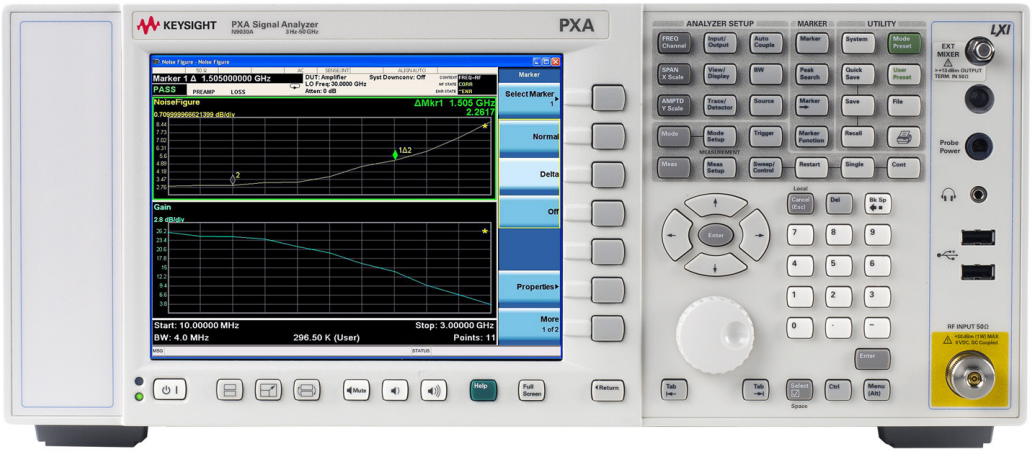
Keysight Technologies
Noise Figure
X-Series Measurement Application
N9069A & W9069A

Technical Overview



- Characterize noise figure and gain of connectorized devices and system blocks with graphic, meter, and table views
- User-definable sweep time and noise source settling time
- Fully-specified measurements with optional internal preamp; improved specifications with external USB preamp
- 50 GHz internal uncertainty calculator
- Noise figure measurements to 110 GHz (Option 526 or greater required) with Keysight Technologies, Inc. K-Series block downconverters
- Move application between X-Series signal analyzers with transportable licensing

KEYSIGHT TECHNOLOGIES

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. Keysight's N/W9069A noise figure measurement application offers development engineers a simple tool to make accurate and repeatable noise figure measurements. Pair this measurement application with an Keysight X-Series signal analyzer for fully specified results up to 26.5 GHz on the CXA, CXA-m MXA and MXE, up to 44 GHz on the EXA, and up to 50 GHz on the PXA. 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, X-Series signal analyzers or the MXE EMI receiver 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.

The U7227A/C/F USB preamps are available to reduce the uncertainty of Y-factor noise figure measurements to 44 GHz. With these preamps and an X-Series signal analyzer, you can obtain better noise figure measurements than with a dedicated noise figure analyzer such as the N8973/ 4/5A.

When using this application on an X-Series signal analyzer or MXE EMI receiver, engineers will also benefit from full RF signal analysis capabilities in one instrument. In addition, the noise figure measurement application is code-compatible with previous Keysight noise figure solutions where hardware and measurements are the same. The application can be configured for remote programming via USB, LAN, or GPIB—all of which are standard for X-Series.

Key Specifications

Definitions

- Specifications describe the performance of parameters covered by the product warranty.
- 95th percentile values indicate the breadth of the population (≈2σ) of performance tolerances expected to be met in 95% of cases with a 95% confidence. These values are not covered by the product warranty.
- Typical values are designated with the abbreviation "typ." These are performance beyond specification that 80% of the units exhibit with a 95% confidence. These values are not covered by the product warranty.
- 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, but is not covered by the product warranty.

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 gain, see the Noise Figure Measurement Guide, literature number N9069-90006.

Performance specifications

PXA with U7227A preamplifier		Specifications			
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		Specifications			
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		Specifications			
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		Specifications			
	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		Specifications			
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		Specifications			
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		Specifications			
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		Specifications			
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		Specifications			
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		Specifications			
	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]

CXA-m		Specifications	
	Frequency	CXA-m full range	
VSWR[1]			
	Frequency		
	10 MHz to 13.6 GHz	2.2	
	13.6 to 26.5 GHz	2.5	
		Internal preamp on	Supplemental information
Noise figure[2, 3]			
	10 MHz to 4.5 GHz	17.25	
	4.5 to 9.5 GHz	20.25	
	9.5 to 13 GHz	21.25	
	13 to 14.5 GHz	19.25	
	14.5 to 19.3 GHz	24.25	
	19.3 to 23 GHz	25.25	
	23 to 24 GHz	27.25	
	24 to 26.5 GHz	34.25	
Noise source ENR			
	Measurement range		
4 to 6.5 dB	0 to 20 dB	± 0.05 dB	
12 to 17 dB	0 to 30 dB	± 0.05 dB	
20 to 22 dB	0 to 35 dB	± 0.1 dB	
Jitter			
		± 0.15 dB	DUT gain range = –20 to +40 dB
Instrument uncertainty for gain[4, 5]			
		± 0.17 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 gain measurements as uncertainty due to relative amplitude uncertainties encountered in the analyzer when making the measurements required for the gain computation. See Keysight 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.

[5] Instrument uncertainty for gain is characterized to the 95th percentile above 3.6 GHz.

[6] “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 Keysight App Note 57-2, literature number 5952-3706E, for details on the use of this specification.

Note: Data subject to change

Computing measurement uncertainty

Keysight provides several versions of a noise figure uncertainty calculator (NFUC). The spreadsheet version gives the user 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/nfuc**

Noise figure and VSWR of the measurement depend on the measurement configuration used and also the gain of the DUT.

For more information about measurement uncertainty, the Using the U7227-Series USB Preamps for Noise Figure Measurements user guide is available.

instructions on calculating noise figure measurement uncertainty using the USB preamplifiers can be found in the U7227-Series user guide.

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Noise figure measurement application	N9069A-1FP	W9069A-1FP	Fixed perpetual license; provides noise figure, gain, Y factor, effective noise temperature, and hot and cold noise measurements of amplifiers and other non-frequency converting devices
Advanced features	N9069A-2FP (Requires 1FP)	W9069A-2FP (Requires 1FP)	Manual mode, external LO control, and measurement of frequency-converting devices, including multi-stage converters
Upgrade to noise figure measurement application	N9069A-AFP	W9069A-AFP	Adds meter display including a strip chart for fixed frequency measurements; fixed perpetual license

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www.keysight.com/find/N9069A-MEU for PXA, MXA, EXA
www.keysight.com/find/W9069A-MEU for CXA

N9030A PXA signal analyzer

Description	Model-Option	Additional information
3.6, 8.4, 13.6, 26.5, 43, 44, or 50 GHz frequency range	N9030A-503, -508, -513, -526, -543, -544, or -550	One required
Electronic attenuator, 3.6 GHz	N9030A-EA3	Recommended
Preamplifier, 3.6, 8.4, 13.6, 26.5, 43, 44, or 50 GHz	N9030A-P03, -P08, -P13, -P26, -P43, -P44, or -P50	One required to meet spec

N9020A MXA signal analyzer

Description	Model-Option	Additional information
3.6, 8.4, 13.6, or 26.5 GHz frequency range	N9020A-503, -508, -513, or -526	One required
Electronic attenuator, 3.6 GHz	N9020A-EA3	Recommended
Preamplifier, 3.0, 8.4, 13.6, 26.5 GHz	N9020A-P03, -P08, -P13, or -P26	One required to meet spec

N9010A EXA signal analyzer

Description	Model-Option	Additional information
3.6, 7.0, 13.6, 26.5, 32, or 44 GHz frequency range	N9010A-503, -507, -513, -526, -532, or -544	One required
Electronic attenuator, 3.6 GHz	N9010A-EA3	Recommended
Fine step attenuator	N9010A-FSA	Recommended
Preamplifier, 3.6, 7.0, 32, 44 GHz	N9010A-P03, -P07, -P32, or -P44	One required to meet spec

N9000A CXA signal analyzer

Description	Model-Option	Additional information
3.0, 7.5, 13.6, 26.5 GHz frequency range	N9000A-503, -507, -513, or -526	One required
Fine step attenuator	N9000A-FSA	One recommended
Preamplifier, 3.6, 7.5, 13.6, 26.5 GHz	N9000A-P03, -P07, -P13, or -P26	One required to meet spec

N9038A MXE EMI receiver

Description	Model-Option	Additional information
8.4 or 26.5 GHz frequency range	N9038A-508 or -526	One required

M9290A CXA-m PXIe signal analyzer

Description	Model-Option	Additional information
3.0, 7.5, 13.6, or 26.5 GHz frequency range	M9290A-F03, -F07, -F13 or -F26	One required
Fine step attenuator	M9290A-FSA	One recommended
Preamplifier, 3.0, 7.5, 13.6, 26.5 GHz	M9290A-P03, -P07, -P13, or -P26	One required to meet spec

Noise source offerings

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 Series of noise sources, or smart noise sources, can be used in conjunction with the X-Series signal analyzers, NFA, and ESA spectrum analyzer. 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, reduce uncertainty of Y-factor noise figure measurements up to 44 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
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

Related Literature

Noise Figure Measurement Accuracy: The Y-Factor Method, Application Note 57-2, literature number 5952-3706E

N9069A & W9069A Noise Figure X-Series Measurement Application Self-Guided Demonstration, literature number 5990-9835EN

Keysight N4000A, N4001A, N4002A SNS Series Noise Sources 10 MHz to 26.5 GHz, Technical Overview, literature number 5988-0081EN

Web

Product pages:
www.keysight.com/find/N9069A
www.keysight.com/find/W9069A

X-Series measurement applications:
www.keysight.com/find/X-Series_Apps

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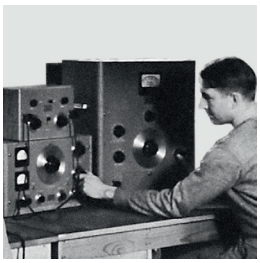

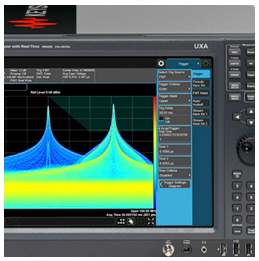

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