

# 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



## 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 s) 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

## Frequency

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

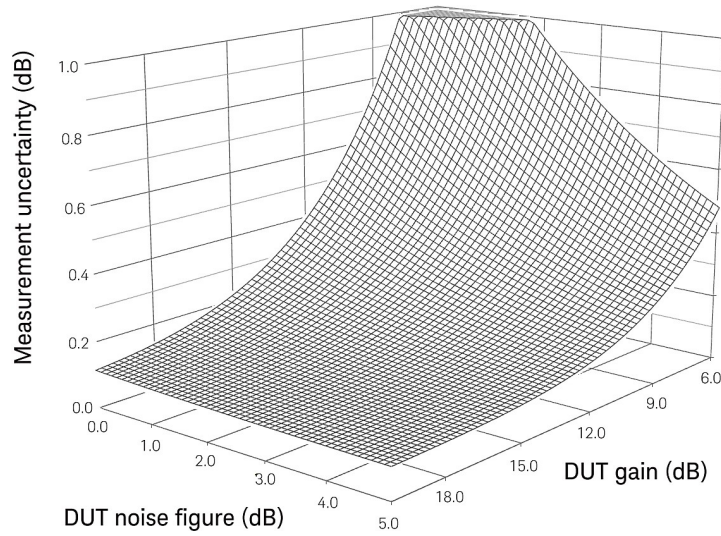
1. The E24 series is defined by international standard IEC 60063. E24 is a preferred series of numbers, with each number being approximately 10% larger than the previous number. It is commonly used for the labeling of 5% tolerance resistors, capacitors, etc.
2. Parts per million (10<sup>-6</sup>)
3. 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

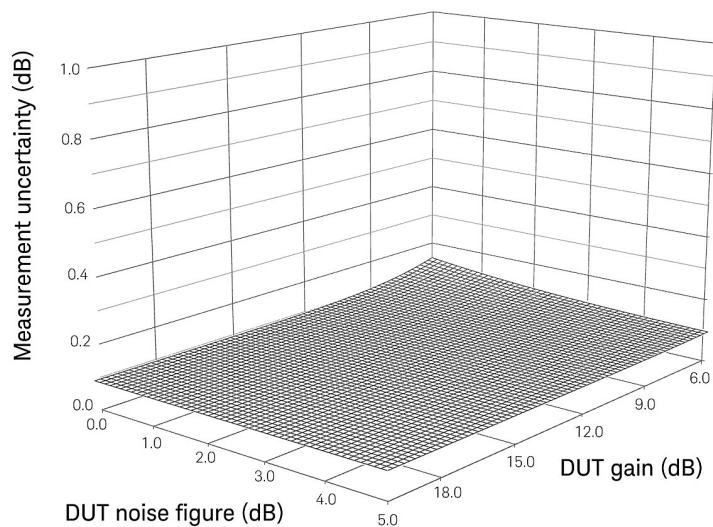
## Noise figure, gain, and uncertainty

Example DUT uncertainties<sup>1</sup>

Without a Preamp



With a USB Preamp<sup>2</sup>



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.

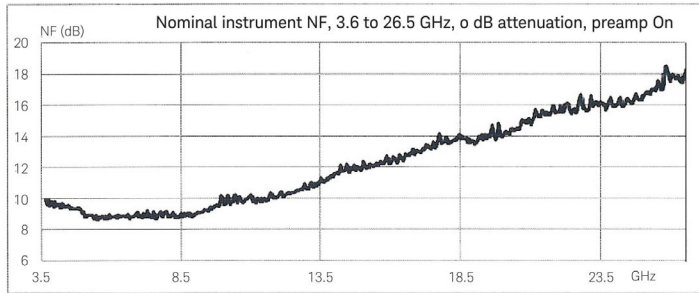
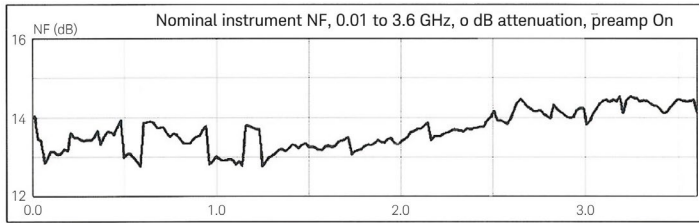
1. These uncertainties assume a measurement made with a N8975B at 1 GHz with a N4000A noise source and a non-frequency-converting DUT. The DUT is assumed to have an input/output match of 1.5 VSWR.
2. Assuming a U7227A/C/F External USB Preamp is not warranted, does not include measurement uncertainty, and is valid only at room temperature (approximately 23°C).

| Description   | Specifications  |                        | Supplemental information  |
|---|---|------------------------|---|
| Noise figure<br>< 10 MHz<br>10 MHz to internal<br>preamplifier's frequency limit <sup>1</sup> |   |                        | Uncertainty calculator <sup>1</sup><br>See note <sup>1</sup><br>Internal and external preamplification recommended <sup>1</sup>             |
| 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 <sup>1</sup>   |   |                        | DUT Gain range = -20 to +40 dB  |
| < 10 MHz  |   |                        | See note <sup>1</sup>   |
| 10 MHz to 3.6 GHz   | ± 0.15 dB   |                        |   |
| > 3.6 GHz   |   |                        | ± 0.11 dB additional <sup>1</sup> 95th percentile, 5 minutes after calibration  |
| <b>Noise Figure uncertainty calculator<sup>1, 2</sup></b>                                     |   |                        |   |
| 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) <sup>1</sup> . Note on DC coupling <sup>1</sup> |
| Instrument input match  |   |                        | See graph: nominal VSWR. Note on DC coupling <sup>1</sup>   |
| Optional NFE improvement/internal Cal <sup>1</sup>  |   |                        | See "Displayed average noise level (DANL) (with noise floor extension) improvement" in the Option NFE - Noise floor extension chapter.      |
| <b>Uncertainty versus calibration options<sup>1</sup></b>                                     |   |                        |   |
| 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 calibration. 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](http://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)<sup>1</sup>

| 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)<sup>1</sup>

| 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<sup>2</sup>

| 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<br>100 MHz to 4 GHz: < 5 dB    | 100 MHz to 4 GHz: < 6 dB<br>4 GHz to 6 GHz: < 5 dB<br>6 GHz to 18 GHz: < 4 dB<br>18 GHz to 26.5 GHz: < 5 dB |                                    |
| Gain          | 10 to 100 MHz: > 16 dB<br>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   |   |
|---|---|
| N8973B, N8974B, N8975B                        | Type-N female, 50 $\Omega$ nominal  |
| N8976B  | 2.4 mm male, 50 $\Omega$ nominal  |
| 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 ( $\mu$ W) | 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.<br>Instrument capable of controlling an external LO via GPIB, LAN, or USB  |
| Upconverting DUT                              | With fixed or variable IF.<br>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.<br>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     |



## Measurement

| Display type and N.F. results (continued) |                              |
|---|------------------------------|
| P hot                                     | Relative power density in dB |
| P cold                                    | Relative power density in dB |

## Front panel

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

## Rear panel connectivity

|   |   |
|---|---|
| 10 MHz out<br>Connector<br>Output amplitude<br>Frequency                                    | BNC female, 50 $\Omega$ nominal<br>$\geq$ 0 dBm nominal<br>10 MHz $\pm$ (10 MHz x frequency reference accuracy)   |
| Ext ref in<br>Connector<br>Input amplitude range<br>Input frequency<br>Frequency lock range | BNC female, 50 $\Omega$ nominal<br>-5 to 10 dBm nominal<br>10 MHz nominal<br>$\pm$ 5 x 10 <sup>-6</sup> of specified external reference input frequency |
| Trigger 1 and 2 inputs<br>Connector<br>Impedance<br>Trigger level range                     | BNC female<br>> 10 k $\Omega$ nominal<br>-5 to 5 V  |
| Trigger 1 and 2 inputs<br>Connector<br>Impedance<br>Trigger level range                     | BNC female<br>50 $\Omega$ nominal<br>5 V TTL nominal  |
| Monitor output<br>Connector<br>Format<br>Resolution   | BVGA compatible, 15-pin mini D-SUB<br>XGA (60 Hz vertical sync rates, non-interlaced) analog RGB<br>1024 x 768  |

| Rear panel   |   |
|--|---|
| Noise source drive +28 V (pulsed)<br>Connector                             | BNC female  |
| SNS Series noise source connector  | For use with Keysight SNS Series noise sources  |
| USB 2.0 ports<br>Master (3 ports)<br>Standard<br>Connector<br>Oupt current | Compatible with USB 2.0<br>USB Type-A female<br>0.5 A nominal   |
| Slave (1 port)<br>Standard<br>Connector<br>Output current                  | Compatible with USB 2.0<br>USB Type-B female<br>0.5 A nominal   |
| GPIB interface<br>Connector<br>GPIB codes<br>GPIB mode                     | IEEE-488 bus connector<br>SH1, AH1, T6, SR1, LR1, PP0, DC1, C1, C2, C3, C28,DT1, L4, C0<br>Controller or device |
| LAN TCP/IP interface<br>Standard<br>Connector                              | 1000 Base-T<br>RJ45 Ethertwist  |

## General Specifications

| Temperature range  |  |
|--|--|
| Operating  | 0 to 55°C  |
| Storage  | -40 to 70°C  |
| EMC  |  |
| <p>Complies with the essential requirements of the European EMC Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):</p> <ul style="list-style-type: none"> <li>• IEC/EN 61326-1 or IEC/EN 61326-2-1</li> <li>• CISPR 11 Group 1, Class A</li> <li>• AS/NZS CISPR 11:2002</li> <li>• ICES/NMB-001</li> </ul> <p>This ISM device complies with Canadian ICES-001<br/>           Get appareil ISM est conforme à la norme NMB-001 du Canada</p> |  |
| Safety   |  |
| <p>Complies with European Low Voltage Directive 2006/95/EC</p> <ul style="list-style-type: none"> <li>• IEC/EN 61010-1 3rd Edition</li> <li>• Canada: CSA C22.2 No. 61010-1-12</li> <li>• U.S.A.: UL 61010-1 3rd Edition</li> </ul>  |  |
| Acoustic statement (European Machinery Directive 2002/42/EC, 1.7.4.2u)   |  |
| <p>Acoustic noise emission<br/>           LpA &lt; 70 dB<br/>           Operator position<br/>           Normal position<br/>           Per ISO 7779</p>   |  |
| Environmental stress   |  |
| <p>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.</p>   |  |
| Power requirements   |  |
| Voltage and frequency  | 100 to 120 V, 50/60/400 Hz<br>220 to 240 V, 50/60 Hz |
| Power consumption<br>On<br>Standby   | 350 W maximum<br>20 W                                |
| Display  |  |
| Resolution   | 1280 × 768, WXGA                                     |
| Size   | 269 mm (10.6 in.) diagonal (nominal)                 |

## General Specifications (continued)

| Data storage  |   |
|---|---|
| Internal External   | ≥ 160 GB nominal (removable solid-state drive) Supports USB 2.0 compatible memory devices |
| Internal External   | ≥ 160 GB nominal (removable solid-state drive) Supports USB 2.0 compatible memory devices |
| Weight (without options)  |   |
| Net   | 18 kg (40 lbs) nominal  |
| Shipping  | 30 kg (66 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 1-year warranty   |   |
| Calibration cycle   |   |
| The recommended calibration cycle is two years: calibration services are available through Keysight service centers |   |



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