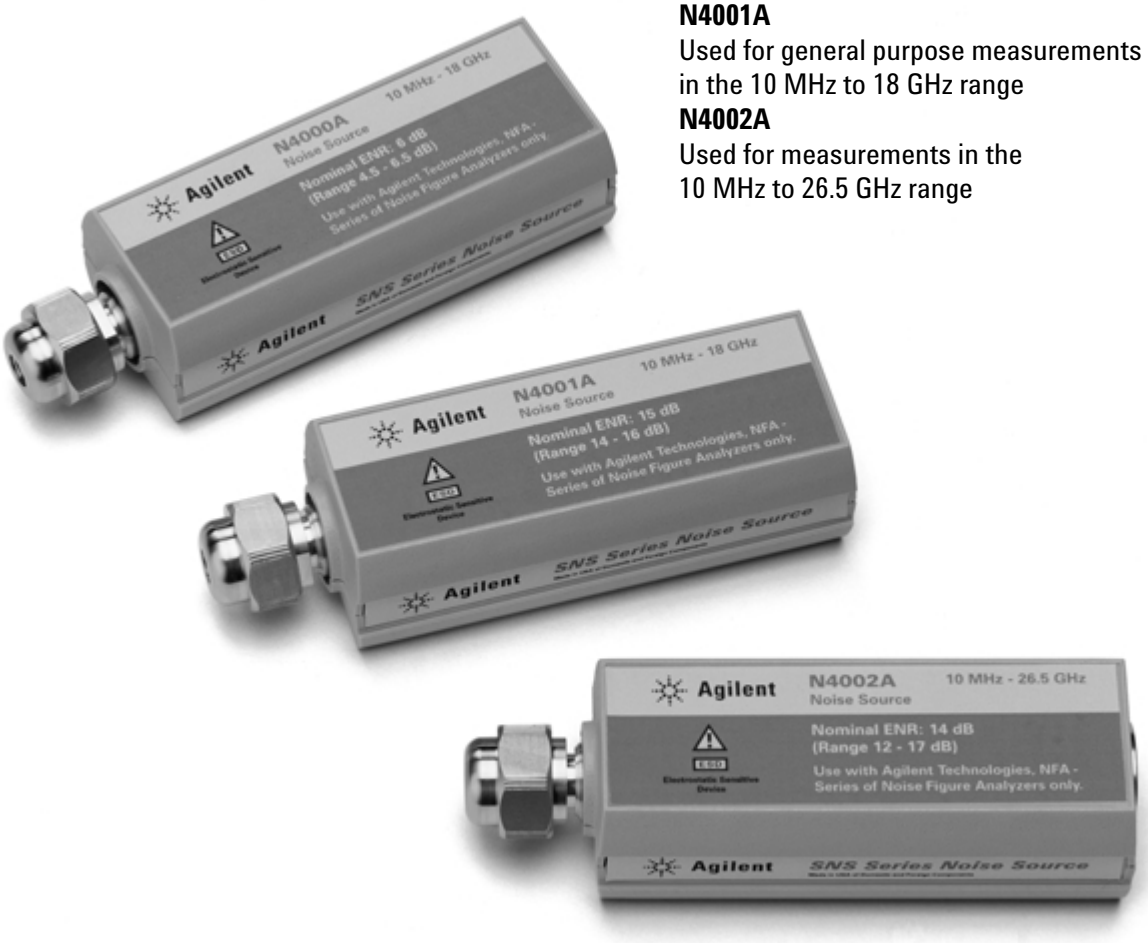
Agilent
N4000A, N4001A, N4002A
SNS Series Noise Sources
10 MHz to 26.5 GHz

Product Overview

Advances in Noise Figure Accuracy

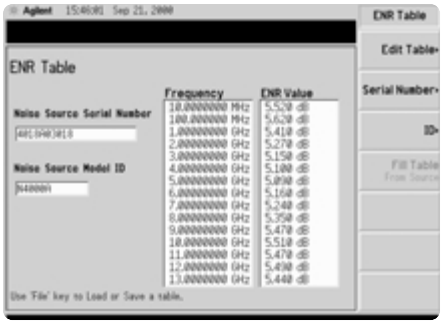
N4000A
Used for low noise figure devices
or devices sensitive to mismatch
in the 10 MHz to 18 GHz range
N4001A
Used for general purpose measurements
in the 10 MHz to 18 GHz range
N4002A
Used for measurements in the
10 MHz to 26.5 GHz range



Agilent Technologies

Noise sources designed to meet specific needs

The Agilent SNS Series of noise sources work in conjunction with the Agilent NFA Series of noise figure analyzers to simplify measurement set-up and improve accuracy. When connected to the Agilent NFA Series, the noise sources automatically download electronically stored calibration data to the analyzers. The noise sources also have the capability to automatically measure their own temperature so that compensation can be applied to the calibration data. These capabilities increase the overall reliability and accuracy of noise figure measurements.



Automatically downloaded ENR data table in the NFA Series of noise figure analyzers

SNS Series key features and benefits

- Automatic download of ENR data to the NFA speeds overall setup time
- Electronic storage of Excess Noise Ratio (ENR) calibration data decreases the opportunity for user error.
- Temperature sensing improves measurement accuracy, leading to tighter specification of device performance.

The N4000A and N4001A, which cover the 10 MHz to 18 GHz frequency range, come with an APC 3.5 (m) connector as standard, and offer the option of a Type-N (m) connector.

The N4002A, which covers the frequency range 10 MHz to 26.5 GHz, has an APC 3.5 (m) connector as standard.

N4000A for low noise figure or mismatch sensitive devices up to 18 GHz

The N4000A is designed to accurately measure devices with low noise figure, or devices whose gain is especially sensitive to small changes in source impedance. This includes most GaAs FET's. The N4000A maintains the same impedance whether turned on or off. By maintaining the same impedance at the input to the device under test (DUT) gain changes are reduced. These gain changes can often masquerade as DUT noise and cause noise figure measurement errors.

The ENR of this noise source is nominally 6 dB from 10 MHz to 18 GHz. DUTs with noise figures up to 20 dB can be accurately and reliably measured with this device. The N4000A noise source has a choice of connectors, with an APC 3.5 (m) as standard.

N4001A for general purpose measurements from 10 MHz to 18 GHz

The N4001A noise source is ideal for general purpose use with a low reflection coefficient and a nominal ENR of 15 dB from 10 MHz to 18 GHz. DUT's with noise figures up to 30 dB can be measured accurately and reliably with this device. The N4001A has a selection of connectors, with an APC 3.5 (m) as standard.

N4002A for measurements up to 26.5 GHz

The N4002A noise source was designed to measure DUT noise figures reliably and accurately up to 30 dB from 10 MHz up to 26.5 GHz accurately and reliably. This noise source comes with an APC 3.5 connector as standard.

Accurate noise power

The output of a noise source, usually given in terms of Excess Noise Ratio (ENR), must be known in order to make accurate noise figure measurements. Any uncertainty in the ENR transfers into uncertainty of the measured noise figure, dB for dB. Agilent provides accurate ENR calibration data with each noise source. ENR uncertainty and reflection coefficients at each frequency point are provided as well.

The following is an example of calibration data for an N4001A noise source:

ENR Data File
Created by N8975A NFA Series Noise Figure Analyzer
Serial Nmber GB40390000 Firmware Revision A.01.01
13:37:07 Mar 28, 2001
Format is: Frequency (Hz), ENR (dB), ENR Unc (dB), # On Refl.Mag (lin), On Refl.Phase (deg),
Off Refl.Mag (lin), Off Refl.Phase (deg) , # On Refl.Mag Unc (lin), On Refl.Phase Unc (deg),
Off Refl.Mag Unc (lin), Off Refl.Phase Unc (deg)
[Filetype ENR]
[Version 1.1]
[Serialnumber US41240152]
[Model N4001A]
[Option 001]
[Caldate 20000727]
[Calduedate 20010727]
[Placeofcal EPSGQ]
[Trackingnum 10]
[Temperature 296.5K]
[Humidity 65%]
[Current 36272]

10000000,	15.281,	0.193,	0.0450,	-136.0,	0.0450,	-136.0,	0.0030,	-6.0,	0.0070,	+6.0,
100000000,	15.291,	0.190,	0.0358,	+168.0,	0.0358,	+168.0,	0.0040,	+4.6,	0.0050,	-4.6,
1000000000,	15.118,	0.151,	0.0398,	+39.6,	0.0398,	+39.6,	0.0100,	+4.5,	0.0067,	+1.5,
2000000000,	14.999,	0.168,	0.0377,	0.168,	0.0377,	-85.7,	0.0056,	+0.9,	0.0086,	+1.9,
3000000000,	14.879,	0.172,	0.0267,	+150.6,	0.0267,	+150.6,	0.0080,	-9.2,	0.0090,	-1.2,
4000000000,	14.795,	0.173,	0.0130,	-18.1,	0.0130,	-18.1,	0.0013,	+16.0,	0.0063,	+10.0,
5000000000,	14.818,	0.179,	0.0359,	+169.5,	0.0359,	+169.5,	0.0024,	-9.3,	0.0035,	-0.3,
6000000000,	14.846,	0.181,	0.0556,	+63.7,	0.0556,	+63.7,	0.0041,	+10.3,	0.0067,	-4.3,
7000000000,	14.895,	0.180,	0.0430,	-37.0,	0.0430,	-27.0,	0.0079,	-2.3,	0.0049,	-2.3,
8000000000,	15.016,	0.198,	0.0232,	-160.3,	0.0232,	-160.3,	0.0091,	-3.8,	0.0053,	-1.8,
9000000000,	15.134,	0.201,	0.0122,	+71.4,	0.0122,	+71.4,	0.0037,	+17.3,	0.0057,	+7.3,
10000000000,	15.253,	0.194,	0.0080,	+116.2,	0.0080,	+116.2,	0.0048,	-1.4,	0.0056,	-5.4,
11000000000,	15.249,	0.243,	0.0241,	+65.7,	0.0241,	+65.7,	0.0059,	+1.5,	0.0049,	+44.5,
12000000000,	15.349,	0.240,	0.0196,	+8.8,	0.0196,	+8.8,	0.0057,	+3.2,	0.0077,	+2.2,
13000000000,	15.383,	0.188,	0.0217,	-5.4,	0.0217,	-5.4,	0.0062,	-6.9,	0.0045,	-1.9,
14000000000,	15.355,	0.178,	0.0228,	-66.6,	0.0228,	-66.6,	0.0075,	+11.2,	0.0065,	+1.2,
15000000000,	15.367,	0.187,	0.0141,	+141.6,	0.0141,	+141.6,	0.0036,	-3.2,	0.0029,	-1.2,
16000000000,	15.421,	0.182,	0.0251,	+6.4,	0.0251,	+6.4,	0.0030,	+7.2,	0.0042,	-1.2,
17000000000,	15.418,	0.174,	0.0242,	-100.5,	0.0242,	-100.5,	0.0048,	-2.7,	0.0050,	+9.7,
18000000000,	15.464,	0.179,	0.0183,	+124.4,	0.0183,	+124.4,	0.0098,	-1.1,	0.0100,	+9.1,

The importance of noise source reflection coefficient

Two aspects of noise source reflection coefficient are important to note:

- A non-zero reflection coefficient contributes to re-reflections between the DUT and the source. The reflections cause uncertainty in the noise power emerging from the source. The measured noise figure, furthermore, refers to the actual noise source impedance rather than the desired 50Ω value. The low reflection coefficient of Agilent SNS Series noise sources can keep this uncertainty under 0.1 dB.

- The change in reflection coefficient between On and Off can cause DUT Gain variations which, in turn, can cause noise figure measurement errors. This problem is effectively eliminated by the N4000A, whose complex reflection coefficient change is specified to be less than 0.01.

Choosing between the N4000A and the N4001A

The key difference between the N4000A and the N4001A noise sources is the nominal 6 dB ENR of the N4000A whereas the N4001A has a nominal 15 dB ENR.

Consider the 6 dB ENR noise source when

- The DUT is especially sensitive to source impedance changes at its input
- There is a need to measure very low noise figures
- The noise figure does not exceed 20 dB

The N40001A is well suited to general-purpose measurements up to 18 GHz, whereas the N4000A is better suited to making measurements on lower noise devices or devices which are sensitive to changes in input impedance. The N4000A contains additional internal attenuation, which provides greater isolation at its output. It is less affected by the ON/OFF condition that is the output impedance of the N4001A. There is a benefit of using a N4000A rather than a N40001A with an added attenuator. The extra attenuaton in the N4000A is included in its calibration and is fully traceable.

SNS Series noise source specifications

Specifications

The specifications are performance standards or limits against which the noise source may be tested. These specifications for the noise source are ONLY valid if the analyzer has been allowed to meet its specified warm up time of 60 minutes. Specifications are valid at ambient temperature 23°Celsius only (296 K).

Instrument model	Frequency range	ENR range
N4000A	10 MHz to 18 GHz	4.5 - 6.5 dB
N4001A	10 MHz to 18 GHz	14 - 16 dB
N4002A	10 MHz to 12 GHz	12 - 16 dB
	12 MHz to 26.5 GHz	14 - 17 dB

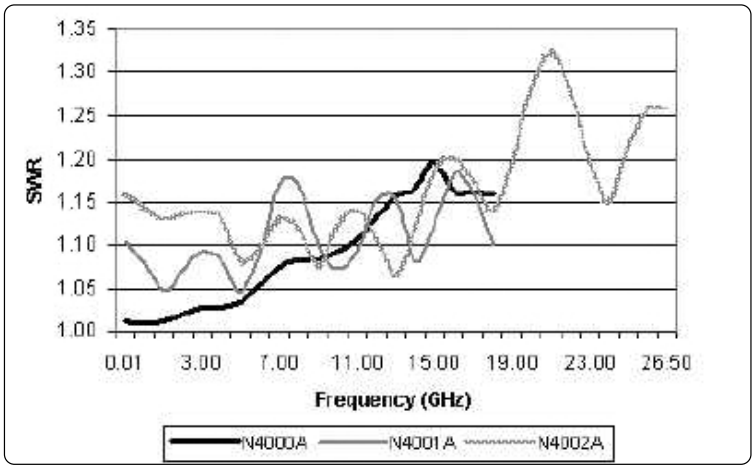


Figure 1. Characteristic SWR at 23°C

Instrument model	Frequency range (GHz)	Max standing wave ratio (SWR)	Reflection coefficient (Rho) (p)
N4000A	0.01 - 1.5	< 1.04:1	0.02
	1.5 - 3.0	< 1.04:1	0.02
	3.0 - 7.0	< 1.13:1	0.06
	7.0 - 18.0	< 1.22:1	0.10
N4001A	0.01 - 1.5	< 1.15:1	0.07
	1.5 - 3.0	< 1.15:1	0.07
	3.0 - 7.0	< 1.20:1	0.09
	7.0 - 18.0	< 1.25:1	0.11
N4002A	0.01 - 1.5	< 1.22:1	0.10
	1.5 - 3.0	< 1.22:1	0.10
	3.0 - 7.0	< 1.22:1	0.10
	7.0 - 18.0	< 1.25:1	0.11
	18.0 - 26.5	< 1.35:1	0.15

Maximum change in complex reflection coefficient between noise source ON and OFF states: 0.01

Supplemental characteristics

Supplemental characteristics are not specifications but are typical characteristics included as additional information for the user.

Termperature sensing accuracy

ENR variation with temperature: < 0.01 dB/°C for 30 MHz to 26.5 GHz

Range: 0 to 55°C
Resolution: 0.25°C
Accuracy: ±1° at 25°C
±2° over 0°C to 55°C

Characteristic ENR (U(Y)) specification

ENR values are given at cardinal frequency points over the frequency range of each noise source. These values are stored within the noise sources internal EEPROM and documented in the calibration report.

The uncertainty analysis for the calibration of the noise sources is in accordance with the ISO/TAG4 guide. The uncertainty data reported on the calibration report is the expanded uncertainty (U(Y)) with 95% confidence level and a coverage factor of 2. This uncertainty analysis is valid for APC 3.5mm and Type-N (option 001) connector types.

Instrument model	Frequency (GHz)	ENR uncertainty (± dB)[1]
N4000A	0.01 - 1.5	0.16
	1.5 - 3.0	0.15
	3.0 - 7.0	0.15
	7.0 - 18.0	0.16
N4001A	0.01 - 1.5	0.14
	1.5 - 3.0	0.13
	3.0 - 7.0	0.13
	7.0 - 18.0	0.16
N4002A	0.01 - 1.5	0.15
	1.5 - 3.0	0.13
	3.0 - 7.0	0.13
	7.0 - 18.0	0.15
	18.0 - 26.5	0.22

1. Characteristic values are met or betterd by 90% of instruments with 90% confidence.

A significant proportion of the expanded uncertainty (U(Y)) is based on the uncertainties provided by the National Standards Institutes. Agilent therefore reserve the right to change the overall expanded uncertainties based on changes in uncertainty values within the National Standards Institutes.

Uncertainties are valid at ambient temperature 23°C ±1°C (296K) only.

A typical characteristic plot of ENR (U(Y)) versus each cardinal frequency point is shown in Figure 2.

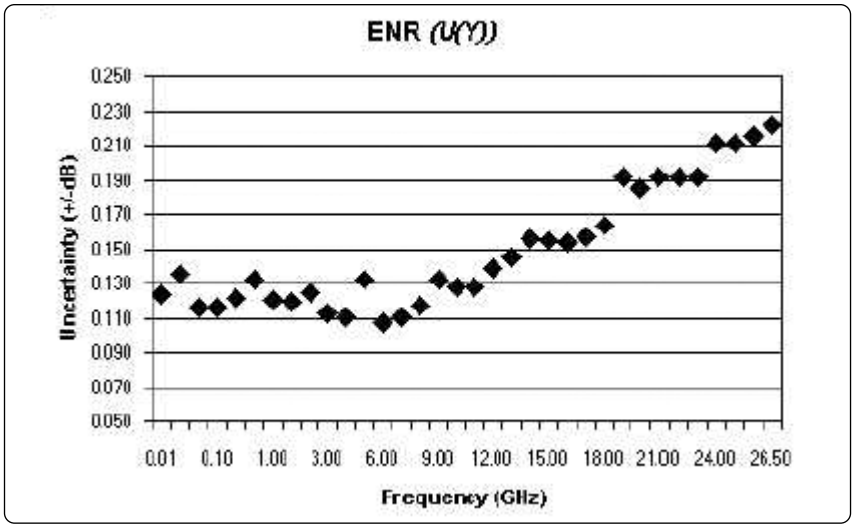


Figure 2. Characteristic ENR plot versus cardinal frequency points

Connector care for the APC-3.5 (m) connector

The APC-3.5 (m) connector is designed for instrumentation applications requiring long life, low reflection coefficient, and good mating capabilities with SMA connectors.

The APC-3.5 (m) can achieve a life expectancy of over 1000 connections if precautions as listed below are taken:

1. Use a torque wrench set to the recommended torque.
2. Tighten the nut only, to prevent the connectors rotating with respect to each other. Friction causes rapid wear of the conducting surfaces.
3. Clean connectors after every 10 connections.
4. Mate with APC-3.5 connectors in good condition.

Casual use of the connector can reduce the life expectancy of APC-3.5 (m) connectors to fewer than 200 connections. Below is a list of several actions that may also reduce the life expectancy of the APC-3.5 (m).

1. Estimating the torque with an ordinary wrench.
2. Twisting the noise source body (accidentally or otherwise) during final tightening or when loosening.
3. Frequent mating with worn-out SMA connectors. This can be a problem with frequently used accessories.

The APC-3.5 (m) connector used on the SNS Series of noise sources has an extra-large nut to make it easier to tighten without applying torque to the noise source body. A 20 mm torque wrench is also available from Agilent for this application. Please contact your local Agilent representative for ordering information.

Agilent 20mm torque wrench 8710-1764

Ordering information

Products

N4000A SNS Series noise source, 10 MHz to 18 GHz, nominal ENR 6 dB
N4001A SNS Series noise source, 10 MHz to 18 GHz, nominal ENR 15 dB
N4002A SNS Series noise source, 10 MHz to 26.5 GHz, nominal ENR 15 dB

All of these noise sources are provided with an APC 3.5 (m) connector as standard

Options

The following option is available with the N4000A and the N4001A:

Connector

N400xA-001	Type-N (m) connector

Service options

Warranty and service

For 3 years, order 36 months of R-51B. For 5 years, order 60 months. Standard warranty is 12 months.

R-51B	Return to Agilent warranty and service plan

Calibration1

For 3 years, order 36 months of the appropriate calibration plan shown below. For 5 years, specify 60 months.

R-50C-001	Standard calibration plan
R-50C-002	Standard compliant calibration plan

Recommended accessories

The new SNS Series of noise sources requires a compatible cable and adaptor to enable their use. The cables are supplied with the NFA Series noise figure analyzers and are also available as separate items.

11730A: 5-foot (1.5 m) power sensor and SNS noise source cable (supplied with NFA)
11730B: 10-foot (3.0m) power sensor and SNS noise source cable
11730C: 20-foot (6.1m) power sensor and SNS noise source cable

A good quality adaptor must be used to connect the SNS series noise source to the input of the NFA series noise figure analyzer. Agilent provides a suitable connector upon purchasing an NFA. These adaptors are also available separately.

83059B precision 35 mm coaxial adaptor

Agilent recommends a torque wrench for use with the large sized (20 mm) APC 3.5 (m) connectored nut found on the Agilent SNS Series noise sources. Agilent also recommends a torque wrench for use with the 5/16” connector on the female to female adaptor when used in conjunction with the NFA Series noise figure analyzers.

8710-1764: 20 mm torque wrench
8710-1765: 5/16” torque wrench

The SNS Series of noise sources is designed specifically for use with the Agilent NFA Series of noise figure analyzers. The NFA Series are recognized as the industry standard for making noise figure measurements. The NFA Series of noise figure analyzers increases speed and accuracy, and offers improved usability. When used in conjunction with the new SNS Series, the NFA Series delivers increased measurement accuracy and convenience to the operator.

Agilent instruments are backed up with a full spectrum of literature and support offerings. A detailed listing follows.

Noise Figure Literature from Agilent

NFA Series - Noise Figure Analyzers - Brochure,
Literature number 5980-0166E

NFA Series - Noise Figure Analyzers - Configuration guide,
Literature number 5980-0163E

NFA Series - Noise Figure Analyzers - NFA Series - Data Sheet
Literature number 5980-0164E

NFA Series - Noise Figure Analyzer - Programming Examples,
Literature number 5968-9498E

Fundamentals of RF and Microwave Noise Figure Measurements,
Application Note 57-1, Literature number 5952-8255

Noise Figure Measurement Accuracy, Application Note 57-2,
Literature number 5968-4545E

10 Hints for Making Successful Noise Figure Measurements,
Application Note 57-3, Literature number 5980-0288E

Key web resources

For the latest information on Agilent noise figure solutions,
visit our web page at:
www.agilent.com/find/nf

For the latest news on the component test industry,
visit our web page at:
www.agilent.com/find/component_test

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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