RIGOL

DNA5000 Series

Vector Network Analyzer

Performance Verification Guide

Jan.2026

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Section	Description	Page

1 Safety Requirement

1.1 General Safety Summary

Please review the following safety precautions carefully before putting the instrument into operation so as to avoid any personal injury or damage to the instrument and any product connected to it. To prevent potential hazards, please follow the instructions specified in this manual to use the instrument properly.

- **Use Proper Power Cord.**

  Only the exclusive power cord designed for the instrument and authorized for use within the local country could be used.

- **Ground the Instrument.**

  The instrument is grounded through the Protective Earth lead of the power cord. To avoid electric shock, it is essential to connect the earth terminal of the power cord to the Protective Earth terminal before connecting any inputs or outputs.

- **Observe All Terminal Ratings.**

  To avoid fire or shock hazard, observe all ratings and markers on the instrument and check your manual for more information about ratings before connecting the instrument.

- **Use Proper Overvoltage Protection.**

  Ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise, the operator might be exposed to the danger of an electric shock.

- **Do Not Operate Without Covers.**

  Do not operate the instrument with covers or panels removed.

- **Do Not Insert Objects Into the Air Outlet.**

  Do not insert anything into the holes of the fan to avoid damaging the instrument.

- **Use Proper Fuse.**

  Please use the specified fuses.

- **Avoid Circuit or Wire Exposure.**

  Do not touch exposed junctions and components when the unit is powered on.

- **Do Not Operate With Suspected Failures.**

  If you suspect damage occurs to the instrument, have it inspected by RIGOL authorized personnel before further operations. Any maintenance, adjustment or

replacement especially to circuits or accessories must be performed by RIGOL authorized personnel.

- **Provide Adequate Ventilation.**

  Inadequate ventilation may cause an increase of temperature in the instrument, which would cause damage to the instrument. So please keep the instrument well ventilated and inspect the air outlet and the fan regularly.

- **Do Not Operate in Wet Conditions.**

  To avoid short circuit inside the instrument or electric shock, never operate the instrument in a humid environment.

- **Do Not Operate in an Explosive Atmosphere.**

  To avoid personal injuries or damage to the instrument, never operate the instrument in an explosive atmosphere.

- **Keep Instrument Surfaces Clean and Dry.**

  To avoid dust or moisture from affecting the performance of the instrument, keep the surfaces of the instrument clean and dry.

- **Prevent Electrostatic Impact.**

  Operate the instrument in an electrostatic discharge protective environment to avoid damage induced by static discharges. Always ground both the internal and external conductors of cables to release static before making connections.

- **Use the Battery Properly.**

  Do not expose the battery (if available) to high temperature or fire. Keep it out of the reach of children. Improper change of a battery (lithium battery) may cause an explosion. Use the RIGOL specified battery only.

- **Handle with Caution.**

  Please handle with care during transportation to avoid damage to keys, knobs, interfaces, and other parts on the panels.

WARNING

Equipment meeting Class A requirements may not offer adequate protection to broadcast services within residential environment.

1.2 Safety Notices and Symbols

Safety Notices in this Manual:

WARNING

Indicates a potentially hazardous situation or practice which, if not avoided, will result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation or practice which, if not avoided, could result in damage to the product or loss of important data.

Safety Notices on the Product:

- **DANGER**

  It calls attention to an operation, if not correctly performed, could result in injury or hazard immediately.

- **WARNING**

  It calls attention to an operation, if not correctly performed, could result in potential injury or hazard.

- **CAUTION**

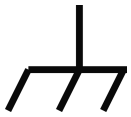
  It calls attention to an operation, if not correctly performed, could result in damage to the product or other devices connected to the product.

Safety Symbols on the Product:

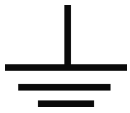
Hazardous Voltage

Safety Warning

Protective Earth Terminal



Chassis Ground



Test Ground

2 Document Overview

This manual guides users to perform tests on the technical specifications of RIGOL DNA5000 series vector network analyzer. For the operation methods during test process, refer to the user guide of this manual.

TIP

For the latest version of this manual, download it from the official website of RIGOL (*http://www.rigol.com*).

Publication Number

PVR01100-1110

Software Version

Software upgrade might change or add product features. Please acquire the latest version of the manual from RIGOL website or contact RIGOL to upgrade the software.

Format Conventions in this Manual

1. **Key**

   The front panel key is denoted by the menu key icon. For example, 

indicates the "System" key.

2. **Menu**

   The menu item is denoted by the format of "Menu Name (Bold) + Character Shading" in the manual. For example, **Frequency** indicates clicking or tapping **Frequency** to enter the frequency setting menu.

3. **Operation Procedures**

   The next step of the operation is denoted by "**>**" in the manual. For example, **Frequency** > **Center** indicates first clicking or tapping **Frequency**, and then clicking or tapping **Center**.

Content Conventions in this Manual

DNA5000 series vector network analyzer includes the following models. Unless otherwise specified, this manual takes DNA5262 as an example to illustrate the functions and operation methods of the DNA5000 series.

Model	Frequency	Number of Channels	Connector
DNA5042	5 kHz to 4.5 GHz	2	N-type Female
DNA5082	5 kHz to 8.5 GHz	2	N-type Female

Model	Frequency	Number of Channels	Connector
DNA5142	5 kHz to 14 GHz	2	N-type Female
DNA5202	5 kHz to 20 GHz	2	3.5mm Threaded Male Connector
DNA5262	5 kHz to 26.5 GHz	2	3.5mm Threaded Male Connector

3 Overview

3.1 To Prepare for the Test

Before test, make the following preparations:

1. Warm up the VNA for at least 60 minutes. Put it in the ambient environment at about 25℃, with the temperature variations not greater than ±1°C within 1 hour.
2. If the power meter is used in the test, first complete the self-calibration for the power meter and zeroing the power meter. For detailed operations, refer to Power Meter User Guide.
3. Ensure that the instrument for the test is within the calibration period (1-year).
4. The test devices shall meet the requirements specified in the following table. You can also use the recommended models in the following table to make measurement.

Test Devices Required

Device Name	Model/Description	Recommended Model
Spectrum Analyzer	5 kHz to 26.5 GHz	RIGOL RSA6000
Power Meter	Power range: -60 dBm to +20 dBm Measurement uncertainty: >0.2 dB Linearity: >0.02 dB (-50 dBm to -20 dBm)	
Program-controlled Attenuator	26.5 GHz, attenuation >60 dB, low loss Attenuation range: 0 dB to 70 dB, with the step 1 dB, 2-port VSWR: >1.5; attenuation uncertainty: >0.006 dB + 0.0004 x attenuation value	
RF Cable	DC to 26.5 GHz, 3.5 mm (M)-3.5 mm (M), 100 cm	CB-3.5M-3.5M-100-L-26G

Device Name	Model/Description	Recommended Model
	DC to 26.5 GHz, NMD 3.5 mm (F)-3.5 mm (F), 63.5 cm	CB-NMD3.5F-3.5F-63-L-26G
Interface Adapter	DC to 26.5 GHz, 3.5 mm (M)-2.92 mm (F) DC to 26.5 GHz, 3.5 mm (F)-2.92 mm (M)	AD-3.5M-2.92F-L-26G AD-3.5F-2.92M-L-26G
Mechanical Calibration Kit	26.5 GHz OPEN, SHORT, LOAD, and THROUGH • Open phase uncertainty: >3° • Short phase uncertainty: >3° • Load reflection coefficient uncertainty: >0.01 • Mechanical calibration kit compliant with IEEE 287	

Note:

1. The frequency range and connector type of the device for calibration shall be compliant with the VNA under calibration. If adapters are used, ensure that the technical specifications after using the adapter still meet the specifications listed in the table above.
2. When making coaxial connections, use the appropriate torque wrench to ensure a secure and reliable connection.

3.2 Specifications

The specification of each test item is provided in Chapter 4. For other specifications, refer to *DNA5000 Data Sheet* (available to download from **RIGOL** website: *http://www.rigol.com*).

TIP

Specifications are valid under the following conditions: the instrument is within the calibration period; stored for at least two hours at 0℃ to 40℃ temperature; 45-minute warm-up. Unless otherwise noted, the specifications in the manual include the measurement uncertainty.

4 Performance Verification Test

4.1 System Dynamic Range

Dynamic range describes the range between the maximum and minimum signal powers that the VNA can accurately measure within a specified frequency range. It calculates the difference between the max. signal power and min. signal power, and is generally expressed in dB. It reflects the VNA's ability of processing both strong and weak signals simultaneously and is a critical parameter for evaluating VNA performance.

In this test, the dynamic range is obtained by subtracting the measured VNA receiver noise floor from the measured VNA transmitter max. output power.

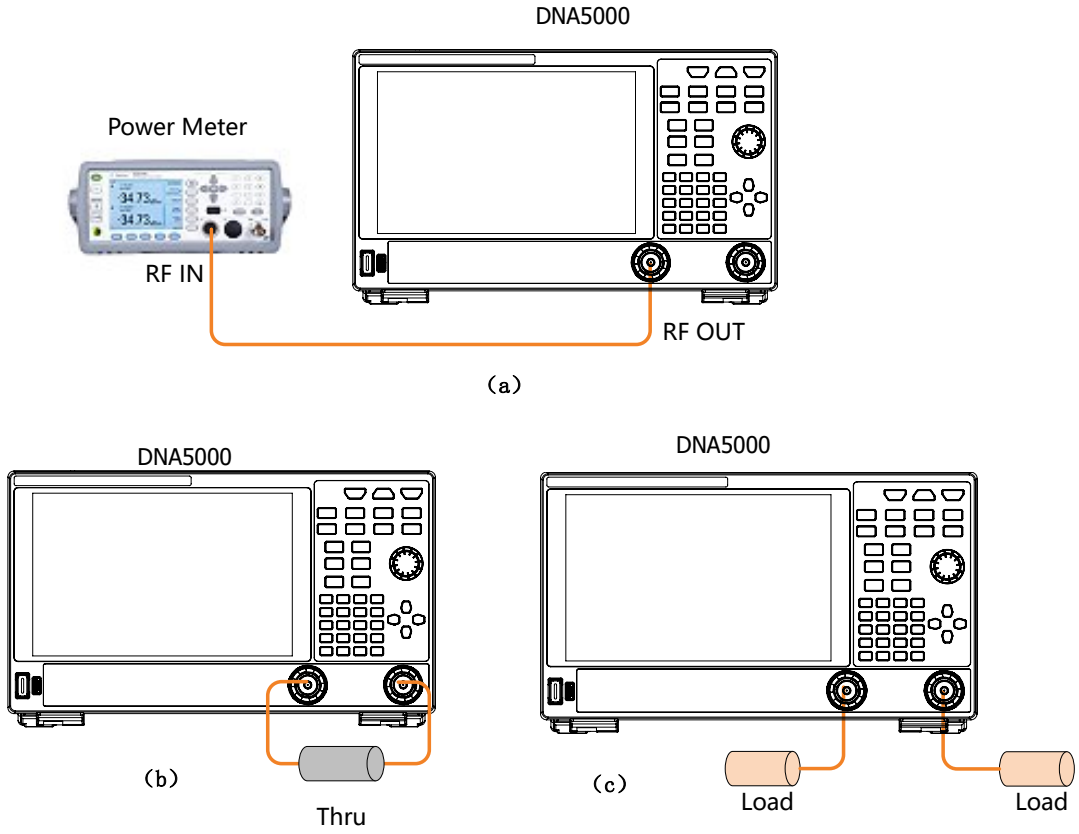
4.1.1 Dynamic Range Specifications

Frequency Range	System Dynamic Range
100 kHz to 10 MHz	105 dB
10 MHz to 6.5 GHz	120 dB
6.5 GHz to 8.5 GHz	117 dB
8.5 GHz to 14 GHz	117 dB
14 GHz to 20 GHz	110 dB
20 GHz to 26.5 GHz	105 dB

[1] System Dynamic Range = Actual Maximum Power - Receiver Noise Floor at 10 kHz IF BW (Normalized to a 10 Hz bandwidth).

4.1.2 Device Connection for Dynamic Range Test

Test devices: Power meter, high-precision cable, calibration kits



4.1.3 Test Procedures for Dynamic Range

1. Measure the Max. Output Signal Power P_{max}

a. Set **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 10 MHz.

c. **Power** > **Main** > **Port Power**: -10 dBm (max. output power)

d. **Avg BW** > **Main** > **IF BW**: 10 kHz

e. Connect Port 1 of VNA to the power meter, as shown in the device connection diagram (a), and the power meter measurement is marked as P_{max}. Warm-up is required before using the power meter to complete the self-calibration.

2. Test the Noise Floor

a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: configure them as the same frequency values. Refer to the specifications table to select a random frequency value within each frequency band.

c. **Sweep** > **Main** > **Sweep Points**: 51

d. **Power**> **Main** > **Port Power**: -20 dBm

e. **Avg BW** > **Main** > **IF BW**: 10 kHz

f. Create a trace: **Trace** > **Trace 1**

g. Set Trace 1 to perform S21 Test. **Measure** > **S-Parameter**: S21

h. Set the display format for Trace 1: **Data Format** > **Main**> **Real**

i. **Trigger** > **Main** > **Trigger Source**: Manual

j. Connect Port 1 of VNA to the power meter, as shown in the device connection diagram (a), and the power meter measurement is marked as P_S. Warm-up is required before using the power meter to complete the self-calibration.

k. Complete the device connections as shown in figure (b). Connect the Through calibration kit between Port 1 and Port 2 to perform the Through calibration on the VNA.

l. After the calibration is complete, connect one 50 Ω match load on each of the two test ports on the VNA respectively, as shown in figure (c).

m. Click or tap "Manual" under "Trigger Source" on the VNA. Then obtain a single standard deviation from the measurement results after a single sweep. Calculate the noise floor of Port 1.

$P_N = 20 \times \lg(\text{stdevN}) + P_S - 10 \times \lg(\text{IFBW} / 10)$

- P_N: final measurement of noise floor, in dBm;
- stdevN: A single standard deviation of measured results after a single sweep;
- P_S: Power meter measurement result, in dBm.
- IFBW: Intermediate frequency bandwidth, in Hz.

3. Calculate dynamic range $D = (P_{max} - P_S) - 20 \times \lg(\text{stdevN}) + 10 \times \lg(\text{IFBW} / 10)$

4. Modify the sweep frequency range according to the specifications table. Then repeat the steps above to complete the dynamic range test for Port 1 under all the working frequency bands.
5. Refer to the test procedure for Port 1 and modify the trace test S12 to complete the dynamic range test for Port 2.

4.1.4 System Dynamic Range Test Record Form

Frequency Band	P_{max}	P_S	P_N	D
100 kHz to 10 MHz				
10 MHz to 6.5 GHz				
6.5 GHz to 8.5 GHz				
8.5 GHz to 14 GHz				
14 GHz to 20 GHz				
20 GHz to 26.5 GHz				

4.2 Output Frequency Accuracy

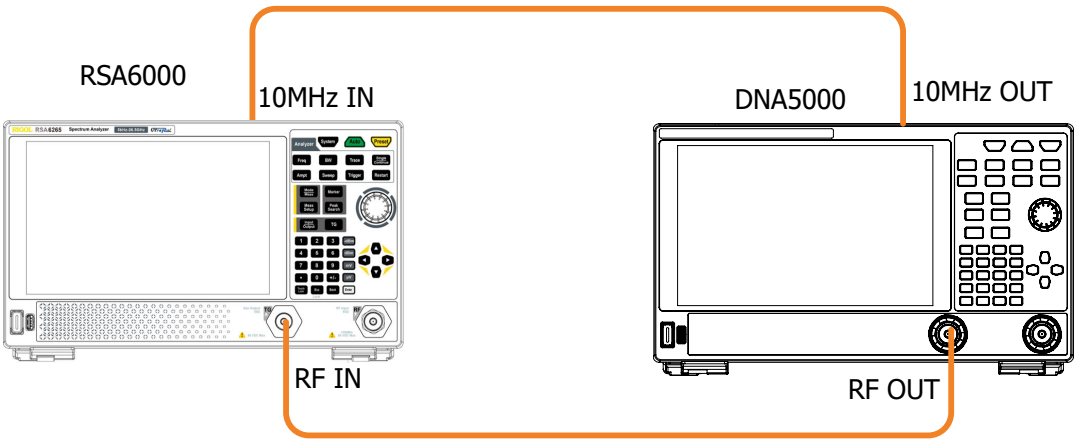
Measures the deviation of the actual frequency value of the VNA output signal from the setting value, usually expressed in ppm.

4.2.1 Frequency Accuracy Specifications

Frequency Range	Frequency Accuracy
Full Frequency Band	<1 ppm

4.2.2 Device Connection for Frequency Accuracy Test

Test devices: spectrum analyzer, high-precision cable, calibration kits



4.2.3 Test Procedures for Output Frequency Accuracy

1. Configure the VNA

a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: configure them as the same frequency values. You can select any test frequency value within each frequency band. The selected frequency value is called Nf (nominal frequency).

c. **Sweep** > **Main** > **Sweep Points**: 1

d. **Avg BW** > **Main** > **IF BW**: 10 Hz

e. Create a trace: **Trace** > **Trace 1**

f. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11

2. Connect Port 1 of the VNA to the input terminal of the spectrum analyzer. Synchronize the spectrum analyzer with the 10 MHz external reference signal of the VNA, as shown in the figure above.

3. Configure the spectrum analyzer to measure the output frequency of Port 1 of VNA. For detailed operations, refer to the document of the specified spectrum analyzer.

a. Set the center frequency of the spectrum analyzer to Nf.

b. Set the span of the spectrum analyzer to 1 MHz, IF BW to 1 kHz.

c. Set the spectrum analyzer to perform the peak search. Record the frequency value of the current peak point as Ff (measured value).

4. Calculate the frequency accuracy

Absolute frequency accuracy: Af = Nf - Ff

Relative frequency accuracy: Rf = Af / Nf (in ppm)

5. Repeat the operation procedures to complete the test.

a. Set the start frequency to be equal to the stop frequency of the sweep. Modify the frequency values to make them cover the whole working frequency range of the VNA. Repeat the above procedures to complete the frequency accuracy test for Port 1.

b. Refer to the test procedure for Port 1. Connect Port 2 and the spectrum analyzer. Modify the trace test S22 to complete the frequency accuracy test for Port 2.

4.2.4 Output Frequency Accuracy Test Record Form

Frequency Band	Nominal Frequency (Nf)	Measured Frequency (Ff)	Absolute Frequency Accuracy (Af)	Relative Frequency Accuracy (Rf)
5 kHz to 100 kHz				
100 kHz to 10 MHz				
10 MHz to 6.5 GHz				
6.5 GHz to 8.5 GHz				
8.5 GHz to 14 GHz				
14 GHz to 20 GHz				
20 GHz to 26.5 GHz				

4.3 Output Power Accuracy

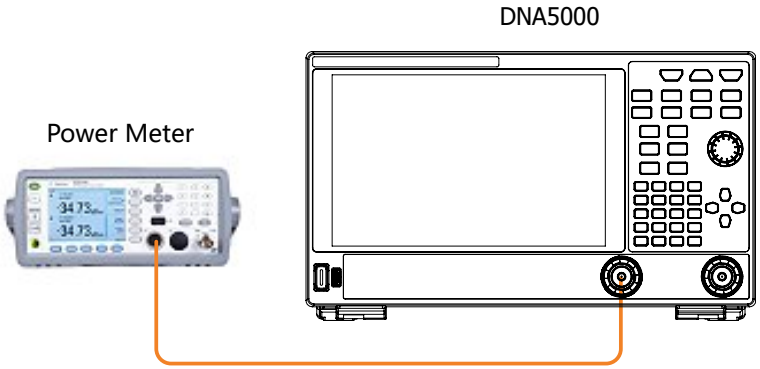
Measures the deviation of the actual value of the output power within the different frequency ranges from the set output power value.

4.3.1 Power Level Accuracy

Frequency Range	Power Level Accuracy
100 kHz to 100 MHz	±1.0 dB
100 MHz to 8.5 GHz	±1.0 dB
8.5 GHz to 26.5 GHz	±1.5 dB

4.3.2 Device Connection for Power Accuracy Test

Test devices: Power meter, high-precision cable, calibration kits



4.3.3 Test Procedures for Power Accuracy

1. Configure the VNA

a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 100 MHz.

c. **Sweep** > **Main** > **Sweep Points**: 11

d. **Power** > **Main** > **Port Power**: -10 dBm

e. **Avg BW** > **Main** > **IF BW**: 10 Hz

f. Create a trace: **Trace** > **Trace 1**

g. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11

h. **Trigger** > **Main** > **Trigger Source**: Manual, **Trigger Mode**: Point

2. Connect Port 1 of the VNA to the power meter, as shown in the figure above. If the power meter is connected to the VNA via the cable, remember to remove the cable

error during the self-calibration of the power meter. Warm-up is required before using the power meter to complete the self-calibration.

3. Click or tap to select **Manual** under Trigger Source of the VNA to start the sweep measurement. Read the power value of the input signal with the power meter, and record the output power P1 (measured value) at the current frequency point.
4. Repeat Step 3 until all the sweep points tests within the current frequency bands are completed.
5. Calculate the difference between the power measured value P1 and the power level setting (**Port Power**: -10 dBm) of the VNA. The max. value of the difference within the current frequency band is considered as the power accuracy.
6. Modify the frequency sweep range to make it cover the whole working frequency band. Then repeat the above steps to measure the power accuracy under the whole working frequency bands.
7. Refer to the test procedure for Port 1 and modify the trace parameters as S22. Connect Port 2 of the VNA to the power meter to complete the output power accuracy test for Port 2.

4.3.4 Output Power Accuracy Test Record Form

Frequency Range	Power (VNA Set)	P1 (Measurement Power)	Power Accuracy
100 kHz to 100 MHz			
100 MHz to 8.5 GHz			
8.5 GHz to 26.5 GHz			

4.4 Output Power Linearity

Measures the linearity error of the output power that varies with the setting values.

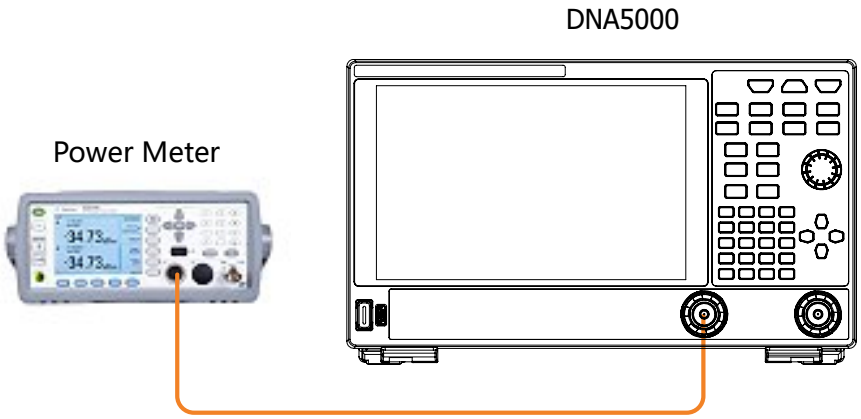
4.4.1 Power Linearity Specifications

Given the power linearity in relative to 0 dBm, sweep mode: -20 dBm ≤ Power ≤ 0 dBm.

Frequency Band	Power Linearity
100 kHz to 100 MHz	±0.6 dB
100 MHz to 8.5 GHz	±0.6 dB
8.5 GHz to 26.5 GHz	±0.6 dB

4.4.2 Device Connection for Power Linearity Test

Test devices: Power meter, high-precision cable, calibration kits



4.4.3 Test Procedures for Power Linearity

1. Configure the VNA

a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 100 MHz.

c. **Sweep** > **Main** > **Sweep Points**: 11

d. **Avg BW** > **Main** > **IF BW**: 10 Hz

e. Create a trace: **Trace** > **Trace 1**

f. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11

g. **Trigger** > **Main** > **Trigger Source**: Manual, **Trigger Mode**: Point

2. Connect Port 1 of the VNA to the input of the power meter, as shown in the figure above. Warm-up is required before using the power meter to complete the self-calibration.
3. Set **Power** > **Main** >**Port Power**: Minimum power P1 specified by current band indicator (where P1 is -20 dBm)
4. Click or tap to select **Manual** under Trigger Source of the VNA to start the sweep measurement. Read the measured power value with the power meter, and record it as power P1' (measured value).
5. Set **Power** > **Main** > **Port Power**: Maximum power value P2 specified by current band indicator (where P2 is 0 dBm).
6. Click or tap to select **Manual** under Trigger Source of the VNA to start the sweep measurement. Read the measured power value with the power meter, and record it as power P2' (measured value).
7. Modify the frequency sweep range according to the specifications table. Then repeat Step 3-6 under the whole working frequency bands of the VNA. Record the measured P1' and P2' values under different frequency bands.
8. Calculate the power linearity of each frequency point according to the formula: P0 = (P2-P1) - (P2'-P1'). Wherein, the worst output power linearity is considered as the output power linearity of this frequency band.
9. Refer to the test procedure for Port 1 and modify the trace parameters as S22 to complete the power linearity test for Port 2.

4.4.4 Power Linearity Test Record Form

Frequency Band	P1	P1'	P2	P2'
100 kHz to 100 MHz				
100 MHz to 8.5 GHz				

Frequency Band	P1	P1'	P2	P2'
8.5 GHz to 26.5 GHz				

P0 = (P2 - P1) - (P2' - P1')

Frequency Band	P0	Limit	Pass/Fail
100 kHz to 100 MHz		±0.6 dB	
100 MHz to 8.5 GHz		±0.6 dB	
8.5 GHz to 26.5 GHz		±0.6 dB	

4.5 Noise Floor

Noise floor calibration is designed to measure the equivalent noise power at the test port input of the Vector Network Analyzer (VNA) under calibration.

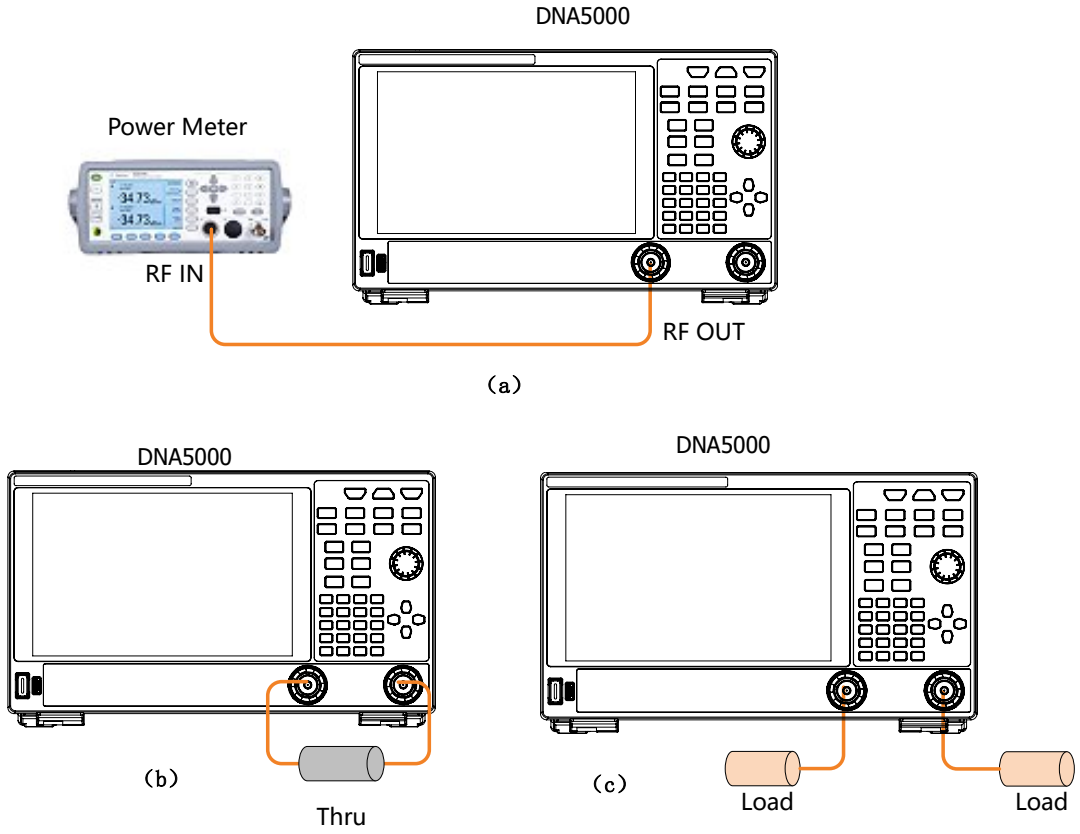
4.5.1 Noise Floor Specifications

Noise Power is defined as the RMS value of the test transmission coefficient at 10 kHz IF BW, and normalized to 1 Hz.

Frequency Range	Noise Floor
100 kHz to 10 MHz	-105 dBm
10 MHz to 6.5 GHz	-120 dBm
6.5 GHz to 8.5 GHz	-119 dBm
8.5 GHz to 14 GHz	-119 dBm
14 GHz to 20 GHz	-114 dBm
20 GHz to 26.5 GHz	-113 dBm

4.5.2 Device Connection for Noise Floor Test

Test devices: Power meter, high-precision cable, calibration kits



4.5.3 Test Procedures for the Noise Floor

1. Configure the VNA

a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: configure them as the same frequency values. Refer to the specifications table to select a random frequency value within each frequency band.

c. **Sweep** > **Main** > **Sweep Points**: 51

d. **Power**> **Main** > **Port Power**: -20 dBm

e. **Avg BW** > **Main** > **IF BW**: 10 kHz

f. Create a trace: **Trace** > **Trace 1**

g. Set Trace 1 to perform S21 Test. **Measure** > **S-Parameter**: S21

h. Set the display format for Trace 1: **Data Format** > **Main**> **Real**

i. **Trigger** > **Main** > **Trigger Source**: Manual

2. Connect Port 1 of VNA to the power meter, as shown in the device connection diagram (a), and the power meter measurement is marked as P_S. Warm-up is required before using the power meter to complete the self-calibration.
3. Complete the device connection as shown in figure (b). Connect the Through calibration kit between Port 1 Port 2 to perform the Through calibration on the VNA.
4. After the calibration is complete, connect one 50 Ω match load on each of the two test ports on the VNA respectively, as shown in figure (c).
5. Click or tap "Manual" under "Trigger Source" on the VNA. Then obtain a single standard deviation from the measurement results after a single sweep. Calculate the noise floor of Port 2.

   $N = 20 \times \lg(stdevN) + P_S - 10 \times \lg(IFBW)$

   - N: final measurement of noise floor, in dBm;
   - stdevN: A single standard deviation of measured results after a single sweep;
   - P_S: Power meter measurement result, in dBm.
   - IFBW: Intermediate frequency bandwidth, in Hz.
6. Repeat the above steps to perform the test for at least three times. Take the median value of the test results as the noise floor results of the current frequency band.
7. Select the test frequency point for the next sweep frequency range according to the specifications table. Repeat the above steps for all the working frequency bands to complete the noise floor test of Port 1.
8. Refer to the test procedure for Port 1 and modify the trace sweep parameters as S12 to complete the noise floor test for Port 2.

4.5.4 Noise Floor Test Record Form

Test Points: _____

Output Power: _____

IF BW: _____

Repetition Count: _____

Frequency Range	Freq	1st Time		2nd Time		3rd Time	
		Ps(dBm)	stdevN	Ps(dBm)	stdevN	Ps(dBm)	stdevN
100 kHz to 10 MHz							
10 MHz to 6.5 GHz							
6.5 GHz to 8.5 GHz							
8.5 GHz to 14 GHz							
14 GHz to 20 GHz							
20 GHz to 26.5 GHz							

Frequency Range	Freq	Ps(dBm)	stdevN
100 kHz to 10 MHz			
10 MHz to 6.5 GHz			
6.5 GHz to 8.5 GHz			
8.5 GHz to 14 GHz			
14 GHz to 20 GHz			
20 GHz to 26.5 GHz			

4.6 Trace Noise

Trace noise measurement aims to evaluate the trace noise of the VNA under specific measurement settings. Trace noise is defined as the standard deviation of random fluctuations in the measured amplitude and phase results, caused by random noise within the system.

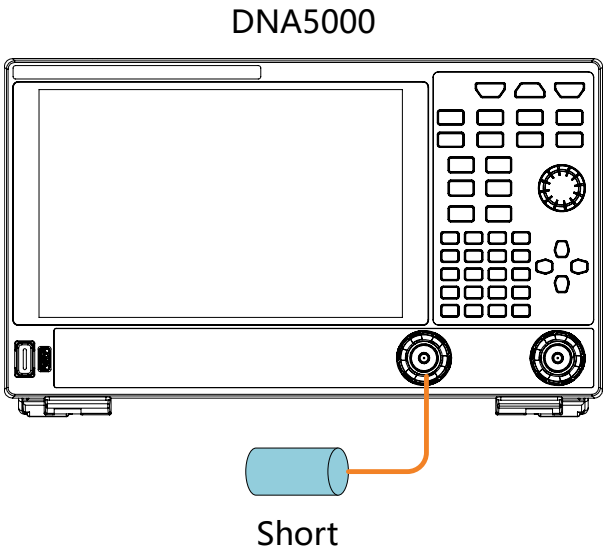
4.6.1 Trace Noise Specifications

Tested under default power at power-on. Transmission and Reflection Trace Noise: for signal < 10 MHz, IF BW is 1 kHz; for signal ≥ 10 MHz, IF BW is 10 kHz.

Frequency Range	Max. Output Power	Magnitude	Phase
100 kHz to 10 MHz	5 dBm	0.006 dB_{rms}	0.045 deg_{rms}
10 MHz to 8.5 GHz	10 dBm	0.0045 dB_{rms}	0.035 deg_{rms}
8.5 GHz to 14 GHz	8 dBm	0.005 dB_{rms}	0.04 deg_{rms}
14 GHz to 20 GHz	8 dBm	0.0055 dB_{rms}	0.045 deg_{rms}
20 GHz to 26.5 GHz	6 dBm	0.007 dB_{rms}	0.05 deg_{rms}

4.6.2 Device Connection for Trace Noise Test

Test devices: High-precision cable (low-loss cable), calibration kits



4.6.3 Test Procedures for Trace Noise

Magnitude

1. Configure the VNA

a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

b. **Sweep** > **Main** > **Start/Stop**: configure them as the same frequency values. Refer to the specifications table to select a random frequency value within each frequency band.

c. **Sweep** > **Main** > **Sweep Points**: 51

d. **Power** > **Main** > **Port Power**: -5 dBm

e. **Avg BW** > **Main** > **IF BW**: 1 kHz (set IF BW to 10 kHz for the frequency band greater than 10 MHz)

f. Create a trace: **Trace** > **Trace 1**

g. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11

h. Set the display format for Trace 1, **Data Format** > **Main** > **Lin Mag**

i. **Trigger** > **Main** > **Trigger Source**: Manual

2. Connect the SHORT calibration kit to Port 1 of the VNA, as shown in the figure above.
3. Click or tap "Manual" under "Trigger Source" on the VNA. Then obtain a single standard deviation and arithmetic average value from the measurement results of the reflection parameter S11 of all the test points within the current frequency band after a single sweep.

   $TN_M = 20 \times lg(1 + stdevM/avgM)$

   - TN_M: trace noise measurement result of reflection parameter, in dB;
   - stdevM: indicates the single standard deviation of the measurement values of reflection parameter of all the test points after a single sweep;
   - avgM: indicates the arithmetic average value of the magnitude of reflection coefficient of all the test points.
4. Repeat the above steps to perform at least three tests. Take the median value of the test results as the magnitude trace noise result of the current frequency band.
5. Modify the frequency range according to the specifications table to make the test cover all the working frequency range. Repeat the above steps and take the worst value as the magnitude trace noise of the current frequency band.
6. Select the test frequency point for the next sweep frequency range according to the specifications table. Repeat the above steps for all the working frequency bands to complete the magnitude trace noise test of Port 1.
7. Refer to the test procedure for Port 1 and modify the trace sweep parameters as S22 to complete the magnitude trace noise test for Port 2.

Phase

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: configure them as the same frequency values. Refer to the specifications table to select a random frequency value within each frequency band.
   c. **Sweep** > **Main** > **Sweep Points**: 51
   d. **Power** > **Main** > **Port Power**: -5 dBm
   e. **Avg BW** > **Main** > **IF BW**: 1 kHz (set IF BW to 10 kHz for the frequency band greater than 10 MHz)
   f. Create a trace: **Trace** > **Trace 1**
   g. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11
   h. Set the display format for Trace 1, **Data Format** > **Main**> **Phase**
   i. **Trigger** > **Main** > **Trigger Source**: Manual
2. Connect the SHORT calibration kit to Port 1 of the VNA, as shown in the figure above.
3. Click or tap "Manual" under "Trigger Source" on the VNA. Then obtain the single standard deviation (stdev P, in degree) of the phase of reflection coefficient S11 of all the test points within the current frequency band after a single sweep.
4. Repeat the above steps to perform the test for at least three times. Take the median value of the test results as the phase trace noise result of the current frequency band.
5. Modify the Phase range according to the specifications table to make the test cover all the working frequency range. Repeat the above steps and take the worst value as the phase trace noise of the current frequency band.
6. Select the test frequency point for the next sweep frequency range according to the specifications table. Repeat the above steps for all the working frequency bands to complete the phase trace noise test of Port 1.

7. Refer to the test procedure for Port 1 and modify the trace sweep parameters as S22 to complete the phase trace noise test for Port 2.

4.6.4 Trace Noise Test Record Form

Test Points: _____

Output Power: _____

IF BW: _____

Repetition Count: _____

Table 4.14 Amplitude Trace Noise

Frequency Range	Freq	1st Time		2nd Time		3rd Time	
		stdev M	avgM	stdev M	avgM	stdev M	avgM
100 kHz to 10 MHz							
10 MHz to 6.5 GHz							
6.5 GHz to 8.5 GHz							
8.5 GHz to 14 GHz							
14 GHz to 20 GHz							
20 GHz to 26.5 GHz							

Table 4.15 Phase Trace Noise

Frequency Range	Freq	1st Time	2nd Time	3rd Time
		stdev P (°)	stdev P (°)	stdev P (°)
100 kHz to 10 MHz				
10 MHz to 6.5 GHz				
6.5 GHz to 8.5 GHz				
8.5 GHz to 14 GHz				

Frequency Range	Freq	1st Time	2nd Time	3rd Time
		stdev P (°)	stdev P (°)	stdev P (°)
14 GHz to 20 GHz				
20 GHz to 26.5 GHz				

Frequency Range	Freq	Amplitude Trace Noise		Phase Trace Noise
		stdev M	avgM	stdev P (°)
100 kHz to 10 MHz				
10 MHz to 6.5 GHz				
6.5 GHz to 8.5 GHz				
8.5 GHz to 14 GHz				
14 GHz to 20 GHz				
20 GHz to 26.5 GHz				

4.7 System Performance Not Calibrated

The test method for the system performance not calibrated takes a two-port vector network analyzer as an example. For the not calibrated system performance of the multi-port vector network analyzer, the test is performed on either one or two ports. The test method is the same as that for the two-port vector network analyzer.

4.7.1 Specifications Without Being Calibrated

Table 4.17 System Performance Without Being Calibrated

Frequency Range	Directivity	Load Match	Source Match	Transmission Tracking	Reflection Tracking
100 kHz to 10 MHz	25 dB	15 dB	25 dB	±1.5 dB	±1.5 dB
10 MHz to 6.5 GHz	25 dB	15 dB	25 dB	±1.5 dB	±1.5 dB
6.5 GHz to 8.5 GHz	25 dB	15 dB	25 dB	±1.5 dB	±1.5 dB
8.5 GHz to 14 GHz	23 dB	13 dB	23 dB	±1.5 dB	±1.5 dB
14 GHz to 20 GHz	20 dB	10 dB	20 dB	±1.5 dB	±1.5 dB

Frequency Range	Directivity	Load Match	Source Match	Transmission Tracking	Reflection Tracking
20 GHz to 26.5 GHz	20 dB	8 dB	20 dB	±1.5 dB	±1.5 dB

4.7.2 Test Procedures

4.7.2.1 Raw Directivity

Raw directivity refers to the ability of VNA to distinguish between forward and reverse signals when the VNA is not calibrated. In other words, it refers to the port isolation from forward transmission signal and reverse reflection signal. It is mainly determined by directivity indicators of directional devices such as directional couplers, if the raw directivity is poor, signal interference is introduced during the measurement of reflection parameters, resulting in inaccurate measurement results.

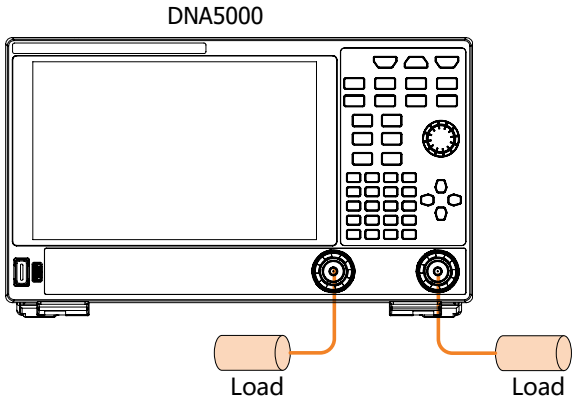


Figure 4.1 Test Device Connection for Raw Directivity

Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 10 MHz.

c. **Sweep** > **Main** > **Sweep Points**: 201

d. **Power**> **Main** >**Port Power**: -10 dBm

e. **Avg BW** > **Main** > **IF BW**: 10Hz

f. Sets Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set **Data Format** > **Main** > **Lin Mag**

g. Sets Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set **Data Format** > **Main** > **Lin Mag**

2. Connect a match load to Port 1 and Port 2 respectively, as shown in the figure above.
3. Click or tap to select **Manual** under Trigger Source on the VNA to start the sweep measurement. After completing a sweep, record the max. peak-to-peak values S11p and S22p of the two traces within the current sweep range.
4. Calculated based on the formula below:

   Forward (port1 → 2) raw directivity E_{fd} = 20 × log (S11p/2)

   Reverse (port2 → 1) raw directivity E_{rd} = 20 x log (S22p/2)
5. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 5 above to complete the raw directivity test for Port 1 and Port 2 under all the working frequency bands.

4.7.2.2 Raw Load Match

Raw load match is defined as the input impedance mismatch of the VNA test port when configured as a receiver, relative to the system reference impedance, prior to error correction or calibration. Impedance mismatch results in signal reflections, reduced power transmission efficiency, and degraded reflection measurement accuracy.

Test Procedures

1. Configure the VNA

   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 10 MHz.

c. **Sweep** > **Main** > **Sweep Points**: 201

d. **Power**> **Main** >**Port Power**: -10 dBm

e. **Avg BW** > **Main** > **IF BW**: 10Hz

f. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set **Data Format** > **Main** > **Log Mag**

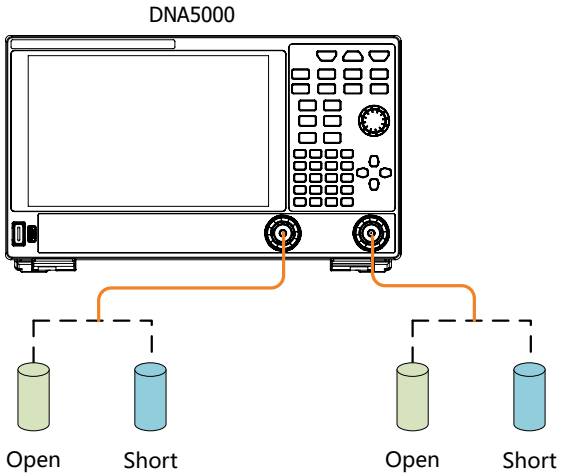
g. Set Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set **Data Format** > **Main** > **Log Mag**

2. Connect a Load match to Port 1 and Port 2 respectively, as shown in *Figure 4.1* .
3. Click or tap "Manual" under "**Trigger Source**" on the VNA to start the sweep measurement. After completing the sweep, record S11 and S22 of each sweep point within the current sweep range. S11 indicates the forward raw load match of the specified frequency point; S22 indicates the reverse raw load match of the specified frequency point. Take the max. value of the measurement results as the raw load match for the current frequency band.
4. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 4 above to complete the forward and reverse raw load match tests for Port 1 and Port 2 under all the working frequency bands.

4.7.2.3 Raw Source Match

The raw source match is a match that looks back from the test port to the source direction when the system is not calibrated. The vector sum of the signals present at the receiver input port is caused by the load mismatch between the test device signal and the signal generator, and between the adapter and the cable.

Device Connection Diagram



Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 10 MHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Power**> **Main** >**Port Power**: -10 dBm
   e. **Avg BW** > **Main** > **IF BW**: 10Hz
   f. Sets Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set **Data Format** > **Main** > **Lin Mag**
   g. Sets Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set **Data Format** > **Main** > **Lin Mag**
2. Connect the "Short" calibration kit to Port 1 and Port 2, as shown in the figure above.

3. Trigger the VNA to complete a sweep manually. Record S11 and S22, S11_Short, and S22_Short at each sweep point.
4. Connect the "Open" calibration kit to Port 1 and Port 2, as shown in the figure above.
5. After manually triggering VNA to complete a sweep, record all measurement points as S11_Open and S22_Open.
6. Calculate the vector sum of the test result for each of the two ports: S11_Short + S11_Open and S22_Short+S22_Open. A_1 is the absolute amplitude value of the vector sum of S11; A_2 is the absolute amplitude value of the vector sum of S22.
7. Calculate the forward initial raw source match and reverse raw source match for each test point according to the formula:

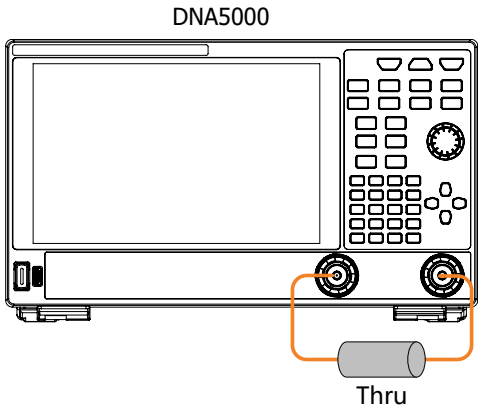
   Forward Raw Source Match: $E_{fs} = 20\log (A_1/2)$

   Reverse Raw Source Match: $E_{rs} = 20\log (A_2/2)$
8. Modify the sweep frequency of VNA according to the specifications table. Then repeat Step 2 through 7 above to complete the raw source match test for Port 1 and Port 2 under different frequencies.

4.7.2.4 Raw Transmission Tracking

Raw transmission tracking refers to the system frequency response for transmission tests when the system is not calibrated, primarily caused by the frequency response of the reference channel, test channel, cable, and adapter.

Device Connection Diagram



Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

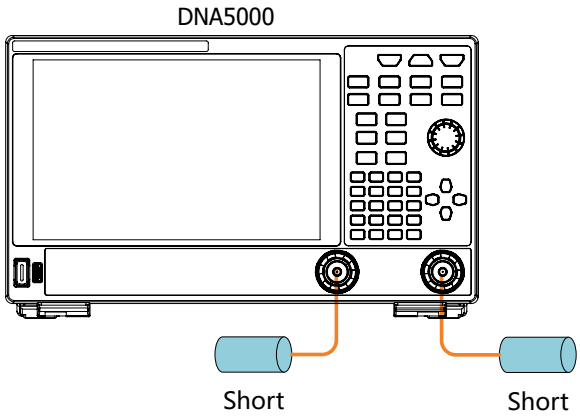
Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 10 MHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Avg BW** > **Main** > **IF BW**: 10 Hz
   e. **Power**> **Main** >**Port Power**: -10 dBm
   f. Set Trace 1 to perform S21 Test. **Measure** > **S-Parameter**: S21; Set**Data Format** > **Main** > **Log Mag**
   g. Set Trace 2 to perform S12 Test.**Measure** > **S-Parameter**: S12; Set**Data Format** >**Main**> **Log Mag**
2. Connect the "Through" calibration kit between Port 1 and Port 2, as shown in the figure above.
3. Click or tap the **Manual** under Trigger Source on the VNA to start the sweep measurement. After completing a sweep, record the measurement values of S21 (Forward Raw Transmission Tracking) and S12 (Reverse Raw Transmission Tracking) at each sweep point in the current sweep range.
4. The worst values of S21 and S12 in the current frequency band are taken as the raw transmission tracking (in ± values).
5. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 4 above to complete the raw transmission tracking test for Port 1 and Port 2 under all the working frequency bands.

4.7.2.5 Raw Reflection Tracking

Raw reflection tracking refers to the frequency response for reflection tests when the system is not calibrated, primarily caused by the frequency response of the reference channel, test channel, cable, and adapter.

Device Connection Diagram



Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 100 kHz to 10 MHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Power**> **Main** >**Port Power**: -10 dBm
   e. **Avg BW** > **Main** > **IF BW**: 10 Hz
   f. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set**Data Format** > **Main** > **Log Mag**
   g. Set Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set**Data Format** > **Main** > **Log Mag**

h. **Trigger** > **Main** > **Trigger Source**: Manual

2. Connect the "Short" calibration kit to Port1 and Port 2 respectively, as shown in the figure above.
3. Click or tap to select **Manual** under Trigger Source on the VNA to start the sweep measurement. After completing a sweep, record the measurement values of S11 (Forward Raw Reflection Tracking) and S22 (Reverse Raw Reflection Tracking) at each sweep point in the current sweep range.
4. The worst values of S11 and S22 in the current frequency band are taken as the raw reflection tracking (in ± values).
5. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 4 above to complete the raw reflection tracking test for Port 1 and Port 2 under all the working frequency bands.

4.7.3 Test Record Form of System Performance Not Calibrated

Directivity Record Form

Directivity Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	S11p	S22p	E_{fd}	E_{rd}
100 kHz to 10 MHz				
10 MHz to 6.5 GHz				
6.5 GHz to 8.5 GHz				
8.5 GHz to 14 GHz				
14 GHz to 20 GHz				
20 GHz to 26.5 GHz				

Load Match Test Record Form

Load Match Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	Forward Load Match	Reverser Load Match
100 kHz to 10 MHz		
10 MHz to 6.5 GHz		
6.5 GHz to 8.5 GHz		
8.5 GHz to 14 GHz		
14 GHz to 20 GHz		
20 GHz to 26.5 GHz		

Source Match Test Record Form

Source Match Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	S11_Open	S22_Open	S11_Short	S22_Short	A_1	A_2	E_{fs}	E_{rs}
100 kHz to 10 MHz								
10 MHz to 6.5 GHz								
6.5 GHz to 8.5 GHz								
8.5 GHz to 14 GHz								
14 GHz to 20 GHz								
20 GHz to 26.5 GHz								

Transmission Tracking Test Record Form

Transmission Tracking Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	Forward Transmission Tracking	Reverse Transmission Tracking
100 kHz to 10 MHz		
10 MHz to 6.5 GHz		
6.5 GHz to 8.5 GHz		
8.5 GHz to 14 GHz		
14 GHz to 20 GHz		
20 GHz to 26.5 GHz		

Reflection Tracking Test Record Form

Reflection Tracking Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	Forward Reflection Tracking	Reverse Reflection Tracking
100 kHz to 10 MHz		
10 MHz to 6.5 GHz		
6.5 GHz to 8.5 GHz		
8.5 GHz to 14 GHz		
14 GHz to 20 GHz		
20 GHz to 26.5 GHz		

4.8 System Performance after Calibration

4.8.1 System Performance Specification after Calibration

Measured condition: 10 Hz IF BW; data not averaged; ambient temperature: 23°C (±3°C), deviation from the calibration temperature less than 1°C.

Table 4.23 System Performance after Error Correction (Calibration)

Frequency Range	Directivity	Load Match	Source Match	Transmission Tracking	Reflection Tracking
5 kHz to 100 kHz	20 dB	20 dB	20 dB	±0.30 dB	±0.30 dB
100 kHz to 10 MHz	42 dB	42 dB	40 dB	±0.01 dB	±0.01 dB
10 MHz to 6.5 GHz	42 dB	38 dB	40 dB	±0.01 dB	±0.01 dB
6.5 GHz to 8.5 GHz	42 dB	38 dB	40 dB	±0.05 dB	±0.03 dB
8.5 GHz to 14 GHz	42 dB	35 dB	36 dB	±0.05 dB	±0.06 dB
14 GHz to 20 GHz	40 dB	35 dB	35 dB	±0.07 dB	±0.07 dB
20 GHz to 26.5 GHz	40 dB	35 dB	35 dB	±0.07 dB	±0.10 dB

4.8.2 Test Procedures

Before test, complete the SOLT calibration for Port 2. For detailed operations, refer to *DNA5000 User Guide*.

Other test procedures are the same as the procedures for "System Performance Not Calibrated".

4.8.2.1 Effective Directivity

Effective directivity refers to the residual directivity error of the VNA after completing the calibration.

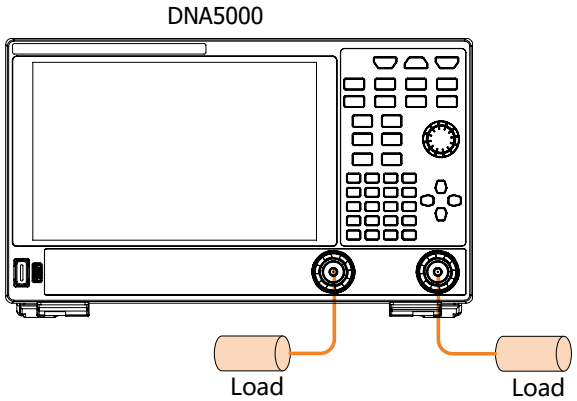


Figure 4.2 Test Device Connection for Effective Directivity

Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 5 kHz to 100 kHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Power**> **Main** >**Port Power**: -10 dBm
   e. **Avg BW** > **Main** > **IF BW**: 10Hz
   f. Sets Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set **Data Format** > **Main** > **Lin Mag**
   g. Sets Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set **Data Format** > **Main** > **Lin Mag**
2. Complete a Full 2-Port SOLT Calibration
3. Connect a match load to Port 1 and Port 2 respectively, as shown in the figure above.
4. Click or tap to select **Manual** under Trigger Source on the VNA to start the sweep measurement. After completing a sweep, record the max. peak-to-peak values S11p and S22p of the two traces within the current sweep range.
5. Calculate based on the formula below:

   Forward (port1 → 2) effective directivity E_{fd} = 20 × log (S11p/2)

   Reverse (port2 → 1) effective directivity E_{rd} = 20 x log (S22p/2)
6. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 5 above to complete the effective directivity test for Port 1 and Port 2 under all the working frequency bands.

4.8.2.2 Effective Load Match

Effective load match refers to the residual error caused by the mismatch between the equivalent input impedance at the measurement port and the system impedance after calibration. It is typically expressed as return loss.

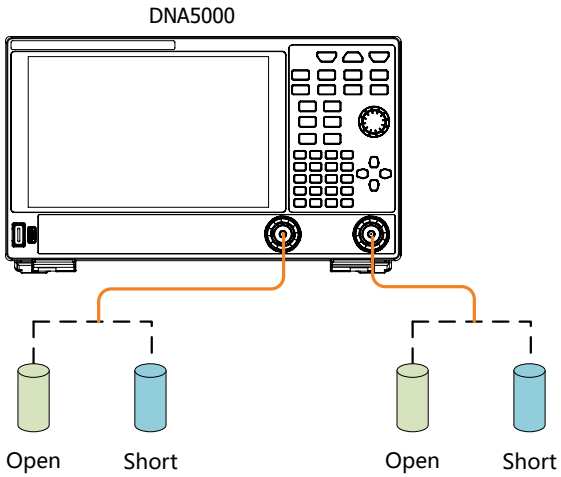
Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 5 kHz to 100 kHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Power**> **Main** >**Port Power**: -10 dBm
   e. **Avg BW** > **Main** > **IF BW**: 10Hz
   f. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set **Data Format** > **Main** > **Log Mag**
   g. Set Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set **Data Format** > **Main** > **Log Mag**
2. Complete a Full 2-Port SOLT Calibration
3. Connect a Load match to Port 1 and Port 2 respectively, as shown in *Figure 4.1* .
4. Click or tap "Manual" under "**Trigger Source**" on the VNA to start the sweep measurement. After completing the sweep, record S11 and S22 of each sweep point within the current sweep range. S11 indicates the forward effective load match of the specified frequency point; S22 indicates the reverse effective load match of the specified frequency point. Take the max. value of the measurement results as the effective load match for the current frequency band.
5. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 4 above to complete the forward and reverse effective load match tests for Port 1 and Port 2 under all the working frequency bands.

4.8.2.3 Effective Source Match

Effective source match refers to the residual error caused by the source output port mismatch after calibration is completed.

Device Connection for Effective Source Match



Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

Test Procedures

1. Configure the VNA

   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency

   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 5 kHz to 100 kHz.

   c. **Sweep** > **Main** > **Sweep Points**: 201

   d. **Power**> **Main** >**Port Power**: -10 dBm

   e. **Avg BW** > **Main** > **IF BW**: 10Hz

   f. Sets Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set **Data Format** > **Main** > **Lin Mag**

   g. Sets Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set **Data Format** > **Main** > **Lin Mag**

2. Connect the "Short" calibration kit to Port 1 and Port 2, as shown in the figure above.
3. Trigger the VNA to complete a sweep manually. Record S11 and S22, S11_Short, and S22_Short at each sweep point.
4. Connect the "Open" calibration kit to Port 1 and Port 2, as shown in the figure above.
5. After manually triggering VNA to complete a sweep, record all measurement points as S11_Open and S22_Open.
6. Calculate the vector sum of the test result for each of the two ports: S11_Short + S11_Open and S22_Short+S22_Open. $A_1$is the absolute amplitude value of the vector sum of S11; $A_2$is the absolute amplitude value of the vector sum of S22.
7. Calculate the forward effective source match and reverse effective source match for each test point according to the formula:

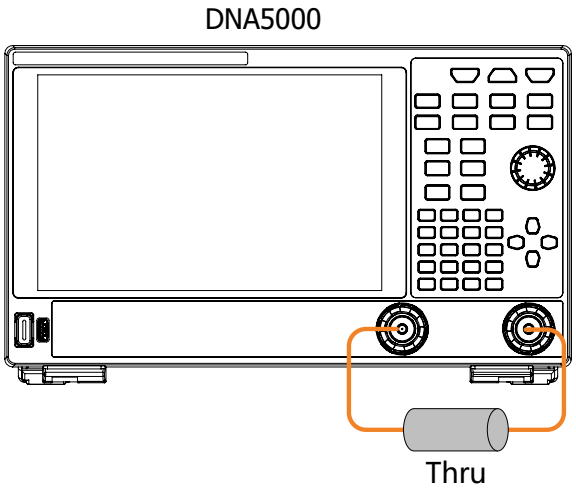
   Forward effective source match: $E_{fs} = 20\log (A_1/2)$

   Reverse effective source match: $E_{rs} = 20\log(A_2/2)$
8. Modify the sweep frequency of VNA according to the specifications table. Then repeat Step 2 through 7 above to complete the effective source match test for Port 1 and Port 2 under different frequencies.

4.8.2.4 Effective Transmission Tracking

Effective transmission tracking refers to the residual error in the transmission frequency response measurement after calibration.

Device Connection for Effective Transmission Tracking



Notice

When connecting devices, connect the calibration kit directly to the port, otherwise you need to consider and eliminate the error interference between the connecting cable and the adapter.

Test Procedures

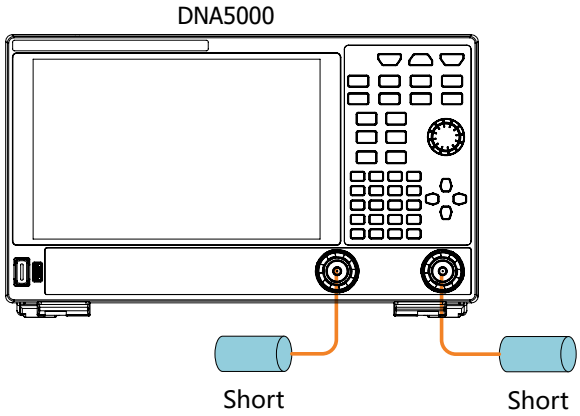
1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 5 kHz to 100 kHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Avg BW** > **Main** > **IF BW**: 10Hz
   e. **Power**> **Main** >**Port Power**: -10 dBm
   f. Set Trace 1 to perform S21 Test. **Measure** > **S-Parameter**: S21; Set**Data Format** > **Main** > **Log Mag**
   g. Set Trace 2 to perform S12 Test.**Measure** > **S-Parameter**: S12; Set**Data Format** >**Main**> **Log Mag**
2. Connect the "Through" calibration kit between Port 1 and Port 2, as shown in the figure above.

3. Click or tap the **Manual** under Trigger Source on the VNA to start the sweep measurement. After completing a sweep, record the measurement values of S21 (Forward Effective Transmission Tracking) and S12 (Reverse Effective Transmission Tracking) at each sweep point in the current sweep range.
4. The worst values of S21 and S12 in the current frequency band are taken as the effective transmission tracking (in ± values).
5. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 4 above to complete the effective transmission tracking test for Port 1 and Port 2 under all the working frequency bands.

4.8.2.5 Effective Reflection Tracking

Effective reflection tracking error refers to the residual error in the reflection frequency response measurement after calibration.

Device Connection for Effective Reflection Tracking



Test Procedures

1. Configure the VNA
   a. **Sweep** > **Main** > **Sweep Type**: Linear Frequency
   b. **Sweep** > **Main** > **Start/Stop**: refer to the specification table. The frequency sweep range for the current test is from 5 kHz to 100 kHz.
   c. **Sweep** > **Main** > **Sweep Points**: 201
   d. **Power**> **Main** >**Port Power**: -10 dBm

e. **Avg BW** > **Main** > **IF BW**: 10Hz

f. Set Trace 1 to perform S11 Test. **Measure** > **S-Parameter**: S11; Set**Data Format** > **Main** > **Log Mag**

g. Set Trace 2 to perform S22 Test. **Measure** > **S-Parameter**: S22; Set**Data Format** > **Main** > **Log Mag**

h. **Trigger** > **Main** > **Trigger Source**: Manual

2. Connect the "Short" calibration kit to Port1 and Port 2 respectively, as shown in the figure above.
3. Click or tap to select **Manual** under Trigger Source on the VNA to start the sweep measurement. After completing a sweep, record the measurement values of S11 (Forward Effective Reflection Tracking) and S22 (Reverse Effective Reflection Tracking) at each sweep point in the current sweep range.
4. The worst values of S11 and S22 in the current frequency band are taken as the effective reflection tracking (in ± values).
5. Modify the sweep frequency range according to the specifications table. Then repeat Step 2 through 4 above to complete the effective reflection tracking test for Port 1 and Port 2 under all the working frequency bands.

4.8.3 Test Record Form of System Performance after Calibration

Directivity Record Form

Directivity Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	S11p	S22p	E_{fd}	E_{rd}
5 kHz to 100 kHz				
100 kHz to 10 MHz				
10 MHz to 6.5 GHz				
6.5 GHz to 8.5 GHz				

Frequency Band	S11p	S22p	E_{fd}	E_{rd}
8.5 GHz to 14 GHz				
14 GHz to 20 GHz				
20 GHz to 26.5 GHz				

Load Match Test Record Form

Load Match Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	Forward Load Match	Reverser Load Match
5 kHz to 100 kHz		
100 kHz to 10 MHz		
10 MHz to 6.5 GHz		
6.5 GHz to 8.5 GHz		
8.5 GHz to 14 GHz		
14 GHz to 20 GHz		
20 GHz to 26.5 GHz		

Source Match Test Record Form

Source Match Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	S11_Open	S22_Open	S11_Short	S22_Short	A_1	A_2	E_{fs}	E_{rs}
5 kHz to 100 kHz								
100 kHz to 10 MHz								
10 MHz to 6.5 GHz								

Frequency Band	S11_Open	S22_Open	S11_Short	S22_Short	A_1	A_2	E_{fs}	E_{rs}
6.5 GHz to 8.5 GHz								
8.5 GHz to 14 GHz								
14 GHz to 20 GHz								
20 GHz to 26.5 GHz								

Transmission Tracking Test Record Form

Transmission Tracking Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	Forward Transmission Tracking	Reverse Transmission Tracking
5 kHz to 100 kHz		
100 kHz to 10 MHz		
10 MHz to 6.5 GHz		
6.5 GHz to 8.5 GHz		
8.5 GHz to 14 GHz		
14 GHz to 20 GHz		
20 GHz to 26.5 GHz		

Reflection Tracking Test Record Form

Reflection Tracking Measurement for Port 1 and Port 2

Test Points: _____

Power Settings for Test Signal: _____

Frequency Band	Forward Reflection Tracking	Reverse Reflection Tracking
5 kHz to 100 kHz		
100 kHz to 10 MHz		

Frequency Band	Forward Reflection Tracking	Reverse Reflection Tracking
10 MHz to 6.5 GHz		
6.5 GHz to 8.5 GHz		
8.5 GHz to 14 GHz		
14 GHz to 20 GHz		
20 GHz to 26.5 GHz		

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