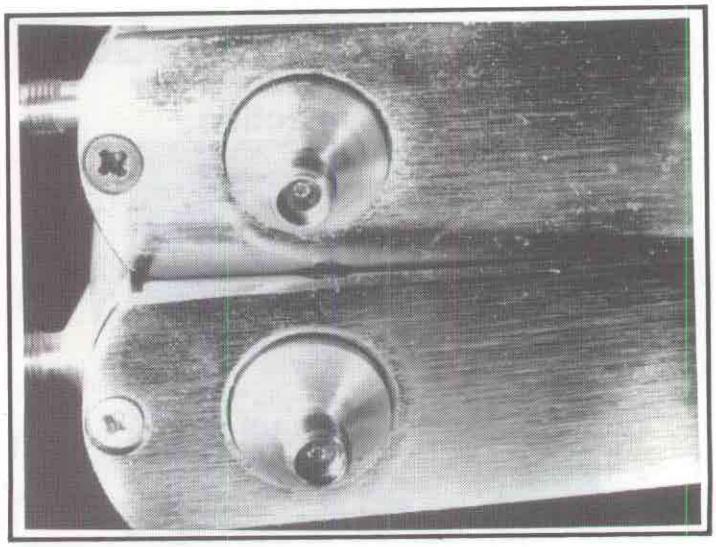
Shown here are two APC-3.5 bridges that have been damaged by being mated to SMA devices that were out-of-spec. The bridge on top has the female center conductor pushed back into the bridge, in this case by an SMA connector with protruding dielectric. The bottom bridge is the victim of a misaligned SMA male connector. Notice that the female fingers have been severely damaged.



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WHEN MATING SMA WITH APC-3.5:

- Always Inspect and Gage SMA Connector
- Only Connect If In-Spec
- Inspect APC-3.5 After Each Connection With SMA
- Use Adapters Whenever Possible, and Check Them Frequently

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Despite all these potential problems, SMA devices can be properly tested with APC-3.5 test equipment as long as the proper care is used. Always inspect and gage the SMA connector and connect it only when it is clean and meets mechanical specifications. After each connection with an SMA device, check the APC-3.5 port for damage. In addition, adapters should be used whenever possible, and they should also be checked frequently.

CONNECTOR SAVERS

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HP offers these dedicated bridge adapters for both male and female 3.5 mm connections. If damage should occur from a connection to an SMA device, then the damage has occurred to the adapter and not to the bridge. These adapters are called connector savers because they can help avoid damage to the connector of the more expensive bridge.

EQUIPMENT REQUIRED

- Cleaning Supplies
  - — Compressed Air
  - — Liquid Freon
  - — Cotton Swabs
- Torque Wrench
- Adapters As Required

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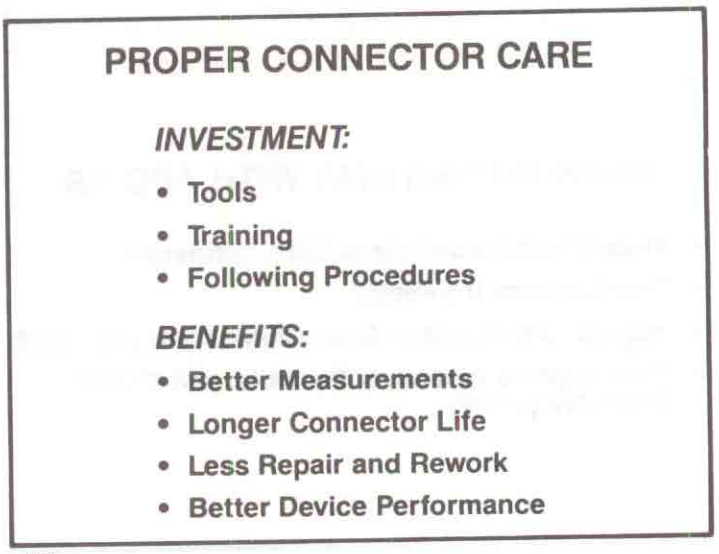
Shown here is a summary of the equipment required for proper connector care.

Connector care requires an small investment in tools and education. The benefits of proper connector care far outweigh the costs. You will make better measurements, connectors will last longer, and devices and test equipment will require less repair and rework.



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