Keysight 86207A
75 Ohm Directional Bridge

Operating and
Service Manual

KEYSIGHT
TECHNOLOGIES

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- www.keysight.com/find/assist
  (worldwide contact information for repair and service)

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1 General Information

This manual contains information for operating, testing, and servicing 86207A bridge.

Manual Overview

Product description

86207A is a high performance 75Ω directional bridge designed for high quality reflection measurements and external source leveling applications over an RF frequency range of 300 kHz to 6 GHz. The bridge achieves a low through loss of 1.5 dB and a high coupling factor of 16 dB. These characteristics make it useful in applications requiring directional couplers, such as power monitoring and closed-loop leveling applications.

Instruments covered by this manual

Each bridge has a unique serial number. The contents of this manual apply directly to bridges with serial numbers.

Specifications & Supplemental Characteristics

Table 1-1 lists bridge specifications, which are the performance standards or limits against which you can test the device.

Table 1-2 lists supplemental (typical, non-warranted) bridge characteristics.

Table 1-1 86207A specifications

Characteristic	Value
Connector	75Ω precision type-N female
Frequency range	300kHz to 3 GHz
Directivity	
– >30 dB	300 kHz to 5 MHz
– >40 dB	5 MHz to 1.3 GHz
– >35 dB	1.3 GHz to 2 GHz
– >30 dB typical	2 to 3 GHz
Port match	
– >20 dB (1.22 SWR)	300kHz to 1.3 GHz
– >18 dB (1.29 SWR)	1.3 to 2 GHz
– > 18 dB typical (1.29 SWR)	2 to 3 GHz

Table 1-2 86207A supplemental characteristics

Characteristic	Value
Nominal through loss	1.5 dB +0.1 dB/GHz
Through loss deviation	±0.2 dB from nominal
Nominal coupling factor – 0.3 MHz to 3 GHz	 16 dB + 0.15 dB/GHz
Coupling factor deviation – 0.3 MHz to 3 GHz – 3 GHz to 6 GHz	 ±0.2 dB from nominal ±0.4 dB from nominal
Max input power	+25 dBm
Max Input voltage – port 1 or port 2 – port 3	 30 VDC 0 VDC
Max input current	1 amp DC[a]
Connector recession[b]	0.204 in to 0.207 in[c]
Weight – net – shipping	 0.57 kg (1.3 lbs) 1.80 kg (4.0 lbs)
Dimensions	160W x 93H x 23D (mm) 6.3W x 3.7H x 1D (in)

[a] Below 1 MHz, directivity and port match will be slightly degraded above 200 mA bias current.

[b] Recession refers to a female type-N connector center conductor dimension.

[c] Before you performance test an HP 86207A bridge, gage all the connectors and enter the results in the test record at the end of "Performance Tests."

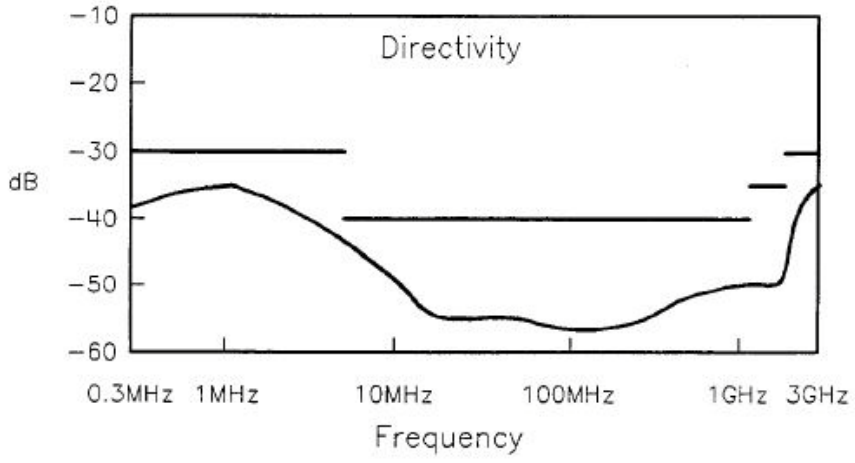

Figure 1-1 Example plot of 86207A directivity

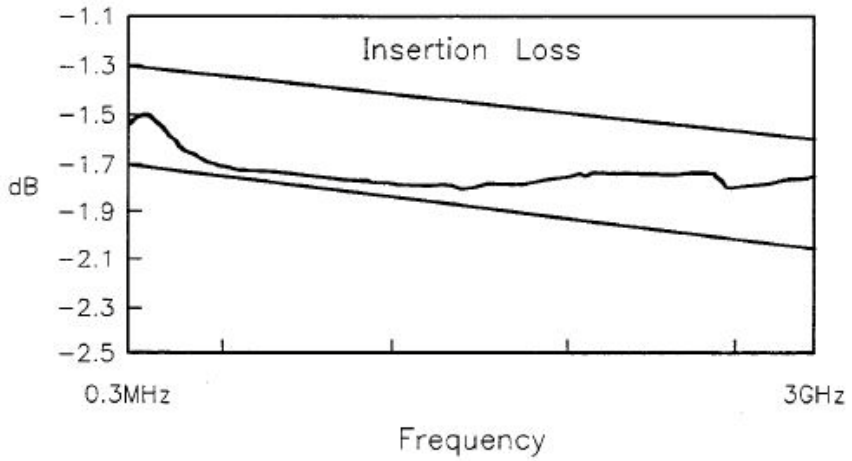

Figure 1-2 Example plot of 86207A insertion loss

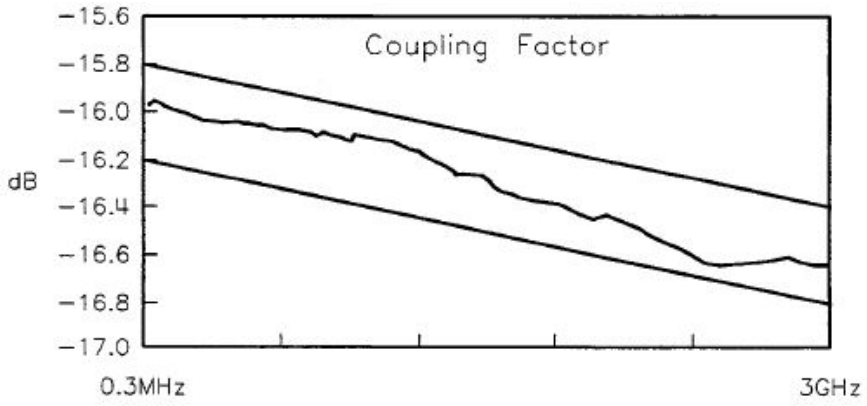

Figure 1-3 Example plot of 86207A coupling factor

Initial Inspection

1. Check the shipping container and packaging material for damage.
2. Check the shipment for completeness.
3. Check the connectors and bridge body for mechanical damage.
4. Check the bridge electrically.
   Refer to the Chapter 3, "Performance Tests" for procedures that check the bridge electrically.

If any of the following conditions exist, notify your nearest Keysight office:

- incomplete shipment
- mechanical damage or defect
- failed electrical test

If you find damage or signs of stress to the shipping container or the cushioning material, keep them for the carrier's inspection. Keysight does not wait for a claim settlement before arranging for repair or replacement.

2 Operation

Overview

This chapter includes the following information on Keysight 86207A directional bridge:

- bridge operation
- bridge features
- operating precautions
- measurement configurations

Bridge Operation

Table 2-1 and Figure 2-1 illustrate the bridge operation. The table shows the port orientation in a reflection measurement and in a power monitoring or leveling configuration. The figure identifies the paths and ports of the bridge and shows the electrical characteristics of each path.

Table 2-1 Port orientation with corresponding application

Part number	Application	
	Reflection measurement	Power monitoring/leveling
1	Test port	Input
2	Input port	Output
3	Coupled	Coupled level

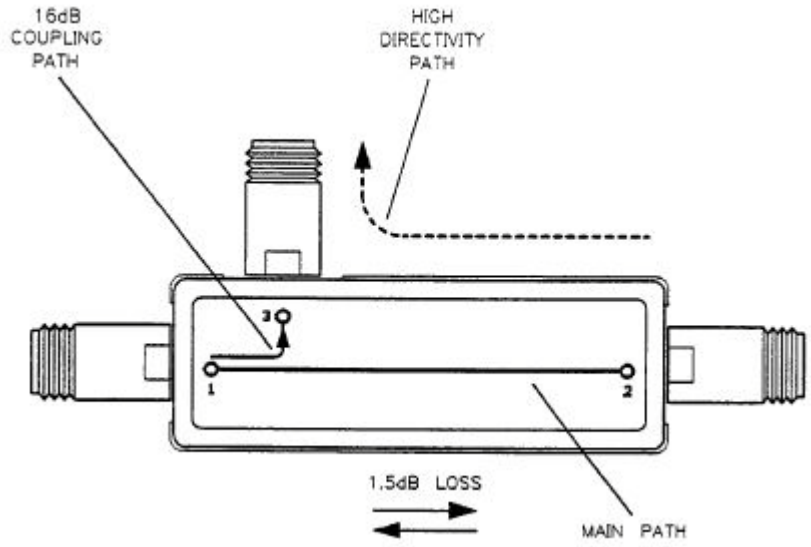

Figure 2-1 86207A bridge ports and measurement paths

Bridge Features

- Frequency range from 300kHz to 3 GHz
- High directivity
- Insertion loss of 1.5 dB (nominal)
- Coupled arm flatness of ±0.2 dB from nominal

86207A operates over an RF frequency range of 300 kHz to 3 GHz and has excellent directivity for high quality reflection measurements. Additionally, the bridge has a very low insertion loss of 1.5 dB which means more power to the device under test; this is especially important in the measurement of high power solid state amplifiers and TWTs. The bridge also features a ±0.2 dB flatness from the nominal 16 dB coupled arm. This capability is valuable in external leveling applications where a power meter or diode detector is used to level the power remotely from the source. Power variations are then minimized, which is important when measuring input-sensitive devices.

CAUTION DC bias may be applied to a DUT through the main arm of the bridge. (**DO NOT** apply bias to the coupled port of the bridge.)

Threaded mounting holes (3.5 mm x 0.5 mm) are located under pre-punched holes in the model number label, as shown in Figure 2-2. Since the bridge package is brass, appropriate caution must be taken to avoid damaging the threaded holes.

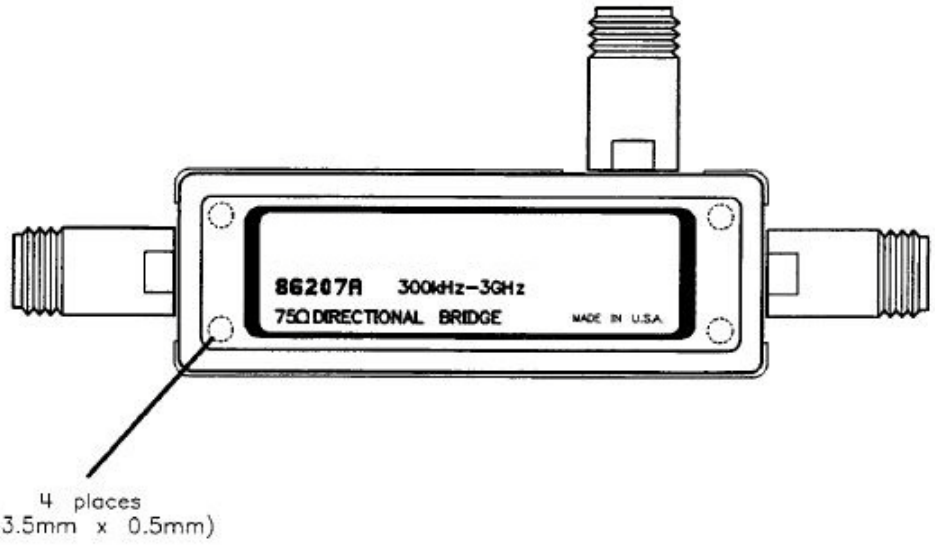

Figure 2-2 Location of threaded mounting holes

Operating Precautions

- Read and observe all cautions.
- Tighten the bridge connectors with fingers only.
- If you must use a wrench, use a torque wrench set at 9.2 cm-kg (12 lb-in).

CAUTION

Electrostatic discharge (ESD) can damage the highly sensitive microcircuits in this device; an ESD as low as 1000V can destroy your bridge.

ESD damage occurs most often as you connect or disconnect a device. Use the bridge at a static-safe workstation and wear a grounding strap. *Never* touch the input connector center contacts, or the contact pins of a connecting cable.

Do *not* apply > +25 dBm RF CW power, or > 1 amp DC or > 0 VDC to port 3 or > 30 VDC to port 1 or 2 of the bridge. Higher current/power/voltage can electrically damage the bridge.

Before you connect a cable to the bridge, always discharge the cable's center conductor static electricity to instrument-ground.

Severe damage to the bridge will result if you connect 50Ω type-N connectors to 75Ω ports.

Do not drop the bridge or subject it to mechanical shock.

Measurement Configurations

This section shows 86207A directional bridge in the following configurations:

- remote reflection measurement using 8711 network analyzer
- vector impedance measurement using two bridges and 8753 network analyzer
- external power leveling with or without a controller
- reflection measurement using a spectrum analyzer and tracking generator

Remote reflection measurement configuration

You can use remote sensing in applications where your DUT is not easily accessible. For example: when measuring the reflection coefficient of an antenna that is located on a tower.

To set up the measurement

1 Connect the equipment as shown in Figure 2-3.

NOTE **The cable length from the analyzer source to the bridge does not affect directivity, but may affect source match. However, you may put an attenuator between the cable and bridge to improve source match.**

Connect the DUT either directly to the bridge or as close as possible.

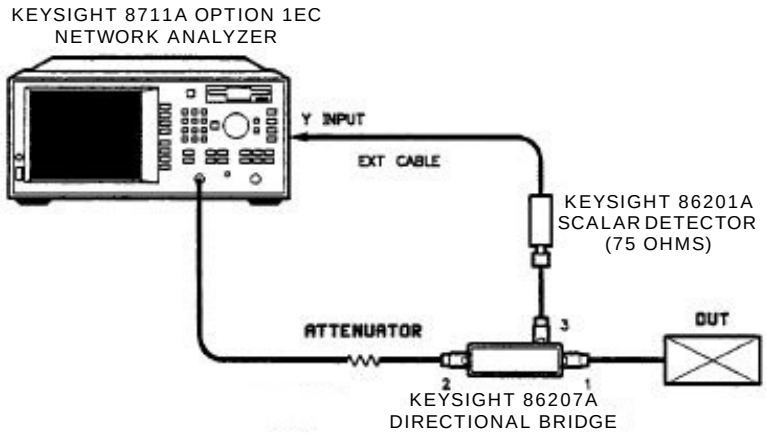

Figure 2-3 Remote directivity measurement setup

2 Set the parameters on the analyzer to measure with an external detector by pressing:

CHAN 1, Det Options, Broadband External, Y/R*

3 With nothing connected to the bridge, make a normalization of the measurement setup by pressing:

CAL, Normalize

4 Connect the DUT to the bridge and adjust the scale/division under the **SCALE** key.

Vector impedance measurement configuration

This configuration provides a low-cost custom test system when full 2-port measurements are not needed.

To set up the measurement

1 Connect the equipment as shown in Figure 2-4.

NOTE You may connect the analyzer input signal to either the A or B input port. Use an A/R or B/R ratio measurement to improve the source match.

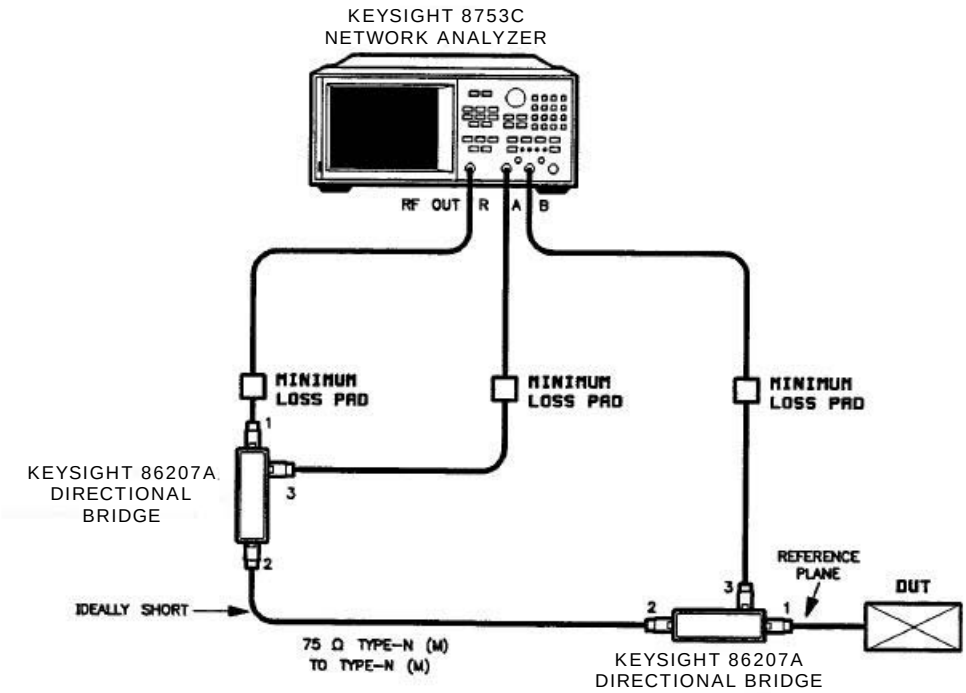

Figure 2-4 Vector impedance measurement setup

2 Choose the following parameters on the analyzer:

PRESET

MEAS, A/R (or **B/R** if you connected the analyzer input signal to the B input port)

MENU, POWER then enter the power value and press **x1**

NUMBER OF POINTS then enter the desired number

START then enter the start frequency and press **x1**

STOP then enter the stop frequency and press **x1**

3 Make a measurement calibration by pressing one of the following key sequences:

CAL

Cal Kit, N 75Ω, Modify 75Ω

Define Standard, 8, x1

Open CF, 33, x1, Std Done

Kit Done, Save User Kit

Return, Calibrate menu

RESPONSE, connect *either* an open or short calibration device to the reference plane and press the corresponding **OPEN (F)** or **SHORT (F)** key.

or

CAL, Cal Kit, N 75Ω, Modify 75Ω

Define Standard, 8, x1

Open CF, 33, x1, Std Done

Kit Done, Save User Kit

Return, Calibrate menu

(for A/R) **S11 1-PORT**

(for B/R) **S22 1-PORT**

Connect an open, short, and load calibration device to the reference plane while pressing the corresponding key for measurement.

4 Connect the DUT to the reference plane and adjust the scale/division under the **SCALE REF** key.

External power leveling configuration

The measurement configuration shown in Figure 2-5 provides precision power levels to a remote DUT. With a power meter and bridge, the source power can be monitored and automatically adjusted.

8360A is used in the following example. Either 8753 or 8625 sources can also be used in this automated measurement configuration.

By substituting a frequency counter for the power meter, this configuration can be used for signal monitoring.

To set up the measurement

1 Connect the equipment as shown in Figure 2-5.

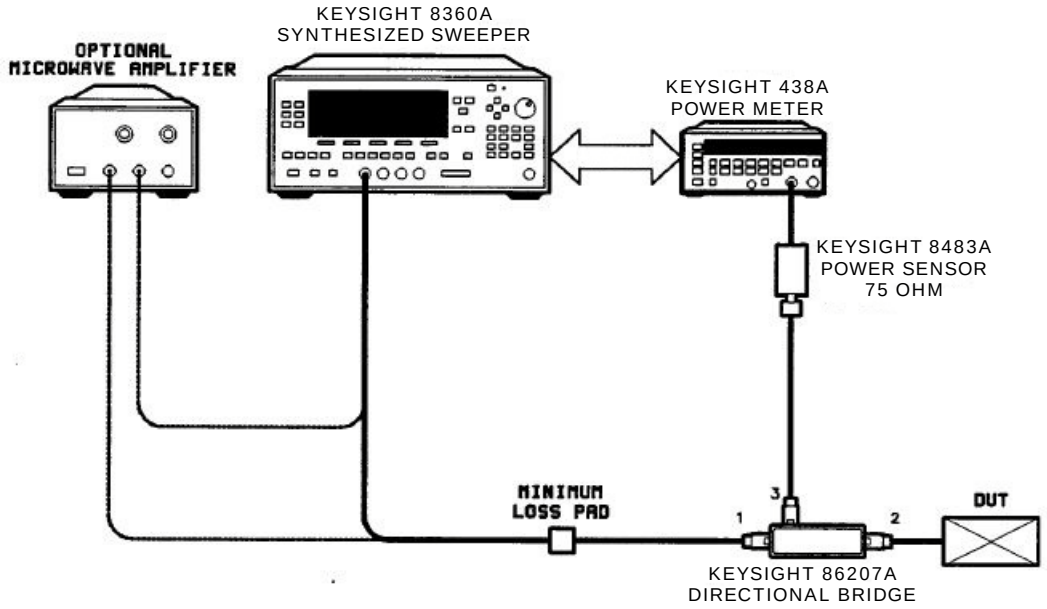

Figure 2-5 External power leveling configuration

2 Zero and calibrate the power meter/sensor.

3 Enter the appropriate power sensor calibration factors into the power meter (can only be done with 438A or 437B) or manually set the calibration factors for an 436A.

4 Enable the power meter/ sensor cal factor array. For operating information on the power meter refer to its operating manual.

5 Connect the power sensor to the bridge as shown in Figure 2-5.

6 Set up the synthesizer parameters by pressing:

PRESET

START then enter the desired start frequency

STOP then enter the desired stop frequency

7 Set up the user flatness correction by pressing:

MENU, Fltness Menu

Delete Menu, Delete All

PRIOR

Auto Fill Start and entered the desired start frequency value

Auto Fill Stop and entered the desired stop frequency value

Auto Fill Incr and entered the desired increment frequency value

8 Set the power meter under synthesizer control to perform the sequence of steps necessary to generate the correction information at each frequency point by pressing:

Mtr Meas Menu, Measure Corr All

9 When a message is displayed, indicating the operation is complete, apply the flatness correction array to your measurement setup by pressing:

FLTNESS ON/OFF (the amber LED should be on)

The power produced at the point where the power meter/sensor was disconnected is now calibrated at the frequencies and power level specified above.

10 On 8360, press:

ALC, Leveling Point ExtDet

11 Set the coupling factor by pressing:

Coupling Factor, -14.5, dB(m)

NOTE The 16 dB coupling factor is partially compensated by the through loss (1.5 dB) to give a 14.5 dB effective coupling factor (relative to the bridge output port).

The bridge coupling flatness has as good as 0.1 dB/GHz power level roll-off with <±0.2 dB error.

Reflection measurement configuration

This configuration is for portable reflection measurement applications.

To set up the measurement

1 Connect the equipment as shown in Figure 2-6.

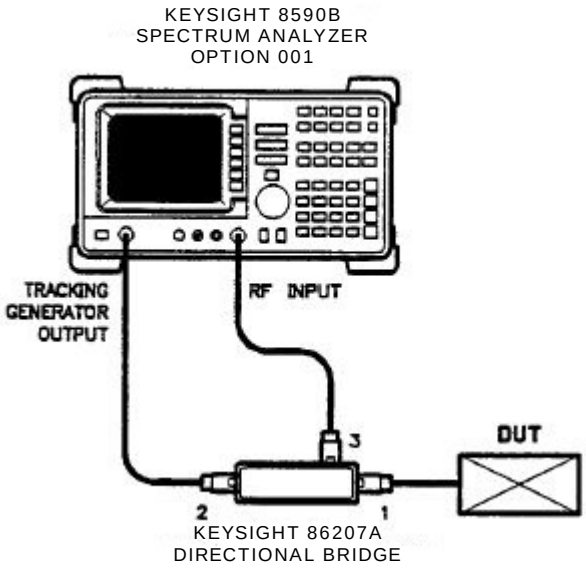

Figure 2-6 Reflection measurement setup

2 On the tracking generator, press:

AUX CTRL

TRACK GEN, SRC PWR ON

3 Set the desired center frequency and span to view the DUT.

4 Replace the DUT with a short circuit.

5 Normalize the trace by pressing:

TRACE

TRACE B, CLEAR WRITE B

BLANK B, MORE 1 OF 3, NORMALIZE ON

The normalized trace or flat line represents 0 dB return loss.

6 Measure the DUT by connecting it to port 1 of the bridge.Terminate the second port of a two-port DUT.

7 Press **MKR** and position the marker with the front panel knob to measure the return loss at the frequency of interest.

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3 Performance Tests

Introduction

Use the procedures in this chapter to test the bridge's electrical performance. None of the tests require you to access the interior of the bridge. The procedures, and an explanation of what they check, are listed below.

- The functional test checks the bridge's typical operation.
- The return loss test verifies that the bridge operates within the return loss specification.
- The directivity test verifies that the bridge operates within the directivity specification.

Performance test record

Record the results of the performance tests on the test record that is located at the end of this chapter.

Tables are also provided for recording the results of the functional test and connector pin depth measurements.

Function Test

The functional test confirms your bridge is operating correctly. The procedure checks the nominal insertion loss and coupling of the bridge.

Recommended equipment

Table 3-1 Recommended equipment for function test

Equipment	Recommended model
Network analyzer	8753C (or 8753A with 85046A)
S-parameter test set	85046A or 85047A
75Ω type-N (m) load	909E
75Ω type-N cable (m)-(f)	part number 8120-2409
Adapters 7 mm to type-N (m) 2 each	11525A
Adaprer 75Ω type-N (f)-(f)	p/n 1250-1529 or 85036-60014 (part of 85036B)
Minimum loss pad 2 each	11852B

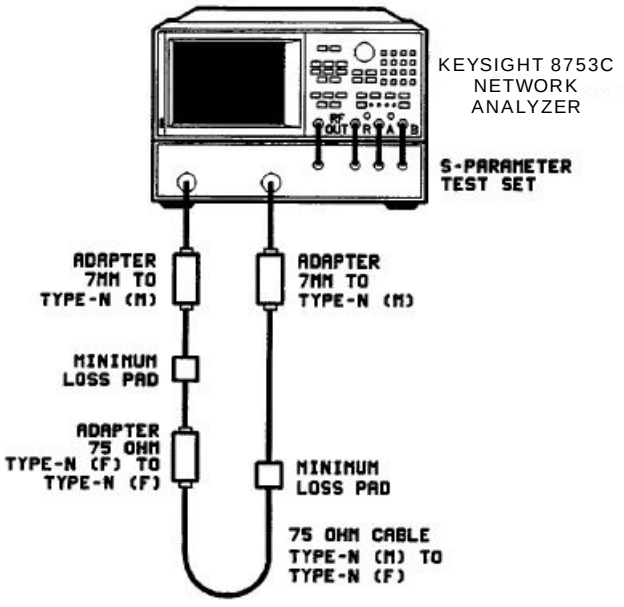

Figure 3-1 Equipment setup for a thru measurement calibration

1 Connect the equipment as shown in Figure 3-1.

2 To perform a thru measurement calibration, press the following keys on 8753.

PRESET

MEAS, S21

CAL, CALIBRATE MENU

RESPONSE, THRU, DONE:RESPONSE

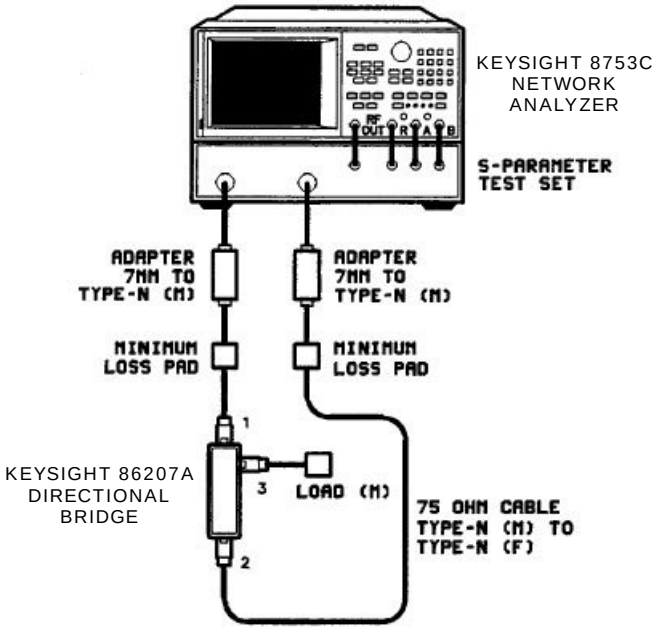

Figure 3-2 Equipment setup for insertion loss measurement

3 Connect the equipment as shown in Figure 3-2.

4 To measure the insertion loss, press the following keys.

SCALE, 1, x1

MKR FCTN, MARKER SEARCH, MAX

The insertion loss shown on the display should be between 0 and 3 dB. Write the maximum insertion loss on the test record located at the end of this chapter.

5 Press **MIN** to find the minimum value and record it also.

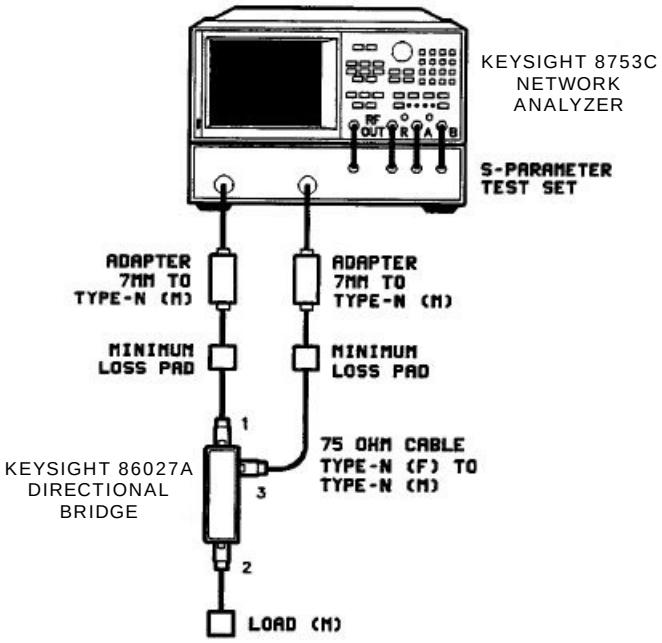

Figure 3-3 Equipment setup for coupling loss measurement

6 Connect the equipment as shown in Figure 3-3.

7 To measure the coupling loss, press the following keys.

SCALE, 5, x1

MKR FCTN, MARKER SEARCH, MAX

The value should be between -14 dB and -18 dB. Write the maximum coupling loss on the test record located at the end of this chapter.

8 Press **MIN** to find the minimum value and record it also.

In case of failure

Check connectors for damage. Clean and gage connectors.

Verify that the calibration kit devices are within their tolerances. Check adapters and cables to make sure that they are not broken.

Return Loss Test

Recommended equipment

Table 3-2 Recommended equipment for return loss test

Equipment	Recommended model
Network analyzer	8753C (or 8753A with 85046A)
S-parameter test set	85046A or 85047A
75Ω type-N calibration kit	85036B
75Ω type-N (m) load	909E
Minimum loss pad	11852B
Adapters 7 mm to type-N (m)	11524A (p/o 85032B)

Procedure

1 Set the IF bandwidth to 100 Hz and select S22 as the measurement parameter, by pressing the following keys on 8753:

PRESET

MEAS, S22

AVG, IF BW, 100, x1

2 Set the stop frequency to 1.3 GHz and select a log frequency sweep, by pressing:

STOP, 1.3, G/n

MENU, TRIGGER MENU, SINGLE

MENU, SWEEP TYPE MENU, LOG FREQ

3 Set the power to 20 dBm, by pressing:

MENU

POWER, 20, x1

4 Perform a one-port calibration on port 2, by pressing:

CAL

CAL KIT, N 75 ohm

RETURN, CALIBRATE MENU, S22 1-PORT

5 When prompted, connect the standards as shown in Figure 3-4.

NOTE When measuring the open and short devices, select OPEN (m) and SHORT (m) on the analyzer. The selection must correspond to the test port, *not* the device being measured. When connecting the open, connect center conductor extender FIRST, then connect the outer conductor.

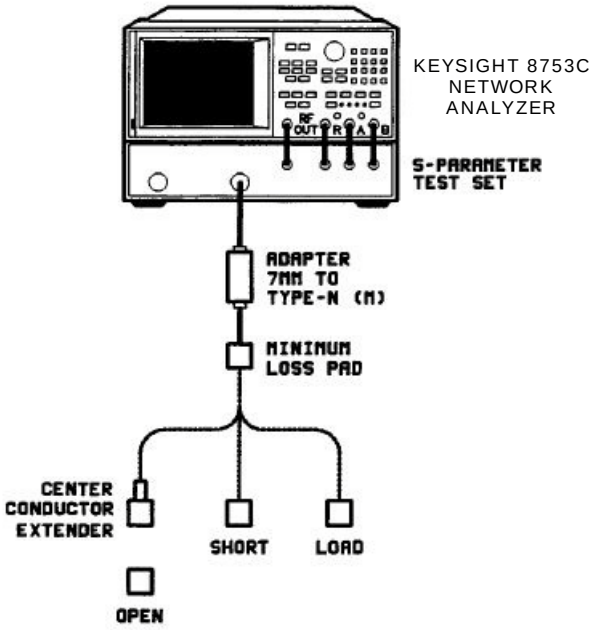

Figure 3-4 Equipment setup for a 522 1-port measurement calibration

6 Save the calibration in a register by pressing:

SAVE, REG 1

7 On channel 2, set a linear frequency sweep from 1.3 to 2 GHz, by pressing:

CH2

MEAS, S22

MENU, COUPLED CH OFF

SWEEP TYPE MENU, LIN FREQ

START, 2, G/n

STOP, 3, G/n

8 Repeat steps 4 and 5 to perform a one-port calibration on port 2.

9 Save the calibration in a register by pressing:

SAVE, REG 2

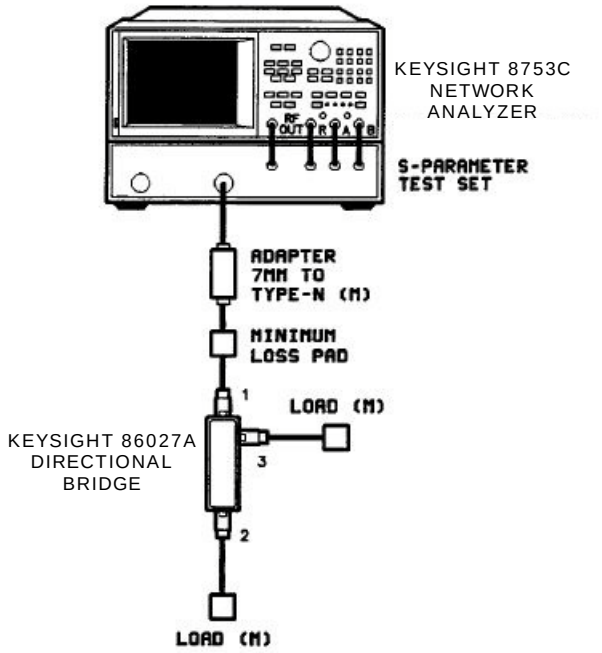

Figure 3-5 Equipment setup for return loss measurement on port 1

10 Connect the equipment as shown in Figure 3-5 to measure the return loss.

NOTE Do not use a female load with a type-N adapter, since an adapter has poor return loss and may affect the measurement.

11 Trigger a new sweep, by pressing:

CHI

MENU, MEASURE RESTART

12 Find the worst-case return loss from 300 kHz to 1.3 GHz, by pressing:

MKR FCTN

MARKER SEARCH, MAX

Write the value on the test record located at the end of this chapter.

13 Trigger a new sweep, by pressing:

CH2

MENU, MEASURE RESTART

14 Find the worst-case return loss from 1.3 to 2 GHz, by pressing:

MKR FCTN

MARKER SEARCH, MAX

Write the value on the test record located at the end of this chapter.

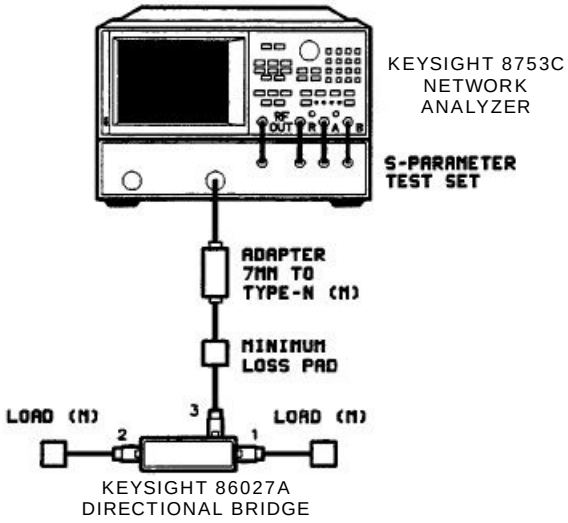

Figure 3-6 Equipment setup for return loss measurement on port 3

15 Connect the equipment as shown in Figure 3-6 and repeat steps 11 through 14 to find the return loss on port 3.

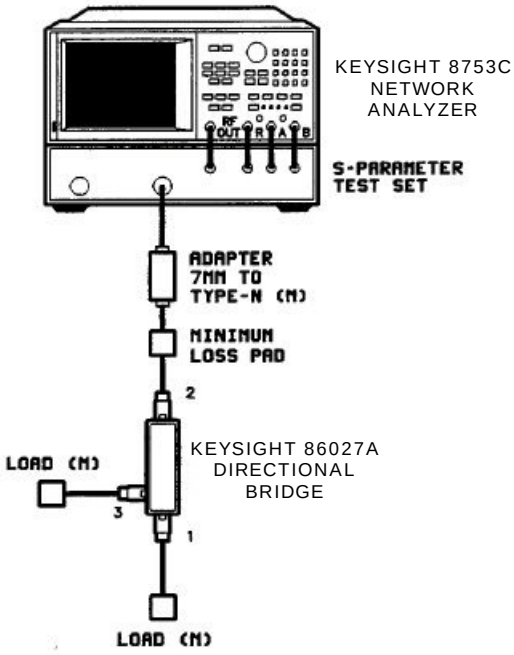

Figure 3-7 Equipment setup for return loss measurement on port 2

16 Connect the equipment as shown in Figure 3-7 and repeat steps 11 through 14 to find the return loss on port 2.

In case of failure

Check connectors for damage. Clean and gage connectors.

Verify that the calibration kit devices are within their tolerances. Check adapters and cables to make sure that they are not broken.

Directivity Test

Recommended equipment

Table 3-3 Recommended equipment for directivity test

Equipment	Recommended model
Network analyzer	8753C (or 8753A with 85046A)
S-parameter test set	85046A or 85047A
75Ω type-N calibration kit	85036B
75Ω type-N (m) load	909E
Adapters 7 mm to type-N (m)	11524A (p/o 85032B)
Minimum loss pad 2 each	11852B
50Ω type-N cable	p/n 8120-4781

Procedure

1. Switch the RF output to port 2 on the test set to prevent the test set from switching the test port power during the calibration, by pressing:

   PRESET

   MEAS, S12

   INPUT PORTS, A/R

2. Set the IF bandwidth to 30 Hz and the analyzer power to 20 dBm, by pressing:

   AVG

   IF BW, 30, x1

   MENU

   POWER, 20, x1

3. Put the analyzer into hold mode and move the reference line up so that the data trace can be seen, by pressing:

   RETURN, TRIGGER MENU, HOLD

   SCALE/REF

   REFERENCE POSITION, 8, x1

4. Set up a log frequency sweep from 300 kHz to 1.3 GHz, by pressing:

   STOP, 5, G/n

   MENU

   SWEEP TYPE MENU, LOG FREQ

5 Make a S22 one-port calibration (to calibrate A/R, even though test port appears to be port 2), by pressing:

CAL

CAL KIT, N 75 ohm, Modify N 75Ω

DEFINE STANDATD, 8, x1

OPEN CΦ, 33, x1, STD DONE

RETURN, CALIBRATE MENU, S22 1-PORT

6 6.When prompted, connect the calibration devices to port 1 of the bridge as shown in ***<xref DIRECT>: undefined*** (measure the load last).

NOTE

When measuring the open and short devices, select OPEN (f) and SHORT (f) on the analyzer. The selection made must correspond to the test port *not* the device being measured.

Measure the open and short circuit devices; then measure the load.

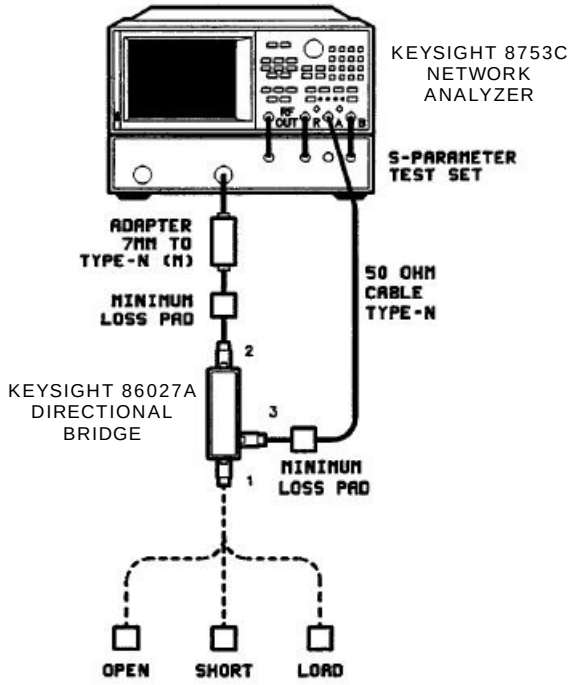

Figure 3-8 Equipment setup for S22 1-port measurement calibration

7 Load the frequency response error term into memory when the calibration is done, by pressing:

SYSTEM

SERVICE MENU, TESTS

34, x1, EXECUTE TEST

DISPLAY, DATA/MEM

CAL, CORRECTION OFF

The resulting display is the uncorrected load data (the last measurement taken during the calibration), normalized to the frequency response of the system.

8 Find the worst-case directivity value of the first two specified ranges (300kHz to 5 MHz and 5 MHz to 1.3 GHz), by pressing:

MKR FCTN

MARKER SEARCH, MAX

Identify which specified range the marker search found as worst case and write the directivity value in the test record located at the end of this chapter.

9 Use the front panel knob to measure the worst case directivity value in the other specified range. Write this value in the test record.

10 Set up a linear frequency sweep from 1.3 GHz to 2 GHz, by pressing:

START, 1.3, G/n

STOP, 2, G/n

MENU, SWEEP TYPE MENU, LIN FREQ

11 Repeat steps 5 through 8.

In case of failure

Check connectors for damage. Clean and gage connectors.

Verify that the calibration kit devices are within their specifications. Check adapters and cables to make sure that they are not broken.

Test Facility _____ Report Number _____

_____ Date _____

_____ Customer _____

_____ Tested by _____

Model _____ Ambient temperature _____ °C

Serial Number _____ Relative humidity _____ %

Options _____ Line frequency _____ Hz (nominal)

Functional Test Performed_____

Special Notes

_____

_____

Test Equipment Used	Model Number	Trace Number	Cal Due Date
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____
7. _____	_____	_____	_____
8. _____	_____	_____	_____

Figure 3-9 86207A test record (1 of 3)

Specifications

Serial Number:	Report Number:		Date:
Test Description	**Minimum Value**	**Measured Results**	**Measurement Uncertainty[1]**
Return Loss			
300 kHz to 1.3 GHz			
Port 1	20 dB	_____	±0.79 dB
Port 2	20 dB	_____	±0.79 dB
Port 3	20 dB	_____	±0.79 dB
1.3 GHz to 2 GHz			
Port 1	18 dB	_____	±0.67 dB
Port 2	18 dB	_____	±0.67 dB
Port 3	18 dB	_____	±0.67 dB
Directivity			
300 kHz to 5 MHz	30 dB	_____	±1.60 dB
5 MHz to 1.3 GHz	40 dB	_____	±6.22 dB
1.3 GHz to 2 GHz	35 dB	_____	±3.00 dB

Figure 3-10 86207A test record (2 of 3)

The measurement uncertainty is quoted for these performance tests using only the recommended models specified at the beginning of each test. The measurement uncertainty quoted represents limits of ±3 times the equivalent standard deviation (3σ) and is intended to represent a 99% confidence level.

Serial Number _____ Report Number _____

_____ Date _____

Functional Test (Typical Operation)
Data Record

Characteristic	Nominal Values		Measured Values	
	Minimum	Maximum	Minimum	Maximum
Insertion Loss	0 dB	3 dB	_____	_____
Coupling Loss	−14 dB	−18 dB	_____	_____

Typical Connector Pin Depths
Data Record

Connector Pin Depth	Minimum Value	Measured Results	Maximum Value
Port 1	0.204 in	_____	0.207 in
Port 2	0.204 in	_____	0.207 in
Port 3	0.204 in	_____	0.207 in

Figure 3-11 86207A test record (3 of 3)

4 Maintenance

Mating Connectors

Table 1-2 lists connector mechanical tolerances. The *Microwave Connector Care Manual* (part number 08510-90064) provides information on the proper maintenance, inspection, and gaging of connectors.

CAUTION **When tightening a connector, do not apply more than 9.2 cm-kg (12 lb-in) of torque. Greater torque can deform the mating surfaces.**

Environment

Operate the bridges only in environments within the limits listed. Storage and shipment environments must meet the conditions shown.

Table 4-1 Environmental requirements

Parameter	Required values/ranges
Temperature	
– Operating	0 to +55 °C
– Storage and shipment	-25 to +75 °C
Humidity	
– Operating	Up to 95%. Protect the bridge from temperature extremes, which can cause condensation.
– Storage and shipment	Up to 95%. Protect the bridge from temperature extremes, which can cause condensation.
Altitude	
– Operating	Up to 7,620m (25,000 feet)
– Storage and shipment	Up to 7,620m (25,000 feet)

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