Keysight Technologies

NFA X-Series Noise Figure Analyzer, Multi-touch N8973B, N8974B, N8975B, N8976B

10 MHz to 3.6, 7.0, 26.5, or 40.0 GHz

Data Sheet

KEYSIGHT TECHNOLOGIES

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Specifications

Specifications describe the performance of parameters covered by the product warranty. These values are only valid for the stated operating frequency, and apply over 0°C to +55°C unless otherwise noted.

95th percentile values indicate the breadth of the population (approx. 2 σ) of performance tolerances expected to be met in 95 percent of the cases with a 95 percent confidence, for any ambient temperature in the range of +20°C to +30°C. In addition to the statistical observations of a sample of instruments, these values include the effects of the uncertainties of external calibration references. These values are not warranted. These values are updated occasionally if a significant change in the statistically observed behavior of production instruments is observed.

Typical describes additional product performance information that is not covered by the product warranty. It is performance beyond specifications that 80 percent of the units exhibit with a 95 percent confidence level over the temperature range of +20°C to +30°C. Typical performance does not include measurement uncertainty.

Nominal values indicate expected performance, or describe product performance that is useful in the application of the product, but are not covered by the product warranty.

The analyzer will meet its specifications when:

- It is within its calibration cycle
- Under auto couple control, except when Auto Sweep Time Rules = Accy
- Signals measured <10 MHz have DC coupling applied
- The analyzer has been stored at an ambient temperature within the allowed operating range for at least two hours before being turned on; if it had previously been stored at a temperature range inside the allowed storage range, but outside the allowed operating range
- The analyzer has been turned on at least 30 minutes with Auto Align set to normal, or, if Auto Align is set to off or partial, alignments must have been run recently enough to prevent an Alert message; if the Alert condition is changed from Time and Temperature to one of the disabled duration choices, the analyzer may fail to meet specifications without informing the user

For the complete specifications guide, visit:
www.keysight.com/find/NFA_X-Series_specifications

Frequency

Frequency range		
N8973B	10 MHz to 3.6 GHz	
N8974B	10 MHz to 7.0 GHz	
N8975B	10 MHz to 26.5 GHz	
N8976B[4]	10 MHz to 40.0 GHz	
Measurement bandwidth (nominal)		
N8973B, N8974B, N8975B, N8976B[5]	1 Hz to 3 MHz (in E24 series increments[1]), 4 MHz, 5 MHz, 6 MHz, 8 MHz	
Frequency reference		
Accuracy	± [RΔt + T + C]	
Aging rate	± 0.1 ppm[2]/year ± 0.15 ppm/2 years	
Temperature stability +20°C to +30°C Full temperature range	 ± 0.015 ppm ± 0.05 ppm	R = aging rate Δt = time since last adjustment T = temperature stability C = calibration accuracy
Achievable initial calibration accuracy	± 0.04 ppm	
Example frequency reference accuracy, Residual FM </= (use less than or equal to symbol) (0.25 Hz x N) p-p in 20 ms nominal 1 year since last adjustment	= ± (1 x 10^{-7} + 5 x 10^{-8} + 4 x 10^{-8}) = ± 0 0.19 ppm	
Frequency readout accuracy (start, stop, center, marker)	± (marker frequency x frequency reference accuracy + 0.25% x span + 5% x RBW + 2 Hz + 0.5 x horizontal resolution[3])	

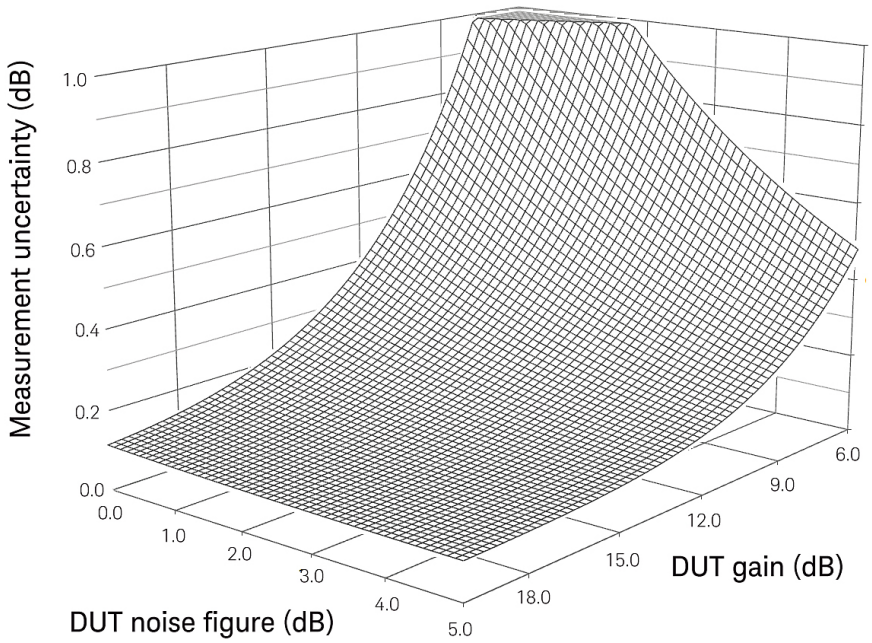
1. The E24 series is defined by international standard IEC 60063. E24 is a preferred series of numbers, with each number being approximately 10% larger than the previous number. It is commonly used for the labeling of 5% tolerance resistors, capacitors, etc.
2. Parts per million (10-6)
3. Horizontal resolution is span/(sweep points – 1).
4. The N8976B ships with 346CK40. The 346CK40 has superior match above 26 GHz, which leads to better uncertainty.
5. IQ analyzer (basic) mode has up to 25 MHz analysis BW.

Note: The NFA X-Series noise figure analyzer is more than a dedicated noise figure analyzer. Each model has full featured spectrum analyzer and IQ analyzer (basic) modes. The analyzer is specified to 44 GHz when in SA or IQ analyzer mode.

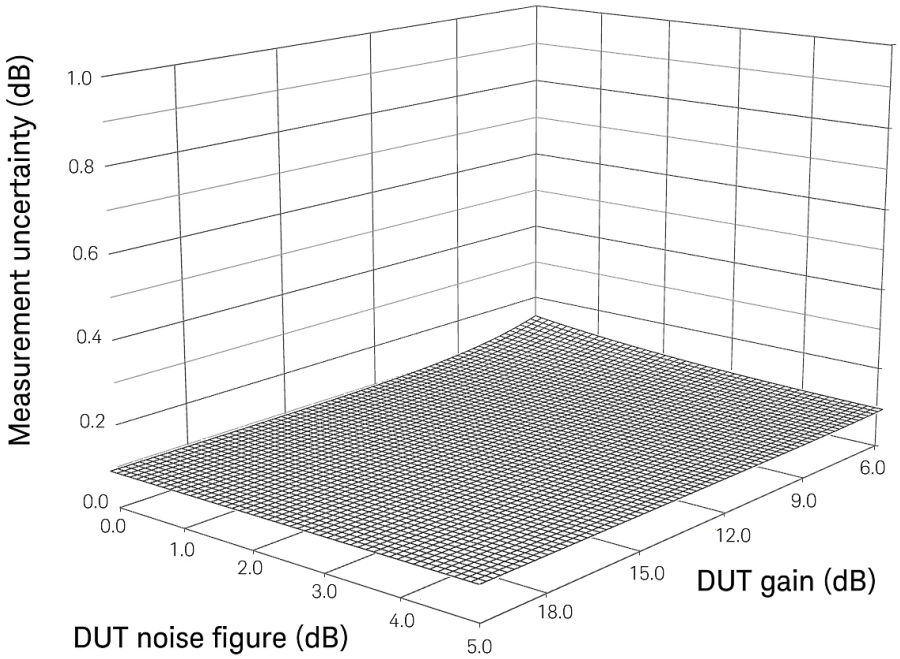
Noise figure, gain, and uncertainty

Example DUT uncertainties[1]

Without a Preamp



With a USB Preamp[2]



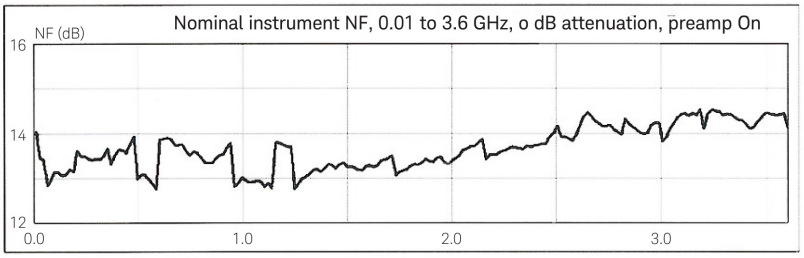
When combined with the U7227A/C/F preamp, the NFA X-Series noise figure analyzer offers improved uncertainty over the previous NFA-A in all of the above hypothetical cases.

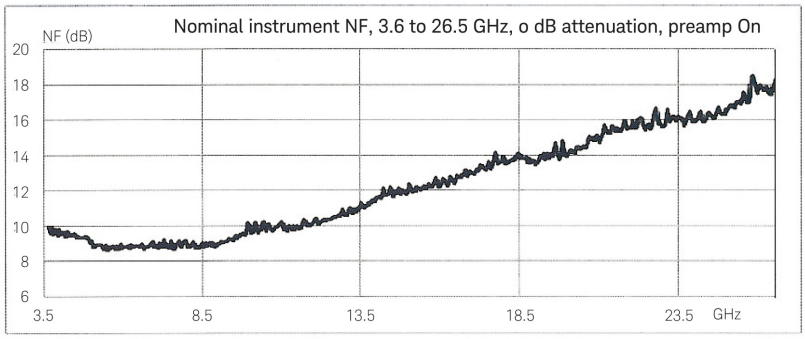
1. These uncertainties assume a measurement made with a N8975B at 1 GHz with a N4000A noise source and a non-frequency-converting DUT. The DUT is assumed to have an input/output match of 1.5 VSWR.
2. Assuming a U7227A/C/F External USB Preamp

Description	Specifications		Supplemental information
Noise figure ‹ 10 MHz 10 MHz to internal preamplifier's frequency limit[1]			Uncertainty calculator[1] See note[1] Internal and external preamplification recommended[1]
Noise source ENR	Measurement range	Instrument uncertainty	
4 to 6.5 dB	0 to 20 dB	± 0.02 dB	
12 to 17 dB	0 to 30 dB	± 0.025 dB	
20 to 22 dB	0 to 35 dB	± 0.03 dB	
Gain			
Instrument uncertainty[1]			DUT Gain range = –20 to +40 dB
‹ 10 MHz			See note[1]
10 MHz to 3.6 GHz	± 0.15 dB		
› 3.6 GHz			± 0.11 dB additional[1] 95th percentile, 5 minutes after calibration
Noise Figure uncertainty calculator[1, 2]			
Instrument noise figure uncertainty	See the noise figure table above		
Instrument gain uncertainty	See the gain table above		
Instrument noise figure			See graphs of "Nominal instrument noise figure"; noise figure is DANL + 176.24 dB (nominal)[1]. Note on DC coupling[1]
Instrument input match			See graph: nominal VSWR. Note on DC coupling[1]
Optional NFE improvement/internal Cal[1]			See "Displayed average noise level (DANL) (with noise floor extension) improvement" in the Option NFE - Noise floor extension chapter.
Uncertainty versus calibration options[1]			
User calibration	Best uncertainties; noise figure uncertainties calculator applies		
Uncalibrated	Worst uncertainties; noise of the analyzer input acts as a second stage noise on the DUT		
Internal calibration	Available with Option NFE. Good uncertainties without the need of reconnecting the DUT and running a clibration. The uncertainty of the analyzer input noise model adds a second-stage noise power to the DUT that can be positive or negative. Running the noise figure uncertainty calculator will usually show that internal calibration achieves 90% of the possible improvement between the uncalibrated and user calibration states.		

1. Refer to NFA X-Series specifications guide for footnote details
2. Online uncertainty calculator at **www.keysight.com/find/nfuc** or use the instrument's built-in calculator.

Nominal instrument noise figure, N8973B, N8974B, N8975B





Internal Preamp noise figure

Frequency	Noise Figure (nominal)
100 kHz to 3.6 GHz	8 dB + (0.001112 * freq in MHz) nominal
3.6 GHz to 8.4 GHz	9 dB nominal
8.4 GHz to 13.6 GHz	10 dB nominal
> 13.6 GHz	DANL + 176.24 dB nominal

Measurement uncertainty is usually dominated by the uncertainty of the noise source, meaning that the instrument's noise figure is negligible for most measurements. For situations when this noise figure becomes non-negligible (i.e. low-gain, low-noise DUTs), the included U7227 Series USB preamp provides extra measurement reliability.

DANL (N8973B, N8974B, N8975B)[1]

Frequency	Specification	Typical
10.0 MHz to 2.1 GHz	–161 dBm	–163 dBm
2.1 GHz to 7.0 GHz	–160 dBm	–162 dBm
7.0 GHz to 13.6 GHz	–160 dBm	–163 dBm
13.5 GHz to 17.1 GHz	–157 dBm	–160 dBm
17.0 GHz to 20.0 GHz	–155 dBm	–159 dBm
20.0 GHz to 26.5 GHz	–150 dBm	–156 dBm

DANL (N8976B)[1]

Frequency	Specification	Typical
10.0 MHz to 1.2 GHz	–164 dBm	–165 dBm
1.2 GHz to 2.1 GHz	–163 dBm	–164 dBm
2.1 GHz to 3.6 GHz	–162 dBm	–163 dBm
3.5 GHz to 20.0 GHz	–160 dBm	–162 dBm
20.0 GHz to 26.5 GHz	–158 dBm	–160 dBm
26.4 GHz to 34.0 GHz	–156 dBm	–159 dBm
33.9 GHz to 40.0 GHz	–153 dBm	–155 dBm

Preamp noise figure and gain[2]

Specification	U7227A	U7227C	U7227F
Frequency	10 MHz to 4 GHz	100 MHz to 26.5 GHz	2 GHz to 50 GHz
Noise figure	10 MHz to 100 MHz: < 5.5 dB 100 MHz to 4 GHz: < 5 dB	100 MHz to 4 GHz: < 6 dB 4 GHz to 6 GHz: < 5 dB 6 GHz to 18 GHz: < 4 dB 18 GHz to 26.5 GHz: < 5 dB	
Gain	10 to 100 MHz: > 16 dB 100 MHz to 4 GHz: > 17 + 0.5F dB	100 MHz to 26.5 GHz: > 16.1 + 0.26F dB	2 GHz to 50 GHz: > 16.5 + 0.23F dB
Averaging	Up to 10,000 measurement results		

* "F" signifies frequency in GHz

1. Preamp on, input terminated, sample or average detector, log averaging, 0 dB input attenuation, IF Gain = High, +20°C to +30°C.
2. See U7227A/C/F Data Sheet for list of specifications

RF input

Connector		
N8973B, N8974B, N8975B	Type-N female, 50 Ω nominal	
N8976B	2.4 mm male, 50 Ω nominal	
Input VSWR		
Input VSWR	**N8973B, N8974B, N8975B**	**N8976B**
10 MHz to 3.6 GHz	< 1.2:1 nominal	1.2:1 nominal
3.6 GHz to 26.5 GHz	< 1.9:1 nominal	1.5:1 nominal
26.5 GHz to 44.0 GHz	N/A	< 1.8:1 nominal

Measurement

Sweep	
Number of points setting	2 to 501, or fixed frequency Start/stop, center/span, Frequency list of up to 501 points
Sweep trigger	Continuous or single
Measurement speed	
Local measurement and display update rate	11 ms (90/s)
Remote measurement and LAN transfer rate	6 ms (167/s)
Marker peak search	5 ms
Center frequency tune and transfer (RF)	22 ms
Center frequency tune and transfer (µW)	49 ms
Measurement/mode switching	75 ms
DUT profiles available	
Amplifier	Includes any non-frequency-converting device (e.g. amplifiers, attenuators, filters, etc)
Downconverting DUT	With fixed or variable IF. Instrument capable of controlling an external LO via GPIB, LAN, or USB
Upconverting DUT	With fixed or variable IF. Instrument capable of controlling an external LO via GPIB, LAN, or USB
System downconverter	Allows the use of an external downconverting mixer as part of the measurement system. Instrument capable of controlling an external LO via GPIB, LAN, or USB

Measurement

Display type and N.F. results	
Type	4U multitouch
Output format	Graphical, table of values, or meter mode
Display channels	2
Number of markers	4
Limit lines	Upper and lower for each of 2 channels
Noise figure	Noise figure (*F* dB), or as a ratio (*F*)
Gain	Gain (G dB)
Y-factor	Y-factor (Y dB)
T effective	Effective noise temperature in Kelvin
P hot	Relative power density in dB
P cold	Relative power density in dB

Front panel

Sweep	
Probe power	
Voltage/current	+15 Vdc ± 7 % at 150 mA max nominal -12.6 Vdc ± 10 % at 150 mA max nominal
USB 2.0 ports	
Master (2 ports)	
Standard	Compatible with USB 2.0
Connector	USB Type-A female
Output current	0.5 A nominal
Master (1 port)	
High power	Compatible with USB 2.0
Connector	USB Type-A Female
Output current	1.0A nominal

Rear panel connectivity

10 MHz out	
Connector	BNC female, 50 Ω nominal
Output amplitude	≥ 0 dBm nominal
Frequency	10 MHz ± (10 MHz x frequency reference accuracy)
Ext ref in	
Connector	BNC female, 50 Ω nominal
Input amplitude range	–5 to 10 dBm nominal
Input frequency	10 MHz nominal
Frequency lock range	± 5 x 10^{-6} of specified external reference input frequency
Trigger 1 and 2 inputs	
Connector	BNC female
Impedance	> 10 kΩ nominal
Trigger level range	–5 to 5 V
Trigger 1 and 2 inputs	
Connector	BNC female
Impedance	50 Ω nominal
Trigger level range	5 V TTL nominal
Monitor output	
Connector	VGA compatible, 15-pin mini D-SUB
Format	XGA (60 Hz vertical sync rates, non-interlaced) analog RGB
Resolution	1024 x 768
Rear panel	
Noise source drive +28 V (pulsed)	
Connector	BNC female
SNS Series noise source connector	For use with Keysight SNS Series noise sources
USB 2.0 ports	
Master (4 ports)	
Standard	Compatible with USB 2.0
Connector	USB Type-A female
Oupt current	0.5 A nominal
Slave (1 port)	
Standard	Compatible with USB 2.0
Connector	USB Type-B female
Output current	0.5 A nominal
GPIB interface	
Connector	IEEE-488 bus connector
GPIB codes	SH1, AH1, T6, SR1, LR1, PP0, DC1, C1, C2, C3, C28,DT1, L4, C0
GPIB mode	Controller or device
LAN TCP/IP interface	
Standard	1000 Base-T
Connector	RJ45 Ethertwist

General Specifications

Temperature range	
Operating	0 to 55°C
Storage	–40 to 70°C
EMC	
Complies with European EMC Directive 2004/108/EC – IEC/EN 61326-1 or IEC/EN 61326-2-1 – CISPR Pub 11 Group 1, class A – AS/NZS CISPR 11:2002 – ICES/NMB-001 This ISM device cmplies with Canadian ICES-001 Get appareil ISM est conforme à la norme NMB-001 du Canada	
Safety	
Complies with European Low Voltage Directive 2006/95/EC – IEC/EN 61010-1 3rd Edition – Canada: CSA C22.2 No. 61010-1-12 – U.S.A.: UL 61010-1 3rd Edition	
Acoustic statement (European Machinery Directive 2002/42/EC, 1.7.4.2u)	
Acoustic noise emission LpA < 70 dB Operator position Normal position Per ISO 7779	
Environmental stress	
Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of storage, transportation, and end-use; those stresses include, but are not limited to, temperature, humidity, shock, vibration, altitude, and power line conditions; test method are aligned with IEC 60068-2 and levels are similar to MILPRF-28800F Class 3.	
Power requirements	
Voltage and frequency	100 to 120 V, 50/60/400 Hz 220 to 240 V, 50/60 Hz
Power consumption	
On	350 W maximum
Standy	20 W
Display	
Resolution	1280 × 768, WXGA
Size	269 mm (10.6 in.) diagonal (nominal)
Data storage	
Internal	≥ 160 GB nominal (removable solid-state drive)
External	Supports USB 2.0 compatible memory devices
Weight (without options)	
Net	16 kg (35 lbs) nominal
Shipping	28 kg (62 lbs) nominal
Dimensions	
Height	177 mm (7.0 in)
Width	426 mm (16.8 in)
Length	368 mm (14.5 in)
Warranty	
The NFA noise figure analyzer is supplied with a standard 3-year warranty	
Calibration cycle	
The recommended calibration cycle is two years: calibration services are available through Keysight service centers	

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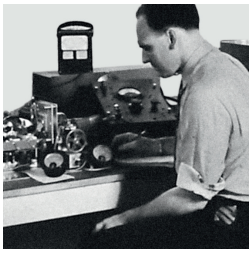

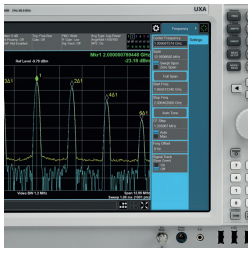

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