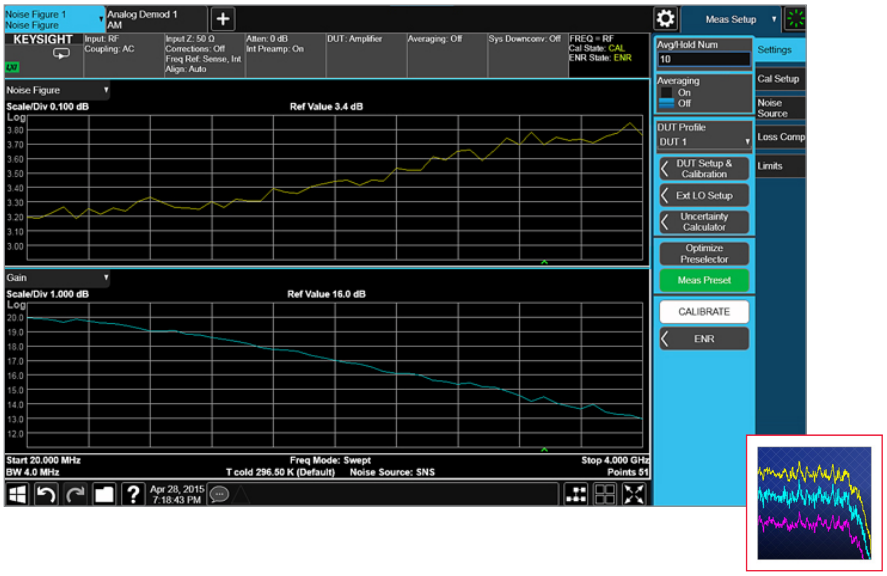
Keysight Technologies
Noise Figure
X-Series Measurement App, Multi-Touch
N9069C

Technical Overview



- Characterize noise figure and gain of connectorized devices and system blocks with graph, meter, and table layouts and built-in uncertainty calculator
- Provide fully-specified measurements with optional internal preamp; improved specifications with external USB preamp
- Speed up multi-DUT measurements with multi-DUT calibration and measurement profiles
- Extend noise figure measurements to 110 GHz (Option 526 or greater required) with Keysight's K-Series block downconverters
- Use multi-touch front panel user interface or SCPI remote interface
- Extend test assets with transportable licenses between all X-Series signal analyzers with multi-touch UI

KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights

Noise Figure Measurement Application

Noise figure is one of the fundamental parameters that differentiates one system, amplifier, or transistor from another. To minimize the problems resulting from noise generated in receiver systems, engineers can either make a weak signal stronger, or reduce the noise of that system or its individual components. The Keysight Technologies, Inc. N9069C noise figure measurement application offers development engineers a simple tool to make accurate and repeatable noise figure measurements. The speed of this application also allows manufacturing engineers to rapidly measure any one of the following in their test racks:

- Noise figure/factor
- Gain
- Effective temperature
- Y-factor
- Hot/cold power density

The noise figure application utilizes the Y-factor method for calculating noise figure. By using a noise source, an X-Series signal analyzer can quickly determine the noise of the device under test. This method is very simple, as it utilizes a ratio of two noise power levels: one measured with the noise source ON and the other with the noise source OFF.

Preamps are available to reduce the uncertainty of Y-factor noise figure measurements. With an optional preamp installed in an X-Series signal analyzer or standard with N8973/N8974/N8975/N8976B NFA X-Series, you can obtain better noise figure measurements. NFA X-Series specifications are not included in this document. For those specifications, please visit **www.keysight.com/find/NFA_X-series_specifications**.

X-Series measurement applications increase the capability and functionality of Keysight signal analyzers to speed time to insight. They provide essential measurements for specific tasks in general-purpose, cellular communications, wireless connectivity and digital video applications, covering more than 40 standards or modulation types. Applications are supported on both benchtop and modular, with the only difference being the level of performance achieved by the hardware you select.

Make fast, accurate noise figure measurements with NFA

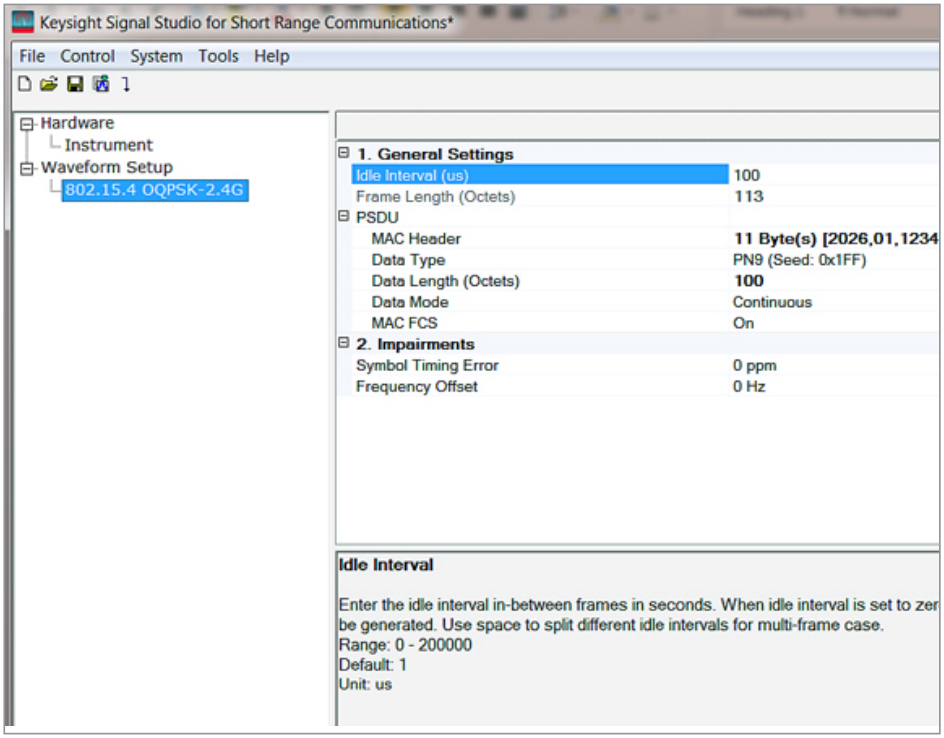
Performing accurate noise figure measurements start with a solid understanding of the uncertainty contributors - your components, subsystems and test equipment. The NFA X-Series noise figure analyzers are the simple way to make fast, accurate and repeatable noise figure measurements up to 40 GHz. With built-in expertise, ease of use features and a best-in-class USB preamplifier, our NFA's help you easily set up complex measurements - providing you with repeatable and reliable results while minimizing the overall uncertainty for your noise figure measurement challenges.

Learn more at:
www.keysight.com/find/nfa

Top Features

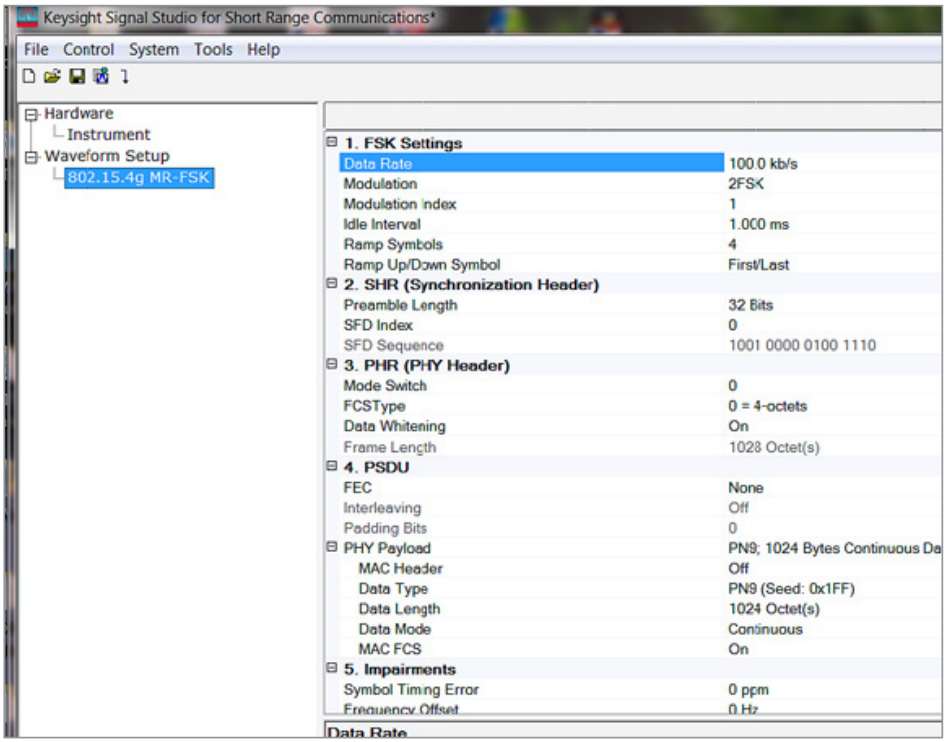
Noise figure and gain measurements for amplifier and converters

The N9069C noise figure measurement application provides accurate noise figure and gain results for the DUT, which can be amplifiers or converters (including multi-stage converters). The noise figure and gain results are shown versus frequencies.



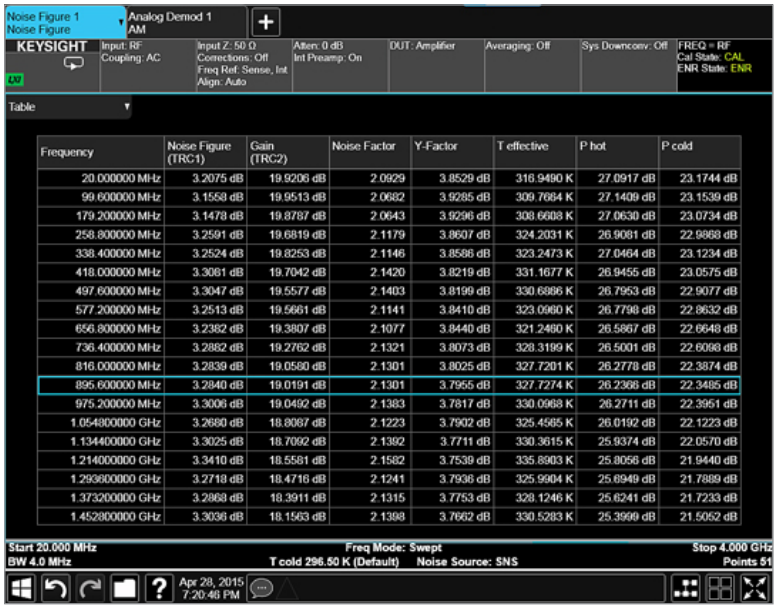
Multi-DUT calibration and measurement profiles

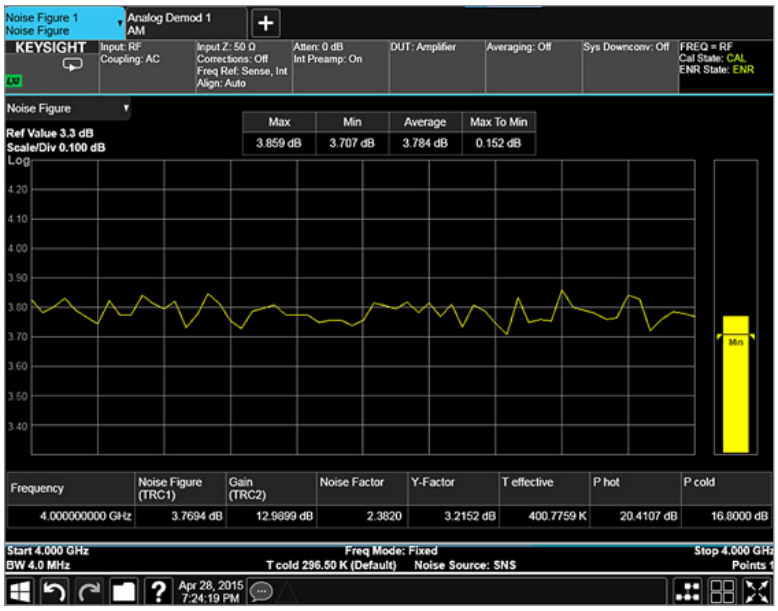
Use this feature to speed up your multi-DUT measurements. It enables you to set up measurement profiles for up to 12 DUTs, calibrate for each profile continuously, and make noise figure measurements on each DUT with the corresponding profile



Simultaneous display of multi-results in table format and meter view

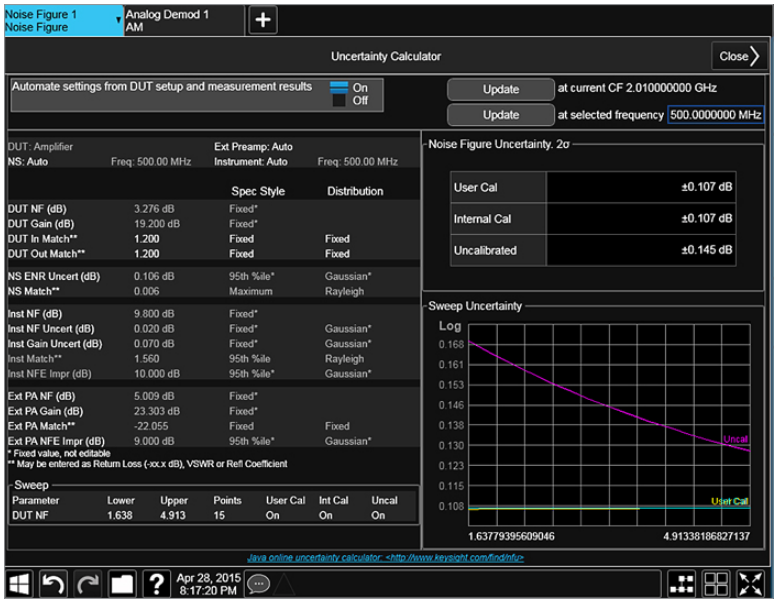
View multiple results of the DUT simultaneously in the table or meter layout. Results include noise figure, gain, noise factor, Y-Factor, T-Effective, P hot, and P cold.





Built-in uncertainty calculator

Use the built-in uncertainty calculator to calculate the measurement uncertainty for the current measurement. It simplifies the process of calculating measurement uncertainty by importing the SNS ENR and the USB preamplifier data (if connected to the analyzer) as well as the instrument data automatically.



Key Specifications

Definitions

- Specifications describe the performance of parameters.
- 95th percentile values indicate the breadth of the population (≈2) of performance tolerances expected to be met in 95% of cases with a 95% confidence.
- Typical values are designated with the abbreviation "typ." These are performance beyond specification that 80% of the units exhibit with a 95% confidence.
- Nominal values are designated with the abbreviation "nom." These values indicate expected performance, or describe product performance that is useful in the application of the product.

Analyzer noise figure is computed from the specified DANL. See specifications on following pages for further explanation.

Noise figure for the combination of USB preamp and analyzer is

$$NF_{sys} = 10 * Log (F_{preamp} + (F_{analyzer} - 1)/G_{preamp})$$

The noise figure and gain of the preamp are specified and warranted.

Analyzer VSWR is characterized to the 95th percentile but not measured and warranted. USB preamp VSWR is measured and warranted and becomes the input VSWR of the measurement system when used.

Instrument uncertainty is defined for gain measurements as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for the gain computation.

The noise figure measurement application is not specified for use below 10 MHz. Instrument uncertainty will nominally be the same as the 10 MHz to 3.6 GHz specifications; however, performance is not warranted. Instrument uncertainty for gain is characterized to the 95th percentile above 3.6 GHz.

These notes apply to the following specifications. For more information on configuring an X-Series signal analyzer for noise figure measurements, depending on the DUT noise figure and gain, see the Noise Figure Measurement Guide, literature number N9069-90001.

Performance specifications

UXA with U7227A preamplifier

Description		Specifications			Supplemental information
VSWR[1]	Frequency	UXA full range	UXA 26.5 GHz + U7227A preamp full range		
Band 0	10 to 100 MHz	1.45	3.57		
Band 0	0.1 to 2 GHz	1.45	1.54		
Band 0	2 to 3 GHz	1.45	1.73		
Band 0	3 to 3.6 GHz	1.45	1.93		
Band 1	3.5 to 4 GHz	1.54	1.93		
Band 1	4 to 8.4 GHz	1.54	–		
Band 2	8.3 to 13.6 GHz	1.57	–		
Band 3	13.5 to 17.1 GHz	1.48	–		
Band 4	17.0 to 26.5 GHz	1.54	–		
Noise figure[2, 3]		Internal preamp on	Internal preamp off + U7227A	Internal preamp on + U7227A	
	10 MHz to 100 MHz	12.25	9.46	5.96	
	0.1 to 2.1 GHz	12.25	9.49	5.45	
	2.1 to 3.6 GHz	14.25	11.35	5.65	
	3.5 to 4.0 GHz	14.25	12.88	5.63	
	4 to 6 GHz	14.25	–	–	
	6 to 8.4 GHz	14.25	–	–	
	8.3 to 13.6 GHz	15.25	–	–	
	13.5 to 16.9 GHz	17.25	–	–	
	16.9 to 18 GHz	19.25	–	–	
	18 to 20 GHz	19.25	–	–	
	20 to 26.5 GHz	23.25	–	–	
Instrument uncertainty for noise figure[4]					
10 MHz to 26.5 GHz					
Noise source ENR	Measurement range				
4 to 6.5 dB	0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using the internal preamp and RBW 4 ≤ MHz
12 to 17 dB	0 to 30 dB	± 0.025 dB	± 0.025 dB	± 0.025 dB	
20 to 22 dB	0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Instrument uncertainty for gain[5, 6]					
	10 MHz to 3.6 GHz	± 0.07 dB	± 0.07 dB	± 0.07 dB	DUT gain range = –20 to +40 dB
	> 3.6 GHz	± 0.13 dB	± 0.13 dB	± 0.13 dB	
Jitter		± 0.15 dB	± 0.15 dB	± 0.15 dB	

Performance specifications

UXA with U7227C preamplifier

Description		Specifications			Supplemental information
VSWR[1]	Frequency	UXA full range	UXA 26.5 GHz + U7227C preamp full range		
Band 0	10 to 100 MHz	1.45	–		
Band 0	0.1 to 3.6 GHz	1.45	1.43		
Band 1	3.5 to 4 GHz	1.54	1.43		
Band 1	4 to 8.4 GHz	1.54	2.32		
Band 2	8.3 to 13.6 GHz	1.57	2.32		
Band 3	13.5 to 17.1 GHz	1.48	2.32		
Band 4	17.0 to 26.5 GHz	1.54	2.32		
Noise figure[2, 3]		Internal preamp on	Internal preamp off + U7227A	Internal preamp on + U7227A	
	10 MHz to 100 MHz	12.25	–	–	
	0.1 to 2.1 GHz	12.25	9.88	6.36	
	2.1 to 3.6 GHz	14.25	11.60	6.52	
	3.5 to 4.0 GHz	14.25	13.06	6.51	
	4 to 6 GHz	14.25	11.64	5.56	
	6 to 8.4 GHz	14.25	10.94	4.61	
	8.3 to 13.6 GHz	15.25	10.66	4.57	
	13.5 to 16.9 GHz	17.25	13.30	4.74	
	16.9 to 18 GHz	19.25	15.77	5.06	
	18 to 20 GHz	19.25	15.37	5.77	
	20 to 26.5 GHz	23.25	20.39	6.25	
Instrument uncertainty for noise figure[4]					
10 MHz to 26.5 GHz					
Noise source ENR	Measurement range				
4 to 6.5 dB	0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using the internal preamp and RBW 4 ≤ MHz
12 to 17 dB	0 to 30 dB	± 0.025 dB	± 0.025 dB	± 0.025 dB	
20 to 22 dB	0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Instrument uncertainty for gain[5, 6]					
	10 MHz to 3.6 GHz	± 0.07	± 0.07	± 0.07	DUT gain range = –20 to +40 dB
	> 3.6 GHz	± 0.13 dB	± 0.13 dB	± 0.13 dB	
Jitter		± 0.15 dB	± 0.15 dB	± 0.15 dB	

Performance specifications

PXA with U7227A preamplifier

Frequency	PXA full range	PXA + U7227A full range		
VSWR[1]				
Frequency				
10 to 100 MHz	1.45	3.57		
0.1 to 2 GHz	1.45	1.54		
2 to 3 GHz	1.45	1.73		
3 to 3.6 GHz	1.45	1.93		
3.5 to 4 GHz	1.54	1.93		
4 to 8.4 GHz	1.54	–		
8.3 to 13.6 GHz	1.57	–		
13.5 to 17.1 GHz	1.48	–		
17.0 to 26.5 GHz	1.54	–		
	Internal preamp on	**Internal preamp off + U7227A**	**Internal preamp on + U7227A**	**Supplemental information**
Noise figure[2, 3]				
10 to 100 MHz	12.25	9.46	5.96	
0.1 to 2.1 GHz	12.25	9.49	5.45	
2.1 to 3.6 GHz	14.25	11.35	5.56	
3.5 to 4 GHz	14.25	13.73	5.63	
4 to 6 GHz	14.25	–	–	
6 to 8.4 GHz	14.25	–	–	
8.3 to 13.6 GHz	15.25	–	–	
13.5 to 17.1 GHz	17.25	–	–	
16.9 to 18 GHz	19.25	–	–	
18 to 20 GHz	19.25	–	–	
20 to 26.5 GHz	23.25	–	–	
Noise source ENR				
Measurement range				
4 to 6.5 dB	0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB	0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB	0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
		± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz		± 0.13 dB	± 0.13 dB	± 0.13 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz		± 0.13 dB	± 0.13 dB	± 0.13 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

PXA with U7227C preamplifier

Frequency	PXA full range	PXA + U7227C full range		
VSWR[1]				
Frequency				
10 to 100 MHz	1.45	–		
0.1 to 3.6 GHz	1.45	1.43		
3.5 to 4 GHz	1.54	1.43		
4 to 8.4 GHz	1.54	2.32		
8.3 to 13.6 GHz	1.57	2.32		
13.5 to 17.1 GHz	1.48	2.32		
17.0 to 26.5 GHz	1.54	2.32		
	Internal preamp on	**Internal preamp off + U7227C**	**Internal preamp on + U7227C**	**Supplemental information**
Noise figure[2, 3]				
10 to 100 MHz	12.25	–	–	
0.1 to 2.1 GHz	12.25	9.88	6.36	
2.1 to 3.6 GHz	14.25	11.60	6.52	
3.5 to 4 GHz	14.25	13.88	6.51	
4 to 6 GHz	14.25	13.28	6.56	
6 to 8.4 GHz	14.25	12.61	4.61	
8.3 to 13.6 GHz	15.25	10.66	4.57	
13.5 to 16.9 GHz	17.25	13.30	4.74	
16.9 to 18 GHz	19.25	15.77	5.06	
18 to 20 GHz	19.25	15.37	5.77	
20 to 26.5 GHz	23.25	18.46	6.25	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.13 dB	± 0.13 dB	± 0.13 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.13 dB	± 0.13 dB	± 0.13 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

PXA with U7227F preamplifier

Frequency	PXA full range	PXA + U7227F full range		
VSWR[1]				
Frequency				
0.01 to 2 GHz	1.39	–		
2 to 3.6 GHz	1.39	2.32		
3.5 to 8.4 GHz	1.50	2.32		
8.3 to 13.6 GHz	1.31	2.32		
13.5 to 17.1 GHz	1.33	2.32		
17.0 to 26.5 GHz	1.34	2.32		
26.4 to 34.5 GHz	1.41	2.32		
34.4 to 40 GHz	1.42	2.32		
40 to 44 GHz	1.42	3.00		
44 to 50 GHz	1.42	3.57		
	Internal preamp on	**Internal preamp off + U7227F**	**Internal preamp on + U7227F**	**Supplemental information**
Noise figure[2, 3]				
10 to 100 MHz	13.25	–	–	
2 to 2.1 GHz	13.25	11.85	10.17	
2.1 to 3.6 GHz	14.25	12.97	10.20	
3.5 to 4 GHz	17.25	18.49	10.39	
4 to 8.4 GHz	17.25	16.48	8.49	
8.3 to 13.6 GHz	17.25	13.19	8.37	
13.5 to 17.1 GHz	17.25	15.64	8.31	
17 to 20 GHz	19.25	16.77	8.42	
20 to 26.5 GHz	20.25	17.21	8.38	
26.4 to 30 GHz	21.25	14.85	8.40	
30 to 34 GHz	23.25	14.92	8.50	
33 to 37 GHz	26.25	18.63	8.83	
37 to 40 GHz	29.25	18.01	9.33	
40 to 43 GHz	31.25	18.39	10.42	
43 to 44 GHz	31.25	18.19	10.35	
44 to 46 GHz	31.25	17.93	11.01	Due to U7227F temperature instability, noise figure measurements are not traceable above 44 GHz with the preamp attached.
46 to 50 GHz	34.25	19.74	11.35	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

MXA with U7227A preamplifier

Frequency	MXA full range	MXA + U7227A full range
VSWR[1]		
Frequency		
10 to 100 MHz	1.52	3.57
0.1 to 2 GHz	1.52	1.43
2 to 3 GHz	1.52	1.73
3 to 3.6 GHz	1.52	1.93
3.5 to 4 GHz	1.68	1.93
4 to 8.4 GHz	1.68	–
8.3 to 13.6 GHz	1.69	–
13.5 to 17.1 GHz	1.66	–
17.0 to 26.5 GHz	1.66	–

	Internal preamp on	Internal preamp off + U7227A	Internal preamp on + U7227A	Supplemental information
Noise figure[2, 3]				
10 to 100 MHz	15.25	12.27	6.40	
0.1 to 2.1 GHz	15.25	10.59	5.65	
2.1 to 3.6 GHz	16.25	11.54	5.69	
3.5 to 4 GHz	16.25	11.38	5.66	
4 to 6 GHz	16.25	–	–	
6 to 8.4 GHz	16.25	–	–	
8.3 to 13.6 GHz	16.25	–	–	
13.5 to 17.1 GHz	19.25	–	–	
17 to 18 GHz	22.25	–	–	
18 to 20 GHz	22.25	–	–	
20 to 26.5 GHz	27.25	–	–	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

MXA with U7227C preamplifier

Frequency	MXA full range	MXA + U7227C full range		
VSWR[1]				
Frequency				
10 to 100 MHz	1.52	–		
0.1 to 3.6 GHz	1.52	1.43		
3.5 to 4 GHz	1.68	1.43		
4 to 8.4 GHz	1.68	2.32		
8.3 to 13.6 GHz	1.69	2.32		
13.5 to 17.1 GHz	1.66	2.32		
17.0 to 26.5 GHz	1.66	2.32		
	Internal preamp on	**Internal preamp off + U7227C**	**Internal preamp on + U7227C**	**Supplemental information**
Noise figure[2, 3]				
10 to 100 MHz	15.25	–	–	
0.1 to 2.1 GHz	15.25	11.89	6.71	
2.1 to 3.6 GHz	16.25	13.14	6.81	
3.5 to 4 GHz	16.25	13.06	6.79	
4 to 6 GHz	16.25	12.45	5.87	
6 to 8.4 GHz	16.25	11.76	4.95	
8.3 to 13.6 GHz	16.25	11.47	4.71	
13.5 to 17.1 GHz	19.25	15.06	5.11	
17 to 18 GHz	22.25	15.77	5.92	
18 to 20 GHz	22.25	15.37	6.43	
20 to 26.5 GHz	27.25	21.36	7.65	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

EXA with U7227A preamplifier

Frequency	EXA full range	EXA + U7227A full range
VSWR[1]		
Frequency		
10 to 100 MHz	1.52	3.57
0.1 to 2 GHz	1.52	1.54
2 to 3 GHz	1.52	1.73
3 to 3.6 GHz	1.52	1.93
3.5 to 4 GHz	1.68	1.93
4 to 8.4 GHz	1.68	–
8.3 to 13.6 GHz	1.69	–
13.5 to 17.1 GHz	1.66	–
17.0 to 26.5 GHz	1.66	–

	Internal preamp on	Internal preamp off + U7227A	Internal preamp on + U7227A	Supplemental information
Noise figure[2, 3]				
10 to 100 MHz	17.25	14.79	6.86	
100 MHz to 2.1 GHz	17.25	12.95	6.00	
2.1 to 3.6 GHz	18.25	13.17	6.05	
3.5 to 4 GHz	18.25	13.00	6.01	
4 to 6 GHz	18.25	–	–	
7 to 13.6 GHz	19.25	–	–	
13.5 to 17.1 GHz	21.25	–	–	
17 to 18 GHz	25.25	–	–	
18 to 20 GHz	25.25	–	–	
20 to 26.5 GHz	29.25	–	–	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

EXA with U7227C preamplifier

Frequency	EXA full range	EXA + U7227C full range		
VSWR[1]				
Frequency				
10 to 100 MHz	1.52	–		
0.1 to 3.6 GHz	1.52	1.43		
3.5 to 4 GHz	1.68	1.43		
4 to 8.4 GHz	1.68	2.32		
8.3 to 13.6 GHz	1.69	2.32		
13.5 to 17.1 GHz	1.66	2.32		
17.0 to 26.5 GHz	1.66	2.32		
	Internal preamp on	**Internal preamp off + U7227C**	**Internal preamp on + U7227C**	**Supplemental information**
Noise figure[2, 3]				
10 to 100 MHz	17.25	–	–	
100 MHz to 2.1 GHz	17.25	14.30	7.08	
2.1 to 3.6 GHz	18.25	14.82	7.23	
3.5 to 4 GHz	18.25	14.73	7.20	
4 to 6 GHz	18.25	14.15	6.33	
6 to 7 GHz	18.25	13.81	5.53	
7 to 13.6 GHz	19.25	15.90	5.34	
13.5 to 17.1 GHz	21.25	21.78	5.66	
17 to 18 GHz	25.25	21.55	7.24	
18 to 20 GHz	25.25	21.06	7.51	
20 to 26.5 GHz	29.25	23.32	8.68	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

EXA with U7227F preamplifier

Frequency	EXA full range	EXA + U7227F full range
VSWR[1]		
Frequency		
0.01 to 2 GHz	1.52	–
2 to 3.6 GHz	1.52	2.32
3.5 to 8.4 GHz	1.68	2.32
8.3 to 13.6 GHz	1.69	2.32
13.5 to 17.1 GHz	1.66	2.32
17.0 to 26.5 GHz	1.66	2.32
26.5 to 40 GHz	–	2.32
40 to 44 GHz	–	3.00

	Internal preamp on	Internal preamp off + U7227F	Internal preamp on + U7227F	Supplemental information
Noise figure[2, 3]				
10 to 1.2 GHz	14.25	–	–	
1.2 to 2.1 GHz	15.25	–	–	
2 to 2.1 GHz	15.25	12.65	10.27	
2.1 to 3.6 GHz	16.25	13.49	10.32	
3.5 to 4 GHz	18.25	19.36	10.49	
4 to 7 GHz	18.25	15.91	8.65	
7 to 20 GHz	18.25	15.91	8.34	
20 to 26.5 GHz	20.25	17.21	8.38	
26.5 to 32 GHz	23.25	19.69	8.56	
32 to 34 GHz	23.25	19.27	8.50	
33.9 to 40 GHz	26.5	23.67	8.72	
40 to 44 GHz	30.25	22.81	10.11	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.02 dB	± 0.02 dB	± 0.02 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
20 to 22 dB 0 to 35 dB	± 0.03 dB	± 0.03 dB	± 0.03 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	
Instrument uncertainty for gain[4, 5]				
10 MHz to 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	DUT gain range = –20 to +40 dB
> 3.6 GHz	± 0.19 dB	± 0.19 dB	± 0.19 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

CXA with U7227A preamplifier

Frequency		CXA full range	CXA + U7227A full range		
VSWR[1]					
Frequency					
10 to 100 MHz		3.0	3.57		
0.1 to 2 GHz		3.0	1.54		
2 to 3 GHz		3.0	1.73		
3 to 4 GHz		3.0	1.93		
4 to 7.5 GHz		3.0	–		
7.5 to 26.5 GHz		2.5	–		
		Internal preamp on	Internal preamp off + U7227A	Internal preamp on + U7227A	Supplemental information
Noise figure[2, 3]					
10 to 100 MHz		17.25	13.92	6.86	
0.1 to 1.5 GHz		17.25	16.80	6.06	
1.5 to 3 GHz		19.25	16.10	6.37	
3 to 4 GHz		19.25	15.64	6.24	
4 to 6 GHz		19.25	–	–	
6 to 7.5 GHz		22.25	–	–	
7.5 to 13.6 GHz		22.25	–	–	
13.6 to 18 GHz		24.25	–	–	
18 to 20 GHz		24.25	–	–	
20 to 24 GHz		27.25	–	–	
24 to 26.5 GHz		37.25	–	–	
Noise source ENR					
Measurement range					
4 to 6.5 dB	0 to 20 dB	± 0.05 dB	± 0.05 dB	± 0.05 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB	0 to 30 dB	± 0.05 dB	± 0.05 dB	± 0.05 dB	
20 to 22 dB	0 to 35 dB	± 0.1 dB	± 0.1 dB	± 0.1 dB	
Jitter					
		± 0.15 dB	± 0.15 dB	± 0.15 dB	DUT gain range = –20 to +40 dB
Instrument uncertainty for gain[4, 5]					
		± 0.20 dB	± 0.20 dB	± 0.20 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

CXA with U7227C preamplifier

Frequency	CXA full range	CXA + U7227C full range		
VSWR[1]				
Frequency				
10 to 100 MHz	3.0	–		
0.1 to 3 GHz	3.0	1.43		
3 to 4 GHz	3.0	1.43		
4 to 7.5 GHz	3.0	2.32		
7.5 to 26.5 GHz	2.5	2.32		
	Internal preamp on	**Internal preamp off + U7227C**	**Internal preamp on + U7227C**	**Supplemental information**
Noise figure[2, 3]				
10 to 100 MHz	17.25	–	–	
0.1 to 1.5 GHz	17.25	18.04	7.12	
1.5 to 3 GHz	19.25	17.67	7.55	
3 to 4 GHz	19.25	17.43	7.47	
4 to 6 GHz	19.25	16.88	6.62	
6 to 7.5 GHz	22.25	18.36	7.10	
7.5 to 13.6 GHz	22.25	18.76	6.36	
13.6 to 18 GHz	24.25	22.53	6.75	
18 to 20 GHz	24.25	22.04	7.10	
20 to 24 GHz	27.25	22.98	7.96	
24 to 26.5 GHz	37.25	32.27	14.75	
Noise source ENR				
Measurement range				
4 to 6.5 dB 0 to 20 dB	± 0.05 dB	± 0.05 dB	± 0.05 dB	Using internal preamp and RBW ≤ 4 MHz
12 to 17 dB 0 to 30 dB	± 0.05 dB	± 0.05 dB	± 0.05 dB	
20 to 22 dB 0 to 35 dB	± 0.1 dB	± 0.1 dB	± 0.1 dB	
Jitter				
	± 0.15 dB	± 0.15 dB	± 0.15 dB	DUT gain range = –20 to +40 dB
Instrument uncertainty for gain[4, 5]				
	± 0.20 dB	± 0.20 dB	± 0.20 dB	

Instrument uncertainty for noise figure, 10 MHz to 26.5 GHz[6]

1. Analyzer VSWR is characterized to the 95th percentile but not measured and warranted. The VSWR measurement is made on the PNA-X which is traceable. The reverse isolation of the USAB preamp is high enough that the system VSWR is insignificantly affected by the analyzer VSWR. So the system VSWR is the warranted VSWR of the USB preamp.
2. Analyzer noise figure is computed from the specified DANL using NF = D - (K - L + B) where D is the DANL (displayed average noise level), K is kTB (-173.98 dBm in a 1 Hz bandwidth at 290 K), L is 2.51 dB (the effect of log averaging used in DANL verifications), N is 0.24 dB (the ratio of the noise bandwidth of the RBW filter with which the DANL is specified to an ideal noise bandwidth), B is ten times the base-10 logarithm of the RBW (in hertz) in which the DANL is specified. B is 0 dB for the 1 Hz RBW. The actual NF will vary from the nominal due to frequency response errors. Frequency response errors help as often as they harm, so NF derived from the DANL is a very good approximation to the true NF. Any other uncertainties created by deriving the noise figure are small second-order uncertainties the GUM does not require.
3. Noise figure for the combination of USB preamp and analyzer is $NF_{sys} = 10*Log(F_{preamp} + (F_{analyzer} - 1)/G_{preamp})$. The noise figure and gain of the preamp are specified and warranted. The noise figure of the analyzer is derived and discussed in [2]. The uncertainty due to the noise figure of the analyzer is smaller than [2].
4. "Instrument Uncertainty" is defined for noise figure analysis as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for a noise figure computation. The relative amplitude uncertainty depends on, but is not identical to, the relative display scale fidelity, also known as incremental log fidelity. The uncertainty of the analyzer is multiplied within the computation by an amount that depends on the Y factor to give the total uncertainty of the noise figure or gain measurement. See Agilent App Note 57-2, literature number 5952-3706E for details on the use of this specification. Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. This application uses the 4 MHz Resolution Bandwidth as default because this is the widest bandwidth with uncompromised accuracy.
5. "Instrument Uncertainty" is defined for gain measurements as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for the gain computation. See Agilent App Note 57-2, literature number 5952-3706E for details on the use of this specification. Jitter (amplitude variations) will also affect the accuracy of results. The standard deviation of the measured result decreases by a factor of the square root of the Resolution Bandwidth used and by the square root of the number of averages. This application uses the 4 MHz Resolution Bandwidth as default since this is the widest bandwidth with uncompromised accuracy.
6. Instrument uncertainty for gain is characterized to the 95th percentile above 3.6 GHz.

Note: Data subject to change

For a complete list of specifications, refer to the appropriate specifications guide:

UXA: **www.keysight.com/find/uxa_specifications**
PXA: **www.keysight.com/find/pxa_specifications**
MXA: **www.keysight.com/find/mxa_specifications**
EXA: **www.keysight.com/find/exa_specifications**
CXA: **www.keysight.com/find/cxa_specifications**
NFA: **www.keysight.com/find/NFA_X-Series_specifications**

Computing measurement uncertainty

Keysight provides three versions of noise figure uncertainty calculation, including

- Built-in noise figure uncertainty calculator (NFUC) enables you to calculate measurement uncertainty directly using the current measurement results.
- Spreadsheet version gives you the most freedom to enter DUT information and instrument specifications to get an accurate noise figure uncertainty. The spreadsheet version of the NFUC can be found at: www.keysight.com/find/nfu
- Online version enables you to sweep on almost all the relevant parameters to see their impact on measurement uncertainty. Access the online version of the NFUC through: www.keysight.com/find/nfuc

Software Licensing and Instrument Configuration

Choose from two license types::

- **Fixed, perpetual license:**
  This allows you to run the application in the X-Series analyzer in which it is initially installed.
- **Transportable, perpetual license:**
  This allows you to run the application in the X-Series analyzer in which it is initially installed, plus it may be transferred from one multi-touch X-Series analyzer to another.

You Can Upgrade!

Options can be added after your initial purchase.
All of our X-Series application options are license-key upgradeable.

N9069C noise figure X-Series measurement application

Model-Option	Description, license type
N9069C-3FP	Noise figure measurement fixed perpetual
N9069C-3TP	Noise figure measurement transportable perpetual

Hardware Configuration

For optimizing noise figure measurements with noise figure measurement application, Keysight recommends a minimum level of X-Series multi-touch signal analyzer hardware functionality at each instrument performance point.
Supported analyzers include:

- UXA N9040B
- PXA N9030B
- MXA N9020B
- EXA N9010B
- CXA N9000B

Capability	Instrument Option	Benefit
Electronic Attenuator	-EA3	Recommended: Fast and reliable attenuation changes ideal for manufacturing without the wear associated with mechanical attenuators up to 3.6 GHz in 1 dB steps
Pre-amplifier	3.6 GHz (-P03) or higher	Required: For maximizing the measurement sensitivity to meet specifications

The following NFA X-Series Noise Figure Analyzers are supported:

- N8973B
- N8974B
- N8975B
- N8976B

The NFA-X-Series comes standard with the fine step attenuator, precision frequency reference, full band preamplifier, noise floor extension, and U7227 USB preamplifier so no additional options are required.

Noise source

346 Series noise sources work with the full range of Keysight noise figure solutions. They are categorized by frequency coverage as well as excess noise ratio (ENR). The SNS noise sources replicate the ENR output and frequency coverage of the 346 Series noise sources, however with the SNS Series, ENR data is stored in an EPROM and is automatically downloaded to the instrument, eliminating the need to manually enter the values into the calibration table at each cardinal frequency point. In addition, a thermistor is built into the sensor to continually update the analyzer with the correct temperature, delivering automatic temperature compensation/correction within the measurement's source.

The U7227A/C/F USB preamplifiers, used with an X-Series signal analyzer reduces uncertainty of Y-factor noise figure measurements up to 50 GHz.

Noise source	Frequency range	ENR
346A	10 MHz to 18 GHz	5 to 7 dB
346B	10 MHz to 18 GHz	14 to 16 dB
346C	10 MHz to 26 GHz	12 to 17 dB
346CK01	1 GHz to 50 GHz	7 to 20 dB
346CK40	1 GHz to 40 GHz	3 to 14 dB
Q347B	33 GHz to 50 GHz	6 to 13 dB
R347B	26.5 GHz to 40 GHz	10 to 13 dB
N4000A	10 MHz to 18 GHz	4.6 to 6.5 dB
N4001A	10 MHz to 18 GHz	14 to 16 dB
N4002A	10 MHz to 26 GHz	12 to 17 dB

Note: If the DUT noise figure is beyond 30 dB, then the Keysight PNA-X Option 029 for noise figure measurements on a network analyzer may be more suitable than the Y-factor method.

USB preamplifiers

Specification	U7227A	U7227C	U7227F
Frequency	10 MHz to 4 GHz	100 MHz to 26.5 GHz	2 GHz to 50 GHz
Gain (dB)	10 to 100 MHz: > 16 100 MHz to 4 GHz: > 0.5F + 17	100 MHz to 26.5 GHz: > 16.1 + 0.26F	2 to 50 GHz: > 16.5 + 0.23F
Input return loss (Input SWR)	10 to 100 MHz: > 5 dB (3.57) 100 MHz to 2 GHz: > 13.5 dB (1.54) 2 to 3 GHz: > 11.5 dB (1.73) 3 to 4 GHz: > 10 dB (1.93)	100 MHz to 4 GHz: > 15 dB (1.43) 4 to 26.5 GHz: > 8 dB (2.32)	2 GHz to 40 GHz: > 8 dB (2.32) 40 to 44 GHz: > 6 dB (3.00) 44 to 50 GHz: > 5 dB (3.57)
Output return loss (Output SWR)	10 MHz to 4 GHz: > 18 dB (1.29)	100 MHz to 4 GHz: > 18 dB (1.29) 4 to 26.5 GHz: > 11 dB (1.78)	2 GHz to 4 GHz: > 18 dB (1.29) 4 to 40 GHz: > 11 dB (1.78) 40 to 50 GHz: > 8 dB (2.32)
Noise figure	10 to 100 MHz: < 5.5 dB 10 MHz to 4 GHz: < 5 dB	100 MHz to 4 GHz: < 6 dB 4 to 6 GHz: < 5 dB 6 to 18 GHz: < 4 dB 18 to 26.5 GHz: < 5 dB	2 to 4 GHz: < 10 dB 4 to 40 GHz: < 8 dB 40 to 44 GHz: < 9 dB 44 to 50 GHz: < 10 dB
Plug and play USB connection	Yes	Yes	Yes
Optimized gain slope for better spectrum analysis	Yes	Yes	Yes
Automatic gain compensation	Yes	Yes	Yes
Automatic temperature compensation	Yes	Yes	Yes

Additional Information

Measurement, user's and programming guides can be found on the product Web page in the document library: **www.keysight.com/find/n9069c**

Literature

Fundamentals of RF and Microwave Noise Figure Measurements - Application Note, literature number 5952-8255EN

Noise Figure Measurement Accuracy – the Y-factor method - Application Note, literature number 5952-3706EN

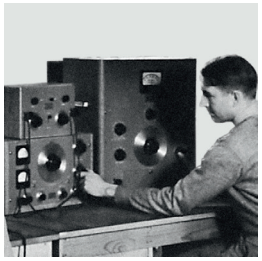
10 Hints for Making Successful Noise Figure Measurements - Application Note, literature number 5980-0288E

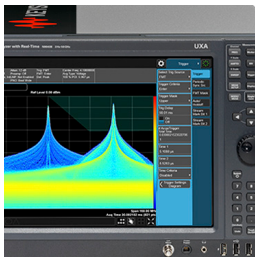
Keysight N4000A, N4001A, N4002A SNS Series Noise Sources 10 MHz to 26.5 GHz - Technical Overview, literature number 5980-0288E

Keysight USB Preamplifiers U7227A/C/F - Technical Overview, literature number 5991-4246EN

Evolving Since 1939

Our unique combination of hardware, software, services, and people can help you reach your next breakthrough. We are unlocking the future of technology.
From Hewlett-Packard to Agilent to Keysight.





myKeysight

myKeysight
www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

www.keysight.com/find/emt_product_registration
Register your products to get up-to-date product information and find warranty information.

KEYSIGHT SERVICES
Accelerate Technology Adoption.
Lower costs.

Keysight Services
www.keysight.com/find/service
Keysight Services can help from acquisition to renewal across your instrument's lifecycle. Our comprehensive service offerings—one-stop calibration, repair, asset management, technology refresh, consulting, training and more—helps you improve product quality and lower costs.

CALIBRATION WARRANTY UP TO 10 YEARS
ASSURANCE PLANS

Keysight Assurance Plans
www.keysight.com/find/AssurancePlans
Up to ten years of protection and no budgetary surprises to ensure your instruments are operating to specification, so you can rely on accurate measurements.

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/n9069C

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 11 2626
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353 Opt. 1 (DE) Opt. 2 (FR) Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-9-7-17)

DEKRA Certified
ISO9001 Quality Management System

www.keysight.com/go/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2015
Quality Management System

KEYSIGHT TECHNOLOGIES
Unlocking Measurement Insights

Published in USA, December 1, 2017
5992-0851EN
www.keysight.com