Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

RPC-2.40 Calibration Kit
09CK001-150 and 09CK010-150

09CK001-150

09CK001-150 (Full Version)

09CK010-150 (Industrial Version)

Contents

1. General Information

Calibration Kit Normal Use 1.1
Warnings 1.2
Kit Contents 1.3
Kit Documentation 1.4
Calibration Certificate 1.5

2. Specifications

Environmental Requirements 2.1
Electrical and mechanical Specifications 2.2

3. Standard Definitions

Standard Definitions 3.1
Installation of Standard Definitions 3.2
Standard Definitions file nomenclature 3.3

4. VNA Calibration

VNA Calibration 4.1
Calibration Check 4.2

5. Calibration Kit Service

Calibration interval 5.1
Spare parts 5.2
Where to send a Kit for Re-Calibration / Repair 5.3
Extent of Rosenberger Re-Calibration Services 5.4

6. Use, Maintenance and Care

Connector Care 6.1
Interface Dimensions and Gauging 6.2
Mechanical Specifications 6.3
Handling and Storage 6.4

7. Connections

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

1. General Information

This User Manual is valid for the Calibration Kits

- 09CK001-150 (Full Version)
- 09CK010-150 (Industrial Version)
- Customer specific RPC-2.40 Calibration Kits, excluding Air Line Kits

The Industrial Version does not contain gauges. So all gauge-related chapters are only applicable if additional gauges are available, e.g. Rosenberger 08GK0KS-010 or comparable ones.
For customer specific Calibration Kits all VNA calibration methods may not be available.

1.1 Calibration Kit Normal Use

Calibration Kits are used as an accessory for Vector Network Analyzers (VNA) to perform vector-error correction. Vector-error correction is the process of characterizing systematic errors of the measurement system by measuring known calibration standards, and then mathematically removing the effects of these errors from subsequent measurements. The measurement accuracy of the calibrated VNA depends mainly on the quality of the calibration kit used. Contributing factors are noise, linearity and temperature stability of the VNA, transmission and reflection stability of a test port cable as well as operator experience and care.

VNAs usually offer several techniques for correcting systematic measurement errors. The standards in this calibration kit allow you to perform one-port OSL (OSM) or two-port OSLT (TOSM) and TRM (TMR) calibrations from DC up to 50 GHz for measurements of components with 2.4 mm connectors.

Components with 1.85 mm connector are mechanically compatible and can also be measured but with reduced accuracy.

1.2 Warnings

The calibration standards and the gauges of this calibration kit are mechanically sensitive devices. High accelerations e.g. when falling down will damage them.

Connect the calibration standards only to test ports and other devices that have been cleaned and checked for gauge, concentricity and integrity of the contact fingers. Detailed procedures are described in Chapter 6 and 7.

Tighten the connector coupling nuts to the recommended torque with the torque wrench. Do not over torque!

Consider the power applied to the Load calibration standards. Maximum power limits for the sum of RF and DC power are defined in the specific data sheets.

It is good lab practice to use at least an ESD wrist strap when handling calibration standards or DUTs on a VNA although the calibration standards themselves are not ESD sensitive. Please consult your VNA manual.

Follow further limitations given in the specific data sheets.

Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

1.3 Kit Contents

Table 1-1 Parts of the 09CK001-150 Calibration Kit

Device	Part number	Remarks	Quantity
Open circuit plug	09S12L-000S3		1
Open circuit jack	09K12L-000S3		1
Short circuit plug	09S12S-000S3		1
Short circuit jack	09K12S-000S3		1
Calibration load plug	09S150-C10S3		1
Calibration load jack	09K150-C10S3		1
Calibration adaptor plug/plug	09S121-S20S3		1
Calibration adaptor jack/jack	09K121-K20S3		1
Combi wrench	03W008-000	5 mm, 6 mm, 7 mm, 8 mm, 9 mm	1
Torque wrench	03W021-000	8 mm wrench size / 0.9 Nm torque	1
Gauge jack (including gauge block)	08W00S-000		1
Gauge plug (including gauge block)	08W00K-000		1

Table 1-2 Parts of the 09CK010-150 Calibration Kit

Device	Part number	Remarks	Quantity
Open circuit plug	09S12L-000S3		1
Open circuit jack	09K12L-000S3		1
Short circuit plug	09S12S-000S3		1
Short circuit jack	09K12S-000S3		1
Calibration load plug	09S150-C10S3		1
Calibration load jack	09K150-C10S3		1
Calibration adaptor plug/plug	09S121-S20S3		1
Calibration adaptor jack/jack	09K121-K20S3		1
Combi wrench	03W008-000	5 mm, 6 mm, 7 mm, 8 mm, 9 mm	1
Torque wrench	03W021-000	8 mm wrench size / 0.9 Nm torque	1

1.4 Kit Documentation

- **USB-Stick**
  Standard Definitions as data files for Vector Network Anaylzer Families PNA (Keysight/Agilent) and ZVA (Rohde&Schwarz). Calibration Certificate as PDF-file.
- **Standard Definitions Cards**
  Printed Standard Definitions that can be used on nearly all Vector Network Analyzers.
- **Kit Info Card**
  Handling precautions and information for installing Standard Definitions on a Vector Network Analyzer.
- **Calibration Certificate**
  See chapter Calibration Certificate.
- **User Manual**
  (This document)

1.5 Calibration Certificate

Each calibration kit comes with a calibration certificate. Measurement results and uncertainties for all calibration standards, the Gauges and the Torque Wrench are included.

Standard scope of delivery is the Factory Calibration.

Optional scope of delivery is the Accredited Calibration. In this case the calibration kit is calibrated in a subcontracted calibration laboratory, which is accredited by the German accreditation body DAkkS (Deutsche Akkreditierungsstelle) according to DIN EN ISO 17025. Calibration Certificates issued by an accredited calibration laboratory are accepted worldwide to demonstrate that measurement results are traceable to national / international standards.

Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

2. Specifications

2.1 Environmental Requirements

The electrical performance of vector network analyzers and test port cables are sensitive to ambient temperature drift. Most manufacturers limit the allowable temperature drift to ± 1 K during measurement calibration and during measurements when the network analyser error correction is turned on. For further information please refer to the VNA specifications.

NOTE: With your fingers being a heat source, avoid unnecessarily handling the devices during calibration.

The calibration standards are less sensitive to temperature changes. The operating temperature range for which the specifications are valid is defined in the specific data sheets.

2.2 Electrical and mechanical Specifications

Electrical and mechanical specifications are defined for all calibration standards, gauges and the torque wrench in the specific data sheets.

3. Standard Definitions

3.1 Standard Definitions

Standard definitions provide the data needed to mathematically describe the electrical characteristics of each calibration standard. Two types of standard definitions are available:

- **Model based** (standard delivery): These are the traditional standard definitions and can be used on both old and modern VNAs. The values of these constants are theoretically derived from the physical dimensions and material of each calibration standard, or from actual measured response. All necessary values are printed on the Standard Definition Cards and stored as data files on an USB stick. Both are included with this calibration kit.
- **Data based** (optional): These standard definitions allow more accurate measurements but can only be used on modern VNAs. They consist of a set of complex measurement values for each calibration standard in a narrow frequency step size. A file containing these values for all Open, Short and Load calibration standards is delivered on an USB stick.

These standard definitions are used in the calibration of the VNA to determine the systematic errors of the measurement system. Please always use the most recent source of information (Standard Definitions Cards or VNA specific files).

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

3.2 Installation of Standard Definitions

The standard procedure to install Standard Definitions is to import them from the USB stick onto your VNA. As standard delivery data files for Vector Network Anaylzer Families PNA (Keysight/Agilent) and ZVA (Rohde&Schwarz) are included. Data files for other VNA families are available on request. If the specific data file is not available, the standard definitions have to be installed manually with the provided information from the Standard Definitions Cards.

- **USB-stick**
  The Kit Info Card gives a brief description for the VNAs described above.
  For all others please consult the VNA operating manual.

- **Manual installation**
  The manual installation is a more complex process. Please consult the VNA operating manual.
  Some network analyzers allow a step by step input of the model based standard definitions during the VNA calibration without previously loading them.

- **Updating**
  After a re-calibration the standard definitions are optimized on the basis of the actual measurements.
  Data files have to be imported like described before.
  For a manual update only the values that have changed have to be modified.

3.3 Standard Definitions file nomenclature

The file name includes the calibration kit type, the serial number, the type of standard definitions and the date of calibration. The file extension defines the VNA types the file can be used on. For further Information see the Application Note AN001.

KitType (SN)_StdDef_CalDate.Ext

- KitType 09CK001-150, 09CK010-150 or customized type
- (SN) Serial number (5 character) enclosed by brackets
- StdDef ‘mb’ stands for model based and ‘db’ for data based, refer to 3.1
- CalDate Date of kit calibration, these standard definition relate to
- Ext e.g. ‘ckt’ file can be used on Keysight/Agilent VNAs PNA family and compatible ones

  ‘calkit’ file can be used on Rohde&Schwarz VNAs ZVA, ZVB, ZVBT, ZNB families and compatible ones

Example file name:

09CK001-150 (BH003)_mb_2020-05-30.calkit

4. VNA Calibration

4.1 VNA Calibration

A VNA is only as useful as the accuracy of the measurements it makes, and this requires the instrument to be calibrated. The calibration process employs a technique called vector error correction, in which error terms are characterized using known standards so that errors can be removed from actual measurements. The process of removing these errors requires the errors and measured quantities to be measured vectorially (thus the need for a vector network analyzer).

Main setting parameters:

It is good practice to start your measurement by selecting the main setting parameters.

- Sweep type (linear / logarithmic)
- Sweep range (start frequency / stop frequency)
- Number of points (frequency step size)
- Source power
- IF bandwidth (small IF bandwidth basically increases the dynamic range)
- Sweep time

Connect test port cables and adapters to your VNA as needed for your specific measurement task.

Calibration techniques

A very large number of calibration techniques have been developed to calibrate a VNA. The following list describes calibration techniques you can apply with this calibration kit along with their features and applicability for use in specific situations.

One-port calibration

OSL (OSM) Open-Short-Load (Open-Short-Match)

When only reflection measurements are needed, the fastest and easiest calibration technique is OSL. It requires 3 connections of calibration standards on the reference plane.

Two-port calibrations

OSLT (TOSM) Open-Short-Load-Thru (Thru-Open-Short-Match)

OSLT is the most commonly used two-port calibration method. The Thru connections are performed by using well-known, precision calibration adapters in male-male or female-female configuration or as a direct connection of the male and the female test ports.

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

TRM (7-term) Thru-Reflect-Match

The male and female Short standards of this kit are designed with the same offset length. So the TRM calibration technique can be used. It requires high reflects with a symmetrical reflection during VNA calibration on both test ports. TRM needs less connections during calibration than OSLT and UOSM.

UOSL (SOLR) (7-term) Unknown-Open-Short-Load (Short-Open-Load- Reciprocal)

The UOSM technique is similar to the OSLT calibration but doesn't need well-known adapters. Even a low loss Device under Test (DUT) can be sufficient as Thru standard. The UOSM technique is particularly well suited for calibration involving different connector types at the test ports and is most effective when data based standards are available.

In cases when the two VNA test ports have different connector systems installed, e.g. RPC-2.40 and RPC-2.92 UOSM can handle this situation. A second calibration kit is needed.

Calibration Procedure

The procedures to perform a VNA calibration are very different between the VNA models. Modern VNA often guide you thru the settings and actions. For details please consult the manual of your specific VNA.

4.2 Calibration Check

It is advisable to check the calibration after error correction has been performed, particularly when test port cables and adapters have been used.

During the calibration
- Calibration standards can easily be mixed up
- Connections may not be tightened correctly

There might be defects
- VNA, e.g. mechanically overloaded test port
- Instable test port cables
- Mechanically overloaded load
- Bent or broken contact fingers

With a Verification Kit, reflection and transmission measurements can be checked in a wide frequency range for DUTs with low and high reflections and low and medium insertion loss. Actual measurement values can be compared to reference values delivered with the Verification Kit standards. This should be done from time to time to identify defects.

Air Lines, Precision Adapters and Mismatch Standards can also be used as a faster method for more frequent checks.

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

5. Calibration Kit Service

5.1 Calibration interval

Rosenberger suggests a calibration interval of 12 months. Depending on the frequency of use, the wear and the actual requirements a different calibration interval might be suitable. This lies in the responsibility of the user.

5.2 Spare parts

Each part of this kit can be ordered separately as spare part with reference to the part number shown in Table 1-1 / Table 1-2 and the quantity desired. Telephone or send your order to your local Rosenberger sales office.

5.3 Where to send a Kit for Re-Calibration / Repair

In case of re-calibration or repair contact your local Rosenberger sales office.

5.4 Extent of Rosenberger Re-Calibration Services

Every calibration kit sent for re-calibration or repair the following services are performed

- Cleaning of connector interfaces
- Optical check of connector mating planes, contact pins and contact fingers
- Check of connector gauge for impermissible protrusion and significant recession
- Electrical measurement of all calibration standards
- Measurement of torque wrench torque
- Measurement of gauges
- Issuing of calibration certificates including measurement values and uncertainties
- Individual optimizing of capacitive coefficients C0 to C3 for all Open calibration standards and short inductance coefficients L0 to L3 for all Short calibration standards for best fitted model based standard definitions.

In case of any defect or abnormality a cost estimation will be issued before continuing repair work.

If a calibration standard has to be replaced or modified, the incoming status is additionally reported in the calibration certificate. This service is excluded when this measurement may damage the Rosenberger measurement setup.

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

6. Use, Maintenance and Care

6.1 Connector Care

It is of particular importance to note that mechanical damage can be inflicted on a connector while making a connection or a disconnection.

6.1.1 Connector Cleaning

To ensure a long and reliable connector life, careful and regular inspection of connectors is necessary and cleaning of connectors is essential to maintain good performance.

Connectors should be inspected initially for dents, raised edges, and scratches on the mating surfaces. Connectors that have dents on the mating surfaces will usually also have raised edges around them and will make less than perfect contact; further to this, raised edges on mating interfaces will make dents in other connectors to which they are mated. Connectors should be replaced unless the damage is very slight.

Awareness of the advantage of ensuring good connector repeatability and its effect on the overall uncertainty of a measurement procedure should encourage careful inspection, interface gauging and handling of coaxial connectors.

Prior to use, a visual examination should be made of a connector or adaptor, particularly for concentricity of the centre contacts and for dirt on the mating planes. It is essential that the axial position of the centre contact of all items offered for calibration should be gauged because the adjoining surfaces of mated centre contacts must not touch. If the centre contacts do touch, there could be damage to the connector or possibly to other parts of the device to which the connector is fitted.

Small particles, usually of metal, are often found on the inside connector mating planes and on the threads. They should be removed to prevent damage to the connector surfaces. The items required for cleaning connectors and the procedure to be followed is described below.

6.1.2 Cleaning procedure

Items required:

- Low pressure compressed air (solvent free).
- Cotton swabs.
- Lint free cleaning cloth.
- Isopropanol.
- Illuminated magnifier or microscope (factor 5 to 10)

NOTE: Isopropanol that contains additives should not be used for cleaning connectors as it may cause damage to plastic dielectric support beads in coaxial and microwave connectors. It is important to take all necessary safety precautions when using chemicals or solvents.

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

- Remove loose particles on the mating surfaces and threads etc. using low-pressure compressed air.
- Clean surfaces using Isopropanol on cotton swabs or lint free cloth. Use only sufficient solvent to clean the surface. When using swabs or lint free cloth, use the least possible pressure to avoid damaging connector surfaces. Do not spray solvents directly on to the connector surfaces or use contaminated solvents.
- Use the low-pressure compressed air once again to remove any remaining small particles and to dry the surfaces of the connector to complete the cleaning process before using the connector.

6.1.3 Cleaning connectors on static sensitive devices

Special care is required when cleaning connectors on test equipment containing electrostatic sensitive devices. When cleaning such connectors always wear at least a grounded wrist strap and observe correct procedures.

6.2 Interface Dimensions and Gauging

It is of the utmost importance that connectors do not damage the test equipment interfaces to which they are connected. Poor performance of many coaxial devices and cable assemblies can often be traced to poor construction and non-compliance with the mechanical specifications. The mechanical gauging of connectors is essential to ensure correct fit and to achieve the best performance. This means that all coaxial connectors fitted on all equipment, cables and terminations etc. should be gauged on a regular basis in order to detect any out of tolerance conditions that may impair the electrical performance.

6.2.1 Gauging connectors

A connector should be gauged before it is used for the very first time or if someone else has used the device to which it is connected.
If the connector is to be used on another item of equipment, the connector on the equipment to be tested should also be gauged.
Connectors should never be forced together when making a connection since forcing often indicates incorrectness and incompatibility. There are some dimensions that are critical for the mechanical integrity, non-destructive mating and electrical performance of the connector.
The mechanical gauging of coaxial connectors will detect and prevent the following problems:

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

Inner conductor protrusion

This may result in buckling of the socket contacts or damage to the internal structure of a device due to the axial forces generated.

NOTE: At no time should the pin depth of the connector be protruding.

Inner conductor recession

This will result in poor reflection and possibly unreliable contact.

6.2.2 Gauges

The Rosenberger gauges are of screw-on type in plug and jack version. They can be used to gauge calibration standards as well as test ports, test port cables, adapters and DUTs.

Naming convention:
A “gauge plug” (male) is used to measure a DUT with plug (male) connector. The gauge itself has a jack (female) connector and needs a gauge block with plug (male) connector. For a “gauge jack” (female) all gender are vice versa.

Checking devices for protrusion or excessive recession only a single measurement is sufficient.

More precise measurements or checking devices very close to critical limits should be done in different orientations averaging up to 4 single measurements.

When a gauge block is used to initially adjust the gauge a torque spanner should be used to tighten up the connection to the correct torque.

6.2.3 Connector gauge measurement resolution

Because of connector gauge measurement resolution uncertainties (one small division on the dial) and variations in measurement technique from user to user connector dimensions may be difficult to measure. Dirt and contamination can cause differences of 0.005 mm and, in addition, the way that the gauge is used can result in larger variations. When using a gauge system for mechanical compliance testing of connectors carry out the following procedure each time:

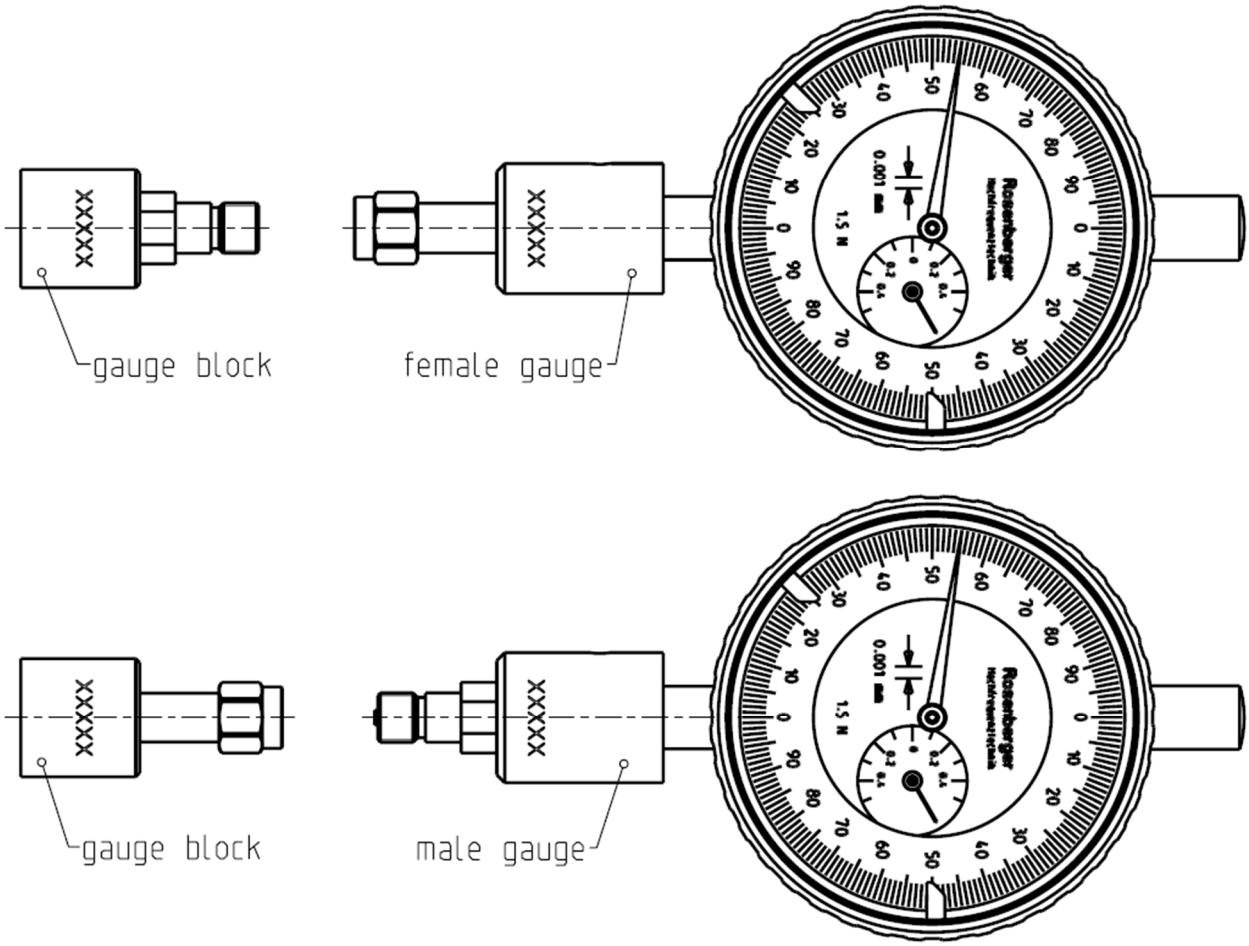
- Carefully inspect the connector to be tested and clean it if necessary.
- Clean and inspect the gauge and the gauge block.
- Carefully zero the gauge with the gauge block in place.
- Remove the gauge block.
- Measure the connector using the gauge and note the reading.
- Repeat the process at least once or more times as necessary.

Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

6.2.4 Gauge blocks

Every connector gauge requires a gauge block that is used to zero the gauge before use. Figure 6-1 shows two sets of gauges and gauge blocks for the 2.4 mm connector.

Figure 6-1 Connector gauges and gauge blocks for the 2.4 mm connector



NOTE: For further Information see user manual 08GK0KS-010

Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

6.3 Mechanical Specifications

Good electrical microwave connections need well-defined mechanical connector dimensions. Pin depth and excentricity of the center conductor have a significant impact on the electrical performance.

Pin depth is the distance the centre conductor mating plane differs from being flush with the outer conductor mating plane (see Figure 6-2). The pin depth of a connector can be in one of two states: either protruding or recessed.

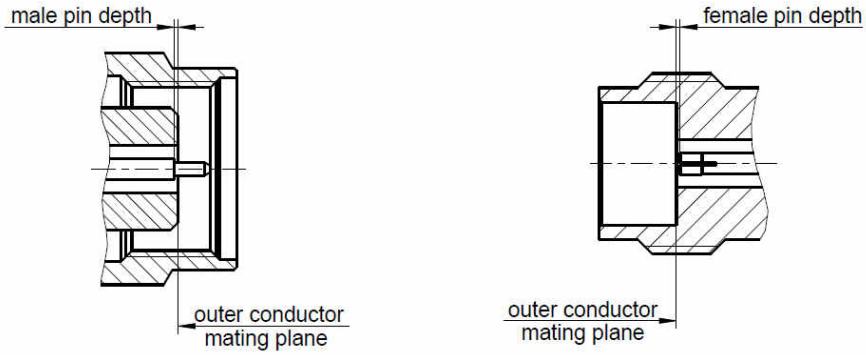
Protrusion is the condition in which the centre conductor extends beyond the outer conductor mating plane. This may result in buckling of the socket contacts or damage to the internal structure of a device due to the axial forces generated.

NOTE: At no time should the pin depth of the connector be protruding.

Recession is the condition in which the centre conductor is set back from the outer conductor mating plane. The amount of unwanted reflections is directly proportional to the pin depth.

Pin depth limits are defined for all calibration standards in the specific data sheets.

Figure 6-2 Connector Pin Depth (recession)



6.4 Handling and Storage

- Install the protective end caps and store the calibration devices in the foam-lined storage case when not in use.
- Never store connectors loose in a box, or in a desk or bench drawer. This is the most common cause of connector damage during storage.
- Keep connectors clean.
- Do not touch mating plane surfaces. Natural skin oils and microscopic particles of dirt are easily transferred to a connector interface and are very difficult to remove.

7. Connections

Good connections require a skilled operator. The most common cause of measurement error is bad connections. The following procedures illustrate how to make good connections.

Making a Connection

The calibration kit comes with a so-called combi-wrench which is a useful tool to make connections. This wrench is made of plastic and helps you to hold the device body and prevent it from rotating while making a connection.

Preliminary Connection

1. Ground yourself and all devices. Always wear a grounded wrist strap and work on a grounded, conductive table mat.

2. Visually inspect the connectors.

3. If necessary, clean the connectors. Refer to 4.1 Connector Care.

4. Use a connector gage to verify that all centre conductors are within the observed pin depth values in Table 2-2. Refer to 4.2 Interface Dimensions and Gaging.

5. Carefully align the connectors. The male connector centre pin must slip concentrically into the contact finger of the female connector.

6. Push the connectors straight together and tighten the connector nut finger tight.

   CAUTION:Do not turn the device body. Only turn the connector nut. Damage to the centre conductor can occur if the device body is twisted.

   Do not twist or screw the connectors together. As the centre conductors mate, there is usually a slight resistance.

7. The preliminary connection is tight enough when the mating plane surfaces make uniform, light contact. Do not overtighten this connection. A connection in which the outer conductors make gentle contact at all points on both mating surfaces is sufficient. Very light finger pressure is enough to accomplish this.

8. Make sure the connectors are properly supported. Relieve any side pressure on the connection from long or heavy devices or cables.

9. Final Connection Using a Torque Wrench

10. Use a torque wrench to make a final connection. Table 4-2 provides information about the torque wrench recommended for use with the calibration kit. A torque wrench is included in the calibration kit.

Dieses Dokument ist urheberrechtlich geschützt • This document is protected by copyright • Rosenberger Hochfrequenztechnik GmbH & Co. KG

How to Separate a Connection

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

CAUTION: Do not turn the device body. Only turn the connector nut. Damage to the centre conductor can occur if the device body is twisted. When disconnecting a sliding load, leave the centre conductor pullback handle in the locked position.

- Use the combi-wrench to prevent the device body from turning.
- Use torque wrench to loosen the connecting nut.
- Complete the separation by hand, turning only the connecting nut.
- Pull the connectors straight apart without twisting, rocking, or bending either of the connectors.

Dieses Dokument ist urheberrechtlich geschützt ● This document is protected by copyright ● Rosenberger Hochfrequenztechnik GmbH & Co. KG

While the information has been carefully compiled to the best of our knowledge, nothing is intended as representation or warranty on our part and no statement herein shall be construed as recommendation to infringe existing patents. In the effort to improve our products, we reserve the right to make changes judged to be necessary.