# Calibration Kit Overview

The Agilent 85050B 7 mm calibration kit is used to calibrate Agilent network analyzers up to 18 GHz for measurements of components with 7 mm connectors.

The standards in this calibration kit allow you to perform simple 1- or 2-port and TRM (thru–reflect–match) calibrations.

This manual describes the 85050B calibration kit and provides replacement part numbers, specifications, and procedures for using, maintaining, and troubleshooting the kit.

## Kit Contents

The 85050B calibration kit includes the following items:

- user's and service guide
- open, short, broadband load, lowband load, and a sliding load termination
- 7 mm gage set
- 3/4 in, 135 N-cm (12 in-lb) torque wrench for use on the 7-mm connectors

Refer to Table 6-1 on page 6-2 for a complete list of kit contents and their associated part numbers.

### Opens and Shorts

The opens and shorts are built from parts that are machined to the current state-of-the-art in precision machining.

The shorts have a one-piece shorting plane that combines the inner and outer conductors. The construction provides for extremely repeatable connections.

The opens have a low-dielectric collet depressor that is flush with the outer conductor.

Both the opens and shorts are constructed so that the pin depth can be controlled very tightly, thereby minimizing phase errors. The lengths of the offsets in the opens and shorts are designed so that the difference in phase of their reflection coefficients is approximately 180 degrees at all frequencies.

### Broadband Load

The broadband load is a metrology-grade termination that has been optimized for performance up to 18 GHz. The rugged internal structure provides for highly repeatable connections. A distributed resistive element on sapphire provides excellent stability and return loss. The broadband load is a valid substitute for a lowband load.

### Sliding Loads

The sliding loads in this kit are designed to provide excellent performance from 3 GHz to 18 GHz. The inner and outer conductors of the airline portion are precision machined to state-of-the-art tolerances. Although the sliding load has exceptional return loss, its superior load stability qualifies it as a high-performance device.

The sliding load was designed with the ability to extend the inner conductor for connection purposes and then pull it back to a preset pin depth. This feature is critical since it minimizes the possibility of damage during the connection, while maintaining a minimum pin depth to optimize performance.

## Calibration Definitions

The calibration kit must be selected and the calibration definitions for the devices in the kit installed in the network analyzer prior to performing a calibration.

The calibration definitions can be:

- resident within the analyzer
- manually entered from the front panel

Class assignments and standard definitions may change as more accurate model and calibration methods are developed. You can download the most recent class assignments and standard definitions from Agilent's Calibration Kit Definitions Web page at www.na.tm.agilent.com/pna/caldefs/stddefs.html.

Refer to your network analyzer user's guide or embedded Help for instructions on manually entering calibration definitions, selecting the calibration kit, and performing a calibration.

**NOTE** The 8510 network analyzer is no longer being sold or supported by Agilent. However, you can download the 8510 class assignments and standard definitions from Agilent's Calibration Kit Definitions Web page at www.na.tm.agilent.com/pna/caldefs/stddefs.html

## Equipment Required but Not Supplied

Connector cleaning supplies and various electrostatic discharge (ESD) protection devices are not supplied with the calibration kit but are required to ensure successful operation of the kit. Refer to Table 6-1 on page 6-2 for ordering information.

# Incoming Inspection

Refer to "Kit Contents" on page 1-2 to verify a complete shipment. Use Table 1-1 to record the serial numbers of all serialized devices in your kit.

Check for damage. The foam-lined storage case provides protection during shipping. If the case or any device appears damaged, or if the shipment is incomplete, refer to "Contacting Agilent" on page 5-4. Agilent will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company. See "Returning a Kit or Device to Agilent" on page 5-3.

# Serial Numbers

A serial number is attached to this calibration kit. The first four digits followed by a letter comprise the serial number prefix; the last five digits are the suffix, unique to each calibration kit.

## Recording the Device Serial Numbers

In addition to the kit serial number, the devices in the kit are individually serialized (serial numbers are labeled onto the body of each device). Record these serial numbers in Table 1-1. Recording the serial numbers will prevent confusing the devices in this kit with similar devices from other kits.

**Table 1-1 Serial Number Record for the 85050B**

| Device | Serial Number |
|---|---|
| **Calibration kit** | ______________________ |
| Broadband load | ______________________ |
| Lowband load | ______________________ |
| Open | ______________________ |
| Short | ______________________ |
| Sliding load | ______________________ |
| Connector gage | ______________________ |
| Gage master | ______________________ |

# Calibration Kits Documented in This Manual

This manual applies to any 85050B calibration kit whose serial number is listed on the title page. If your calibration kit has a different serial number prefix, refer to the "Calibration Kit History" section below for information on how this manual applies.

## Calibration Kit History

This section describes calibration kits with serial number prefixes lower that the ones listed on the title page.

### 85050B Kits with Serial Prefix 3027A

These calibration kits did not have a calibration definitions disk to support the Agilent 8510C network analyzer. The part numbers provided in this manual are the recommended replacement parts for these kits. The devices in these kits should meet the specifications published in this manual.

# Preventive Maintenance

The best techniques for maintaining the integrity of the devices in the kit include:

- routine visual inspection
- cleaning
- proper gaging
- proper connection techniques

All of these are described in Chapter 3 , "Use, Maintenance, and Care of the Devices." Failure to detect and remove dirt or metallic particles on a mating plane surface can degrade repeatability and accuracy and can damage any connector mated to it. Improper connections, resulting from pin depth values being out of the observed limits (see Table 2-2 on page 2-5) or from bad connection techniques, can also damage these devices.

# When to Calibrate

A network analyzer calibration remains valid as long as the changes in the systematic error are insignificant. This means that changes to the uncorrected leakages (directivity and isolation), mismatches (source match and load match), and frequency response of the system are small (<10%) relative to accuracy specifications.

Change in the environment (especially temperature) between calibration and measurement is the major cause in calibration accuracy degradation. The major effect is a change in the physical length of external and internal cables. Other important causes are dirty and damaged test port connectors and calibration standards. If the connectors become dirty or damaged, measurement repeatability and accuracy is affected. Fortunately, it is relatively easy to evaluate the general validity of the calibration. To test repeatability, remeasure one of the calibration standards. If you can not obtain repeatable measurements from your calibration standards, maintenance needs to be performed on the test port connectors, cables and calibration standards. Also, maintain at least one sample of the device under test or some known device as your reference device. A verification kit may be used for this purpose. After calibration, measure the reference device and note its responses. Periodically remeasure the device and note any changes in its corrected response which can be attributed to the test system. With experience you will be able to see changes in the reference responses that indicate a need to perform the measurement calibration again.

# 2 Specifications

# Environmental Requirements

### Table 2-1 Environmental Requirements

| Parameter | Limits |
|---|---|
| Temperature | |
| Operating[a] | +20 °C to +26 °C |
| Storage | –40 °C to +75 °C |
| Error-corrected range[b] | ± 1 °C of measurement calibration temperature |
| Relative humidity | Type tested, 0% to 95% at 40 °C, non-condensing |

a. The temperature range over which the calibration standards maintain conformance to their specifications.
b. The allowable network analyzer ambient temperature drift during measurement calibration and during measurements when the network analyzer error correction is turned on. Also, the range over which the network analyzer maintains its specified performance while correction is turned on.

## Temperature—What to Watch Out For

Changes in temperature can affect electrical characteristics. Therefore, the operating temperature is a critical factor in performance. During a measurement calibration, the temperature of the calibration devices must be stable and within the range shown in Table 2-1.

**IMPORTANT** Avoid unnecessary handling of the devices during calibration because your fingers are a heat source.

# Mechanical Characteristics

Mechanical characteristics such as center conductor protrusion and pin depth are *not* performance specifications. They are, however, important supplemental characteristics related to electrical performance. Agilent Technologies verifies the mechanical characteristics of the devices in the kit with special gaging processes and electrical testing. This ensures that the device connectors do not exhibit any center conductor protrusion or improper pin depth when the kit leaves the factory.

"Gaging Connectors" on page 3-6 explains how to use gages to determine if the kit devices have maintained their mechanical integrity. Refer to Table 2-2 on page 2-5 for typical and observed pin depth limits.

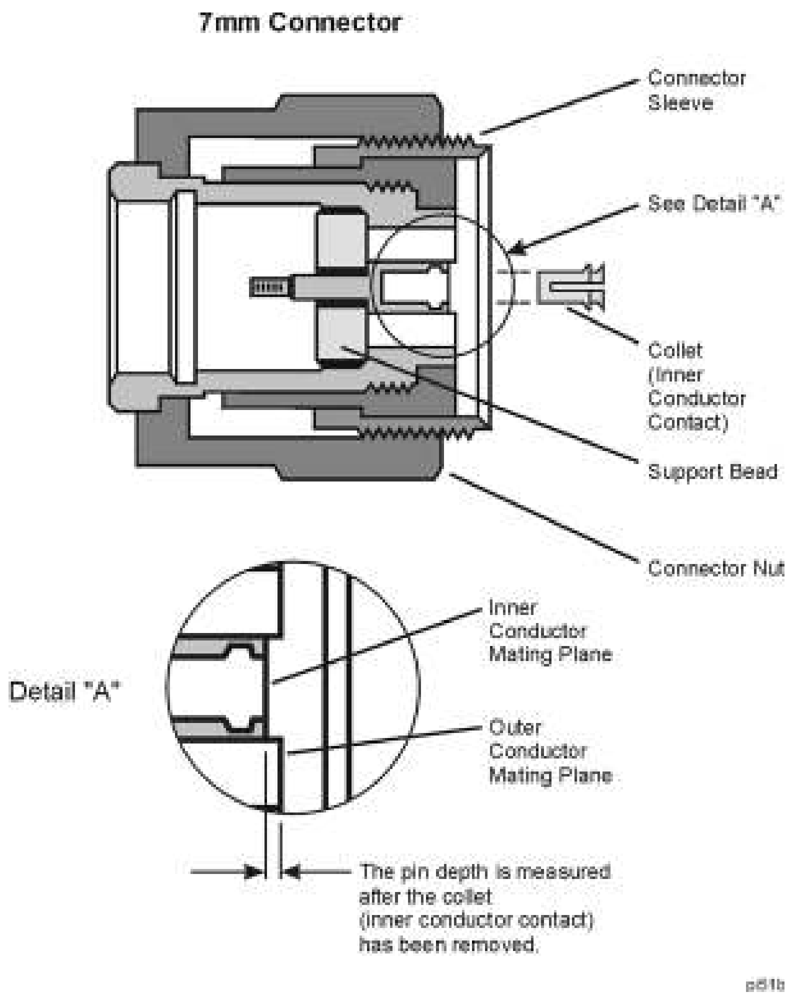
## Pin Depth

Pin depth is the distance the center conductor mating plane differs from being flush with the outer conductor mating plane. See Figure 2-1. The pin depth of a connector can be in one of two states: either protruding or recessed.

**Protrusion** is the condition in which the center conductor extends beyond the outer conductor mating plane. This condition will indicate a positive value on the connector gage.

**Recession** is the condition in which the center conductor is set back from the outer conductor mating plane. This condition will indicate a negative value on the connector gage.

### Figure 2-1 Connector Pin Depth



The pin depth value of each calibration device in the kit is not specified, but is an important mechanical parameter. The electrical performance of the device depends, to some extent, on its pin depth. The electrical specifications for each device in the kit take into account the effect of pin depth on the device's performance. Table 2-2 lists the typical pin depths and measurement uncertainties, and provides observed pin depth limits for the devices in the kit. If the pin depth of a device does not measure within the *observed* pin depth limits, it may be an indication that the device fails to meet electrical specifications. Refer to Figure 2-1 for a visual representation of proper pin depth (slightly recessed).

### Table 2-2 Pin Depth Limits

| Device | Typical Pin Depth micrometers ($10^{-4}$ inches) | Measurement Uncertainty[a] micrometers ($10^{-4}$ inches) | Observed Pin Depth Limits[b] micrometers ($10^{-4}$ inches) |
|---|---|---|---|
| Opens | 0 to –12.7<br>(0 to –5.0) | +10.2 to –10.2<br>(+ 4.0 to –4.0) | +10.2 to –22.91<br>(+ 4.0 to –9.0) |
| Shorts | 0 to –5.1<br>(0 to –2.0) | +6.4 to –6.4<br>(+ 2.5 to –2.5) | +6.4 to –11.4<br>(+ 2.5 to –4.5) |
| Broadband loads | 0 to –7.62<br>(0 to –3.0) | +4.1 to –4.1<br>(+ 1.6 to –1.6) | +4.1 to –11.7<br>(+ 1.6 to –4.6) |
| Lowband loads | -5 to –63.5<br>(-2 to –25.0) | +4.1 to –4.1<br>(+ 1.6 to –1.6) | -0.9 to –67.6<br>(-0.4 to –26.6) |
| Sliding loads | 0 to –7.6<br>(0 to –3.0) | +4.1 to –4.1<br>(+ 1.6 to –1.6) | +4.1 to –11.1<br>(+ 1.6 to –4.6) |

a. Approximately +2 sigma to –2 sigma of gage uncertainty based on studies done at the factory according to recommended procedures.
b. Observed pin depth limits are the range of observation limits seen on the gage reading due to measurement uncertainty. The depth could still be within specifications.

**NOTE** When measuring pin depth, the measured value (resultant average of three or more measurements) is *not* the true value. Always compare the measured value with the observed pin depth limits in Table 2-2 to evaluate the condition of device connectors.

# Electrical Specifications

The electrical specifications in Table 2-3 apply to the devices in your calibration kit when connected with an Agilent precision interface.

### Table 2-3 Electrical Specifications for 85050B 7 mm Devices

| Device | Specification | Frequency (GHz) |
|---|---|---|
| Lowband loads | ≥ 52 dB Return loss | dc to 2 GHz |
| Broadband loads | ≥ 38 dB Return loss | dc to 18 GHz |
| Sliding loads[a] | ≥ 52dB Return loss | dc to 18 GHz[b] |
| Short[c] (collet style) | ± 0.2° from nominal | dc to 2 GHz[d] |
| | ± 0.3° from nominal | 2 to 8 GHz[d] |
| | ± 0.5° from nominal | 8 to 18 GHz[d] |
| Open[c] (with collet pusher) | ± 0.3° from nominal | dc to 2 GHz[d] |
| | ± 0.4° from nominal | 2 to 8 GHz[d] |
| | ± 0.6° from nominal | 8 to 18 GHz[d] |

a. Assuming proper usage, the specifications for the residual return loss after calibration for the sliding load termination include:
  - the quality of the airline portions within the sliding load, combined with
  - the effective stability of the sliding element.

  Proper usage includes the following practices:
  - Connector mating surfaces are clean.
  - The changes in slide positioning are NOT done in equal steps since this results in very poor calibration for some portions of the frequency range.
  - The center conductor of test port connectors are nominally set back from the outer conductor.
    Sliding loads are designed to allow the center conductor to be moved. The position of the sliding load center conductor should be set by a reference block and not positioned flush against the center conductor of the test port.

b. The ratio of center conductor diameter to outer conductor diameter is selected from the mechanical tolerance range to meet electrical specifications.

c. The specifications for the opens and shorts are given as allowed deviation from the nominal model as defined in the standard definitions.

d. Nominal, in this case, means the electrical characteristics as defined by the calibration definitions downloaded from the Web at http:na.tm.agilent.com/pna/caldefs/stddefs.html