
Keysight 2-Port and 4-Port PNA Network Analyzer

N5224B 900 Hz to 43.5 GHz

N5225B 900 Hz to 50 GHz

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This is a complete list of the technical specifications for the N5224B and N5225B PNA network analyzers with the following options:

2-Port Model

Option 210 – 2-port, single source, with metrology configuration

4-Port Model

Option 410 – 4-port, dual source, with metrology configuration

See block diagrams on page 42.

Notes

This document provides technical specifications for the 85056A and N4693A calibration kits.

Please download our free Uncertainty Calculator from http://www.keysight.com/find/na_calculator to generate the curves for your calibration kit and PNA setup.

For all tables in this data sheet, the specified performance at the exact frequency of a break is the degraded value of the two specifications at that frequency.

Definitions

All specifications and characteristics apply over a 25 °C ±5 °C range (unless otherwise stated) and 90 minutes after the instrument has been turned on.

Specification (spec.): Warranted performance. Specifications include guardbands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Characteristic (char.): A performance parameter that the product is expected to meet before it leaves the factory, but that is not verified in the field and is not covered by the product warranty. A characteristic includes the same guardbands as a specification.

Typical (typ.): Expected performance of an average unit which does not include guardbands. It is not covered by the product warranty.

Nominal (nom.): A general, descriptive term that does not imply a level of performance. It is not covered by the product warranty.

Supplemental performance data (SPD): Represents the value of a parameter that is most likely to occur; the expected mean or average.

Calibration: The process of measuring known standards to characterize a network analyzer's systematic (repeatable) errors.

Corrected (residual): Indicates performance after error correction (calibration). It is determined by the quality of calibration standards and how well "known" they are, plus system repeatability, stability, and noise.

Uncorrected (raw): Indicates instrument performance without error correction. The uncorrected performance affects the stability of a calibration.

Standard: When referring to the analyzer, this includes no options unless noted otherwise.

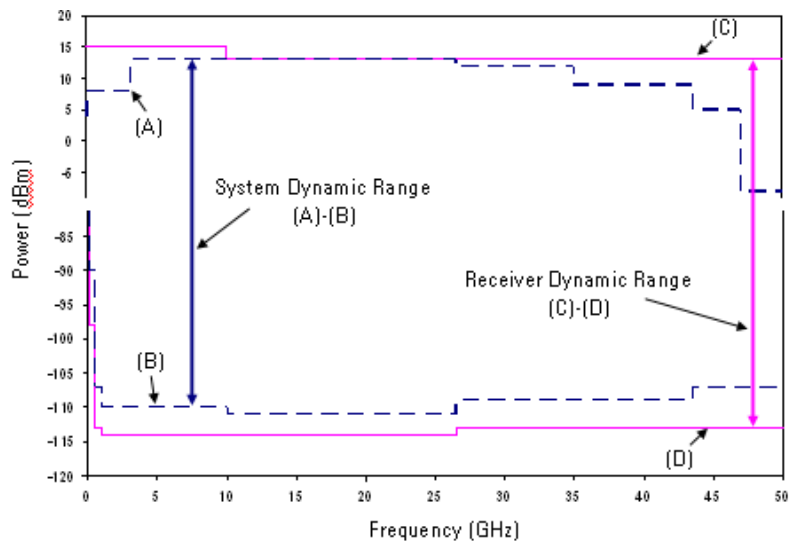
Corrected System Performance

The specifications in this section apply for measurements made with the N5224B and N5225B PNA network analyzers with the following conditions:

- 10 Hz IF bandwidth
- No averaging applied to data
- Isolation calibration with an averaging factor of 8

System Dynamic Range and Receiver Dynamic Range

- **System Dynamic Range** is defined as the specified source maximum output power (spec) minus the noise floor (spec).
- **Receiver Dynamic Range** is defined as the test port compression at 0.1 dB (typical) minus the noise floor (typical).



NOTE

The effective dynamic range must take measurement uncertainties and interfering signals into account. This set-up should only be used when the receiver input will never exceed its maximum receiver input. When the analyzer is in segment sweep mode, it can have predefined frequency segments which will output a higher power level when the extended dynamic range is required (i.e. devices with high insertion loss), and reduced power when the maximum receiver input level will occur (i.e. devices with low insertion loss). The extended range is only available in one-path transmission measurements.

It may typically be degraded at particular frequencies below 500 MHz due to spurious receiver residuals.

Table 1a. System Dynamic Range and Receiver Dynamic Range, N5224B, Option 210, 410

| Description | Specification | | | Typical | | | |
|--------------------|-----------------------------------|------------------------------------|---------------------------------|---------------------------|-------------------------------------|---|---------------------------------|
| | System Dynamic Range (dB) (A)-(B) | Max Leveled Output Power (dBm) (A) | Test Port Noise Floor (dBm) (B) | System Dynamic Range (dB) | Receiver Dynamic Range (dB) (C)-(D) | 0.1 dB Compression at Test Port (dBm) (C) | Test Port Noise Floor (dBm) (D) |
| 10 MHz to 50 MHz | 76 | 6 | -70 | 87 | 90 | 15 | -75 |
| 50 MHz to 100 MHz | 92 | 7 | -85 | 103 | 106 | 15 | -91 |
| 100 MHz to 250 MHz | 102 | 7 | -95 | 112 | 112 | 12 | -100 |
| 250 MHz to 500 MHz | 109 | 7 | -102 | 119 | 119 | 12 | -107 |
| 500 MHz to 1 GHz | 113 | 7 | -106 | 124 | 124 | 12 | -112 |
| 1 GHz to 2 GHz | 121 | 7 | -114 | 131 | 130 | 12 | -118 |
| 2 GHz to 3.2 GHz | 121 | 7 | -114 | 129 | 130 | 12 | -118 |
| 3.2 GHz to 10 GHz | 121 | 7 | -114 | 132 | 130 | 12 | -118 |
| 10 GHz to 13.5 GHz | 121 | 7 | -114 | 131 | 132 | 12 | -120 |
| 13.5 GHz to 16 GHz | 121 | 7 | -114 | 132 | 132 | 12 | -120 |
| 16 GHz to 26.5 GHz | 121 | 7 | -114 | 130 | 132 | 12 | -120 |
| 26.5 GHz to 30 GHz | 117 | 7 | -110 | 126 | 128 | 12 | -116 |
| 30 GHz to 35 GHz | 117 | 7 | -110 | 124 | 128 | 12 | -116 |
| 35 GHz to 40 GHz | 112 | 4 | -108 | 122 | 128 | 12 | -116 |
| 40 GHz to 43.5 GHz | 112 | 4 | -108 | 120 | 124 | 10 | -114 |

Table 1b. System Dynamic Range and Receiver Dynamic Range, N5225B, Option 210, 410

| Description | Specification | | | Typical | | | |
|--------------------|-----------------------------------|------------------------------------|---------------------------------|---------------------------|-------------------------------------|---|---------------------------------|
| | System Dynamic Range (dB) (A)-(B) | Max Leveled Output Power (dBm) (A) | Test Port Noise Floor (dBm) (B) | System Dynamic Range (dB) | Receiver Dynamic Range (dB) (C)-(D) | 0.1 dB Compression at Test Port (dBm) (C) | Test Port Noise Floor (dBm) (D) |
| 10 MHz to 50 MHz | 76 | 6 | -70 | 87 | 90 | 15 | -75 |
| 50 MHz to 100 MHz | 92 | 7 | -85 | 103 | 106 | 15 | -91 |
| 100 MHz to 250 MHz | 102 | 7 | -95 | 112 | 112 | 12 | -100 |
| 250 MHz to 500 MHz | 109 | 7 | -102 | 119 | 119 | 12 | -107 |
| 500 MHz to 1 GHz | 113 | 7 | -106 | 124 | 124 | 12 | -112 |
| 1 GHz to 2 GHz | 121 | 7 | -114 | 131 | 130 | 12 | -118 |
| 2 GHz to 3.2 GHz | 121 | 7 | -114 | 129 | 130 | 12 | -118 |
| 3.2 GHz to 10 GHz | 121 | 7 | -114 | 132 | 130 | 12 | -118 |
| 10 GHz to 13.5 GHz | 121 | 7 | -114 | 131 | 132 | 12 | -120 |
| 13.5 GHz to 16 GHz | 121 | 7 | -114 | 132 | 132 | 12 | -120 |
| 16 GHz to 26.5 GHz | 121 | 7 | -114 | 130 | 132 | 12 | -120 |
| 26.5 GHz to 30 GHz | 117 | 7 | -110 | 126 | 128 | 12 | -116 |
| 30 GHz to 35 GHz | 117 | 7 | -110 | 124 | 128 | 12 | -116 |
| 35 GHz to 40 GHz | 112 | 4 | -108 | 122 | 128 | 12 | -116 |
| 40 GHz to 43.5 GHz | 112 | 4 | -108 | 120 | 124 | 10 | -114 |
| 43.5 GHz to 47 GHz | 109 | 0 | -109 | 117 | 126 | 10 | -116 |
| 47 GHz to 50 GHz | 101 | -8 | -109 | 116 | 126 | 10 | -116 |

N5224B and N5225B Corrected System Performance, Option 210, 410

For any S_{ii} reflection measurement:

- $S_{jj} = 0$.

For any S_{ij} transmission measurement:

- $S_{ji} = S_{ij}$ when $S_{ij} \leq 1$
- $S_{ji} = 1/S_{ij}$ when $S_{ij} > 1$
- $S_{kk} = 0$ for all k

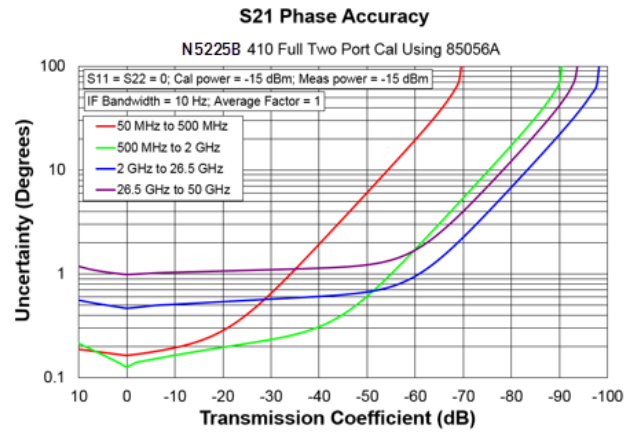
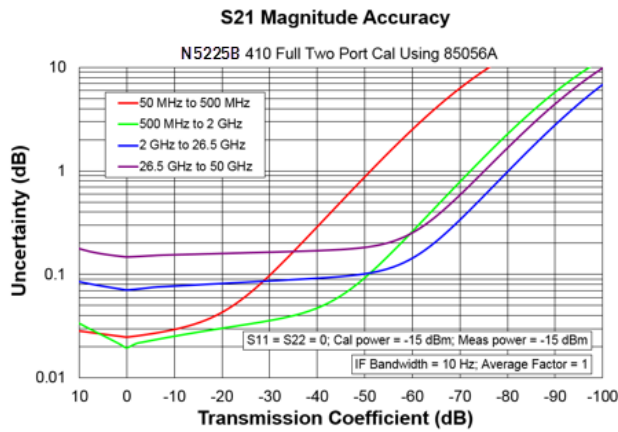
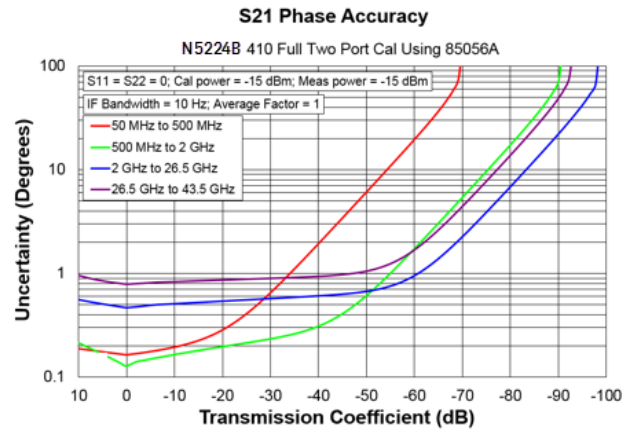
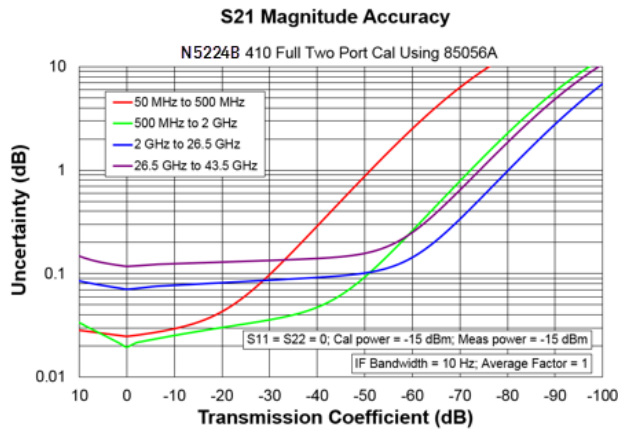
Applies to the N5224B/5A Option 210 or 410 analyzers, 85133F flexible test port cable set, and a full 2-port calibration. Also applies to the following condition:

Environmental temperature $23^\circ \pm 3^\circ \text{C}$, with $< 1^\circ \text{C}$ deviation from calibration temperature

Table 2a. N5224B and N5225B with 85056A Calibration Kit

| Description | Specification (dB) | | | | | | |
|-----------------------|--------------------|-----------------|-----------------|------------------|------------------|------------------|------------------|
| | 10 MHz to 50 MHz | 50 MHz to 2 GHz | 2 GHz to 10 GHz | 10 GHz to 20 GHz | 20 GHz to 30 GHz | 30 GHz to 40 GHz | 40 GHz to 50 GHz |
| Directivity | 42 | 42 | 42 | 42 | 38 | 38 | 36 |
| Source Match | 41 | 41 | 38 | 38 | 33 | 33 | 31 |
| Load Match | 42 | 42 | 42 | 42 | 38 | 38 | 35 |
| Reflection Tracking | | | | | | | |
| Mag | 0.001 | 0.001 | 0.008 | 0.008 | 0.020 | 0.020 | 0.027 |
| Phase (degree) | 0.009 | 0.009 | 0.054 | 0.054 | 0.133 | 0.133 | 0.180 |
| Transmission Tracking | | | | | | | |
| Mag | 0.019 | 0.012 | 0.022 | 0.035 | 0.078 | 0.078 | 0.128 |
| Phase (degree) | 0.127 | 0.080 | 0.147 | 0.232 | 0.513 | 0.513 | 0.845 |

Transmission Uncertainty, Option 210, 410



Reflection Uncertainty, Option 210, 410

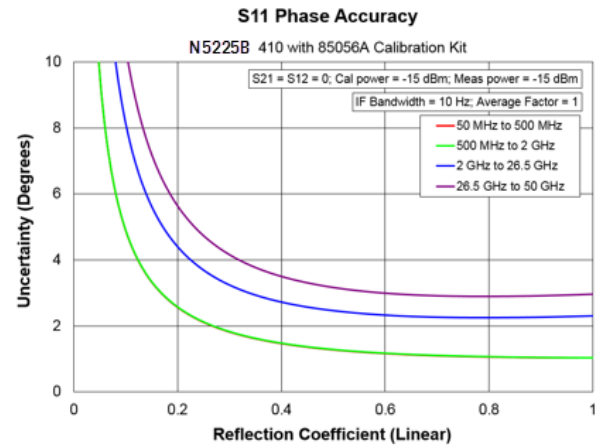
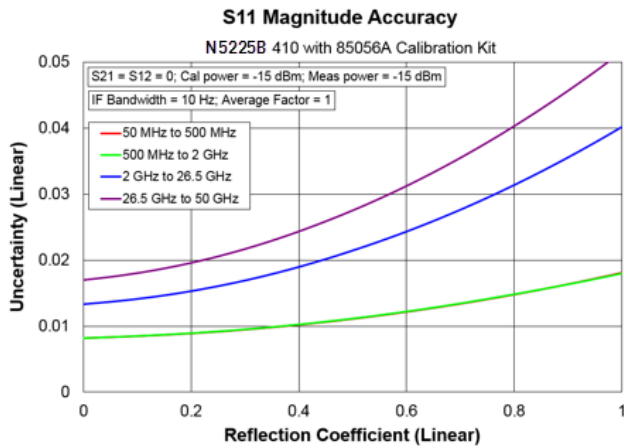
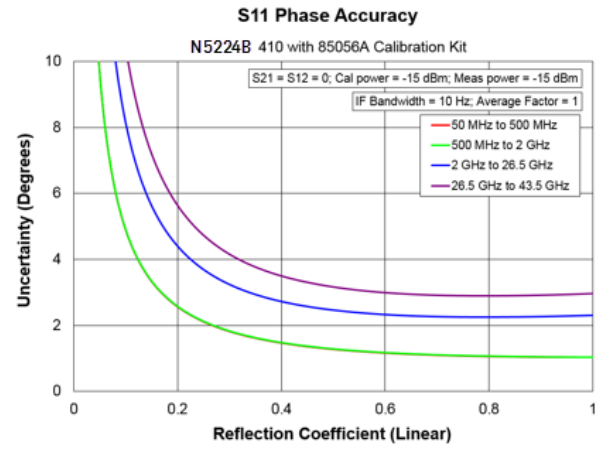
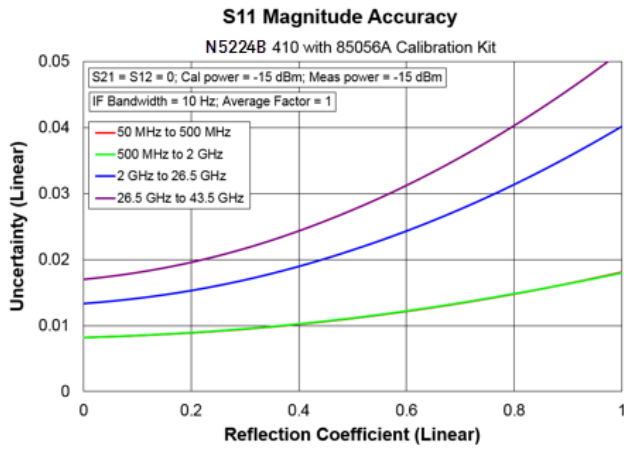
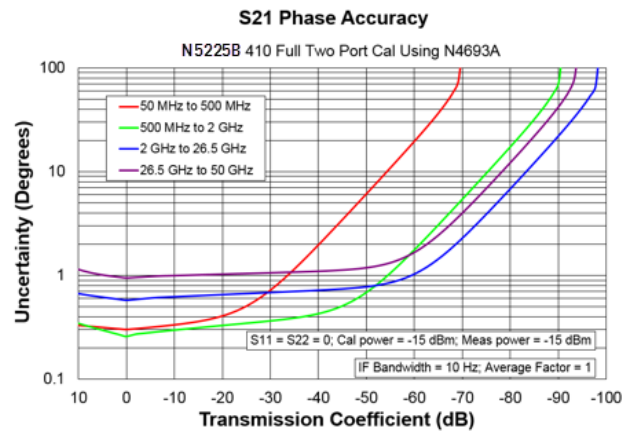
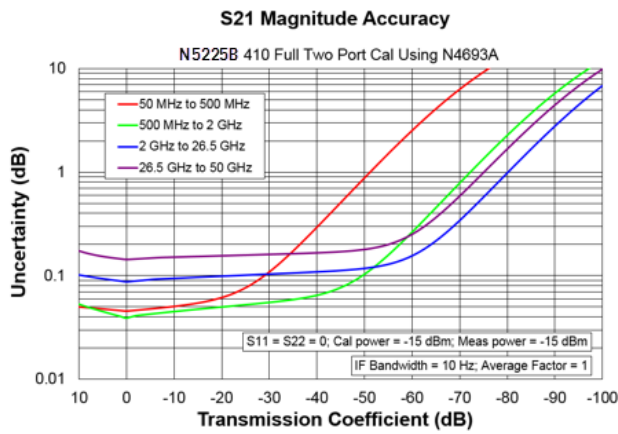
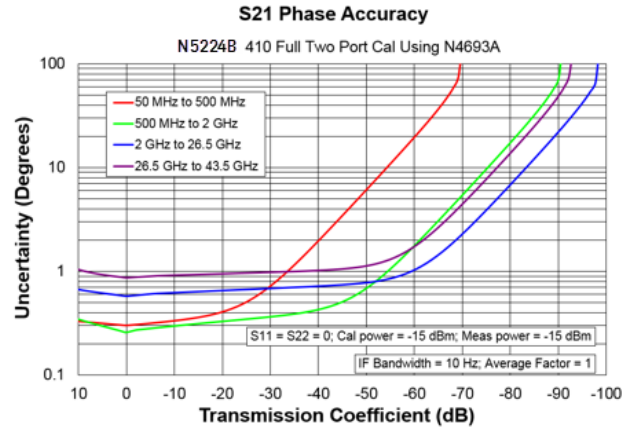
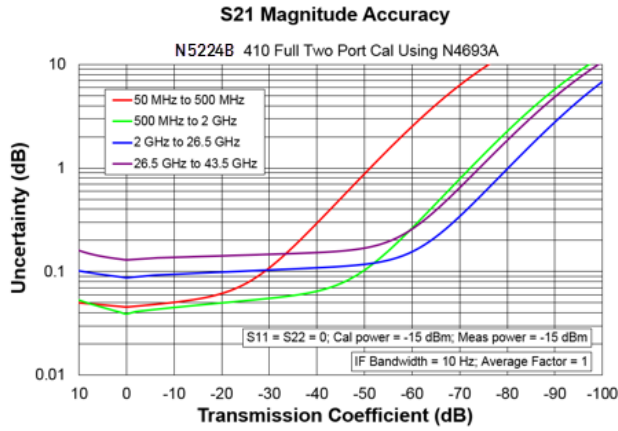


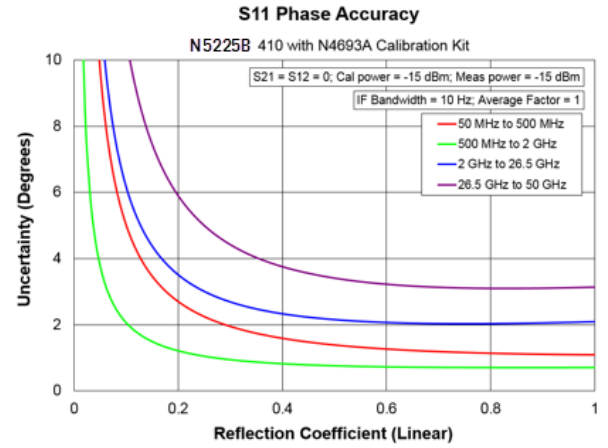
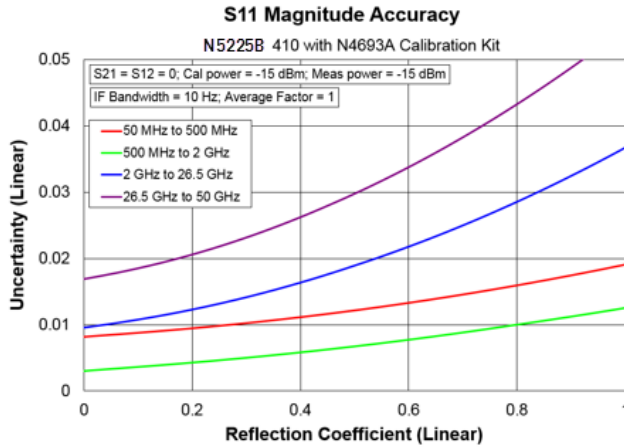
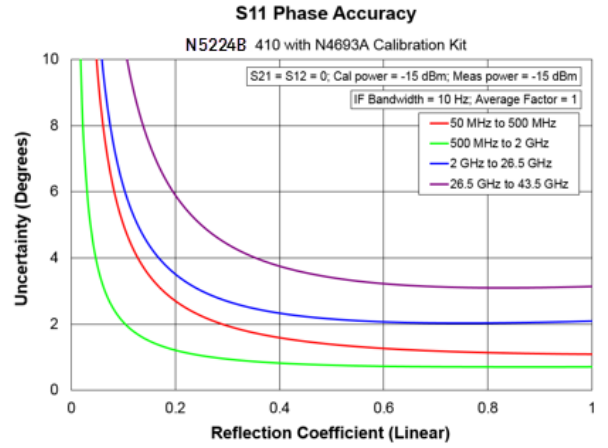
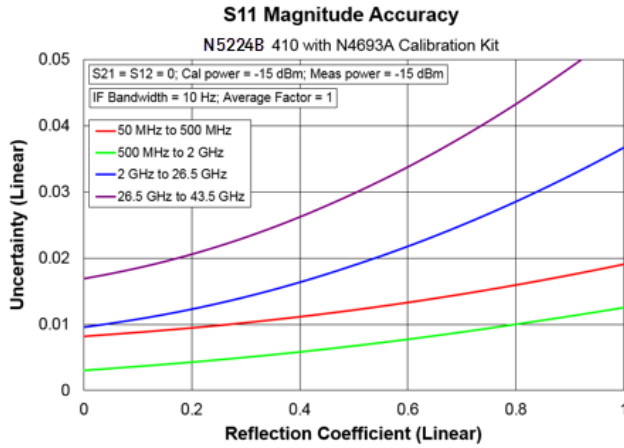
Table 2b. N5224B and N5225B with N4693A 2-Port Electronic Calibration Module

| Description | Specification (dB) | | | | | | |
|-----------------------|--------------------|-----------------|-----------------|------------------|------------------|------------------|------------------|
| | 10 MHz to 50 MHz | 50 MHz to 2 GHz | 2 GHz to 10 GHz | 10 GHz to 20 GHz | 20 GHz to 30 GHz | 30 GHz to 40 GHz | 40 GHz to 50 GHz |
| Directivity | 32 | 55 | 49 | 49 | 38 | 38 | 36 |
| Source Match | 25 | 46 | 42 | 42 | 33 | 33 | 31 |
| Load Match | 25 | 45 | 41 | 41 | 38 | 38 | 35 |
| Reflection Tracking | | | | | | | |
| Mag | 0.050 | 0.030 | 0.040 | 0.040 | 0.020 | 0.020 | 0.027 |
| Phase (degree) | 0.330 | 0.198 | 0.264 | 0.264 | 0.133 | 0.133 | 0.180 |
| Transmission Tracking | | | | | | | |
| Mag | 0.081 | 0.031 | 0.043 | 0.045 | 0.078 | 0.078 | 0.128 |
| Phase (degree) | 0.532 | 0.207 | 0.287 | 0.300 | 0.513 | 0.513 | 0.845 |

Transmission Uncertainty, Option 210, 410



Reflection Uncertainty, Option 210, 410



Uncorrected System Performance

Specifications apply to following conditions:

- Cable loss not included in Transmission Tracking.
- Crosstalk measurement conditions: normalized to a thru, measured with shorts on all ports, 10 Hz IF bandwidth, averaging factor of 8, alternate mode, source power set to the specified maximum power.

Table 3a. Error Terms (dB), All Ports, Option 210, 410 – Specifications

| Description | Directivity | Source Match | Load Match | Transmission Tracking | Reflection Tracking | Crosstalk |
|----------------------|-------------|--------------|------------|-----------------------|---------------------|-----------|
| 10 MHz to 50 MHz | 18 | 18 | 17 | -- | -- | -- |
| 50 MHz to 200 MHz | 22 | 22 | 22 | -- | -- | -- |
| 200 MHz to 500 MHz | 24 | 26 | 26 | -- | -- | -- |
| 500 MHz to 3.2 GHz | 25 | 22 | 21 | -- | -- | -- |
| 3.2 GHz to 10 GHz | 22 | 17 | 19 | -- | -- | -- |
| 10 GHz to 13.5 GHz | 18 | 14 | 17 | -- | -- | -- |
| 13.5 GHz to 16 GHz | 18 | 14 | 15 | -- | -- | -- |
| 16 GHz to 20 GHz | 18 | 13 | 15 | -- | -- | -- |
| 20 GHz to 24 GHz | 16 | 14 | 15 | -- | -- | -- |
| 24 GHz to 26.5 GHz | 16 | 14 | 15 | -- | -- | -- |
| 26.5 GHz to 43.5 GHz | 16 | 10 | 13 | -- | -- | -- |
| 43.5 GHz to 46 GHz | 15 | 10 | 13 | -- | -- | -- |
| 46 GHz to 50 GHz | 15 | 9 | 10 | -- | -- | -- |

Table 3b. Error Terms (dB), All Ports, Option 210, 410 - Typical

| Description | Directivity | Source Match | Load Match | Transmission Tracking | Reflection Tracking | Crosstalk |
|--------------------|-------------|--------------|------------|-----------------------|---------------------|-----------|
| 10 MHz to 50 MHz | 21 | 26 | 24 | +/- 1.0 | +/- 0.7 | -82 |
| 50 MHz to 200 MHz | 28 | 30 | 28 | +/- 1.0 | +/- 0.7 | -85 |
| 200 MHz to 500 MHz | 33 | 30 | 30 | +/- 1.0 | +/- 0.7 | -110 |
| 500 MHz to 3.2 GHz | 30 | 27 | 26 | +/- 1.0 | +/- 0.7 | -120 |
| 3.2 GHz to 10 GHz | 25 | 22 | 24 | +/- 1.0 | +/- 0.7 | -120 |
| 10 GHz to 13.5 GHz | 23 | 22 | 23 | +/- 1.0 | +/- 0.7 | -120 |
| 13.5 GHz to 16 GHz | 20 | 21 | 20 | +/- 1.0 | +/- 0.7 | -120 |
| 16 GHz to 20 GHz | 19 | 19 | 21 | +/- 1.0 | +/- 0.7 | -120 |
| 20 GHz to 24 GHz | 20 | 20 | 21 | +/- 1.0 | +/- 0.7 | -120 |
| 24 GHz to 26.5 GHz | 21 | 19 | 20 | +/- 1.0 | +/- 0.7 | -120 |
| 26.5 GHz to 35 GHz | 19 | 16 | 18 | +/- 1.0 | +/- 0.7 | -120 |
| 35 GHz to 43.5 GHz | 19 | 16 | 18 | +/- 1.0 | +/- 0.7 | -115 |
| 43.5 GHz to 46 GHz | 19 | 18 | 18 | +/- 1.0 | +/- 0.7 | -105 |
| 46 GHz to 50 GHz | 19 | 14 | 15 | +/- 1.0 | +/- 0.7 | -100 |

Test Port Output

See Block diagrams for all models and option beginning on page 42.

Table 4. Frequency Information, Option 210, 410

| Description | Specification | Typical |
|---|--------------------|---|
| N5224B Frequency Range | 10 MHz to 43.5 GHz | -- |
| N5225B Frequency Range | 10 MHz to 50 GHz | -- |
| Frequency Resolution | 1 Hz | -- |
| Frequency Accuracy | +/- 0.7 ppm | -- |
| Initial Frequency Accuracy ¹ | ±0.2 ppm | ±0.1 ppm |
| Frequency Stability | -- | ±0.05 ppm, -10° to 70° C ² ±0.5 (first year) ³ |

¹ Verified after Factory Frequency Reference adjustment, or after adjustment at a Keysight Service Center.

² Assumes no variation in time.

³ Assumes no variation in temperature.

Table 5. Maximum Leveled Power (dBm), All Ports, Option 210, 410

| Description | Specification | Typical |
|--------------------|---------------|---------|
| 10 MHz to 50 MHz | 6 | 12 |
| 50 MHz to 1 GHz | 7 | 12 |
| 1 GHz to 2 GHz | 7 | 13 |
| 2 GHz to 3.2 GHz | 7 | 11 |
| 3.2 GHz to 10 GHz | 7 | 14 |
| 10 GHz to 13.5 GHz | 7 | 11 |
| 13.5 GHz to 16 GHz | 7 | 12 |
| 16 GHz to 20 GHz | 7 | 11 |
| 20 GHz to 24 GHz | 7 | 10 |
| 24 GHz to 26.5 GHz | 7 | 10 |
| 26.5 GHz to 30 GHz | 7 | 10 |
| 30 GHz to 35 GHz | 7 | 8 |
| 35 GHz to 43.5 GHz | 4 | 6 |
| 43.5 GHz to 47 GHz | 0 | 1 |
| 47 GHz to 50 GHz | -8 | 0 |

Table 6. Power Level Accuracy (dB), Option 210, 410

| Description | Specification | Typical |
|----------------------|---------------|---------|
| 10 MHz to 50 MHz | +/- 1.5 | +/- 0.5 |
| 50 MHz to 1 GHz | +/- 1.0 | +/- 0.4 |
| 1 GHz to 3.2 GHz | +/- 1.2 | +/- 0.1 |
| 3.2 GHz to 13.5 GHz | +/- 1.5 | +/- 0.3 |
| 13.5 GHz to 20 GHz | +/- 1.5 | +/- 0.2 |
| 20 GHz to 26.5 GHz | +/- 1.8 | +/- 0.2 |
| 26.5 GHz to 43.5 GHz | +/- 2.2 | +/- 0.3 |
| 43.5 GHz to 50 GHz | +/- 3.2 | +/- 0.5 |

Table 7a. Power Level Linearity (dB), Option 210, 410 – Specification

| Description | Port 1 or 3 ¹ -25dBm ≤ P < -20dBm | Port 1 or 3 ¹ -20dBm ≤ P < -15dBm | Port 1 or 3 ¹ P ≥ -15dBm |
|-------------------|---|---|--|
| 10 MHz to 50 MHz | +/-2.5 | +/-1.5 | +/-1.5 |
| 50 MHz to 500 MHz | +/-2.0 | +/-1.5 | +/-1.5 |
| 500 MHz to 50 GHz | +/-1.5 | +/-1.5 | +/-1.5 |

¹ Either port can be used as the source port.

Table 7b. Power Level Linearity (dB), Option 210, 410 – Specification

| Description | Port 2 or 4 ¹ -25dBm ≤ P < -20dBm | Port 2 or 4 ¹ -20dBm ≤ P < -15dBm | Port 2 or 4 ¹ P ≥ -15dBm |
|-------------------|---|---|--|
| 10 MHz to 50 MHz | +/-2.5 | +/-1.5 | +/-1.5 |
| 50 MHz to 3.2 GHz | +/-2.0 | +/-1.5 | +/-1.5 |
| 3.2 GHz to 50 GHz | +/-1.5 | +/-1.5 | +/-1.5 |

¹ Either port can be used as the source port.

Table 8. N5224 and N5225B Power Sweep Range (dB), All Ports, Option 210, 410

| Description | Specification | Typical |
|--------------------|---------------|---------|
| 10 MHz to 50 MHz | 31 | 39 |
| 50 MHz to 1 GHz | 32 | 39 |
| 1 GHz to 2 GHz | 32 | 40 |
| 2 GHz to 3.2 GHz | 32 | 39 |
| 3.2 GHz to 10 GHz | 32 | 41 |
| 10 GHz to 13.5 GHz | 32 | 39 |
| 13.5 GHz to 16 GHz | 32 | 41 |
| 16 GHz to 26.5 GHz | 32 | 39 |
| 26.5 GHz to 30 GHz | 32 | 40 |
| 30 GHz to 35 GHz | 32 | 39 |
| 35 GHz to 43.5 GHz | 29 | 36 |
| 43.5 GHz to 47 GHz | 25 | 33 |
| 47 GHz to 50 GHz | 17 | 29 |

Table 9. Nominal (Preset) Power (dBm)

| Description | N5224B | N5225B |
|--------------|--------|--------|
| Preset Power | -5 | -15 |

Table 10. Power Resolution and Maximum/Minimum Settable Power, All Models, Option 210, 410

| Description | Specification (dB) | Typical (dBm) |
|------------------------|--------------------|---------------|
| Power Resolution | 0.01 | |
| Maximum Settable Power | -- | 30 |
| Minimum Settable Power | -- | -30 |

Table 11. 2nd and 3rd Harmonics at Max Specified Power (dBc)

Option 210, 410 - Typical

Listed frequency is fundamental frequency; test at max specified power.

| Description | 2 nd Harmonic | 3 rd Harmonic |
|-------------------------------|--------------------------|--------------------------|
| 10 MHz to 50 MHz ¹ | -15 | -15 |
| 50 MHz to 2 GHz ¹ | -21 | -15 |
| 2 GHz to 13.5 GHz | -18 | -19 |
| 13.5 GHz to 16.7 GHz | -60 | -65 |
| 16.7 GHz to 25 GHz | -60 | -- |

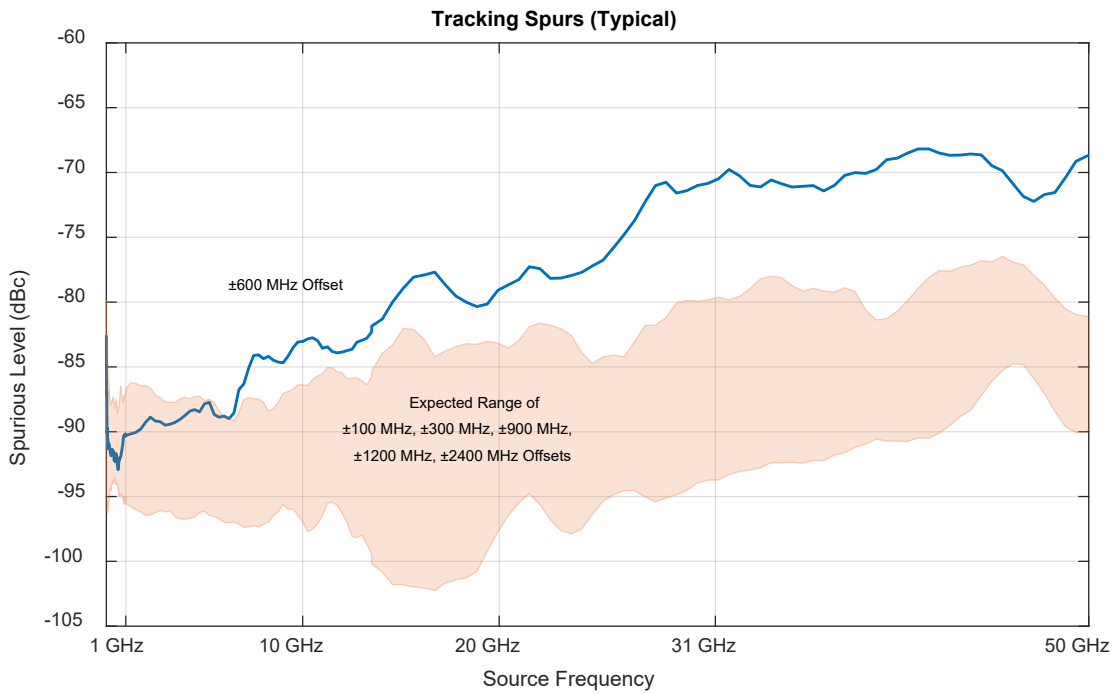
Table 12. Non-Harmonic Spurs at Nominal Power (dBc)

Listed frequency is Source CW frequency, tested at 0 dBm.

| Description | Non-Harmonic | ±600 MHz Tracking Spur |
|------------------|--------------|------------------------|
| 10 MHz to 1 GHz | -80 | -80 |
| 1 GHz to 10 GHz | -85 | -81 |
| 10 GHz to 20 GHz | -82 | -75 |
| 20 GHz to 31 GHz | -80 | -70 |
| 31 GHz to 50 GHz | -77 | -67 |

¹ Non-harmonic spurs are negligible with Option 425 installed and LFE enabled.

Tracking Spurs (Linear Frequency Scale)



Tracking Spurs (Logarithmic Frequency Scale)

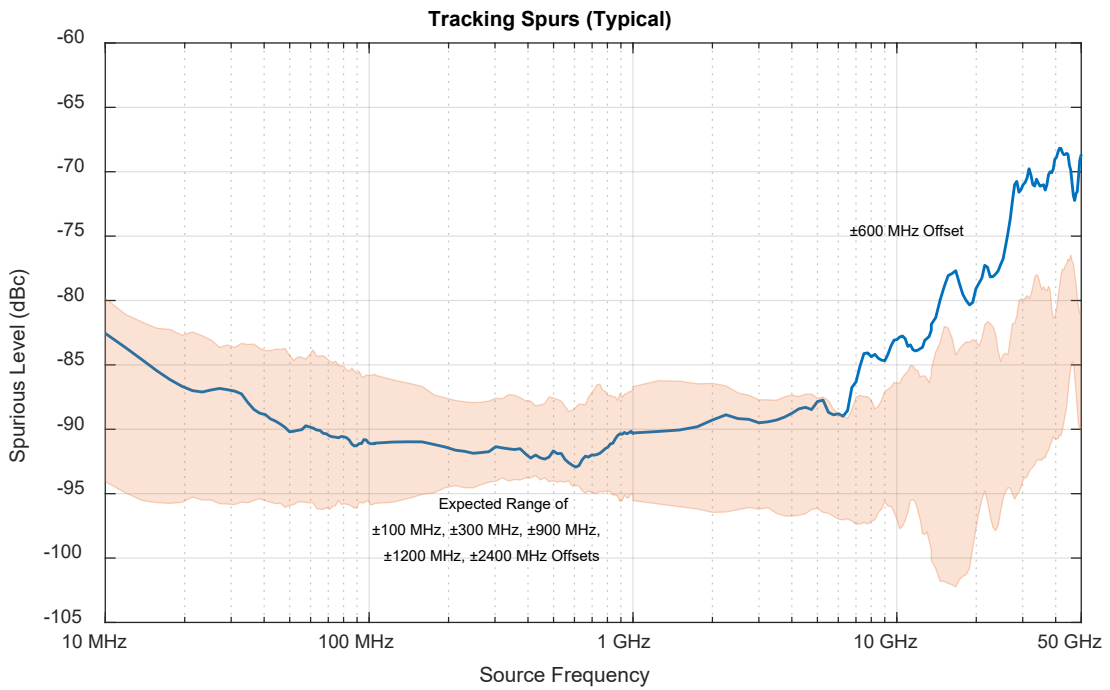


Table 13a. Phase Noise (dBc/Hz), Option 210, 410, with UNY, Port 1, 3 - Typical

| CW Frequency | 100 Hz Offset | 1 kHz Offset | 10 kHz Offset | 100 kHz Offset | 1 MHz Offset | 10 MHz Offset |
|--------------|---------------|--------------|---------------|----------------|--------------|---------------|
| 1 GHz | -112 | -132 | -137 | -143 | -145 | -144 |
| 5 GHz | -103 | -123 | -132 | -135 | -147 | -150 |
| 10 GHz | -96 | -116 | -126 | -130 | -142 | -146 |
| 20 GHz | -91 | -111 | -118 | -123 | -135 | -139 |
| 26.5 GHz | -87 | -106 | -115 | -121 | -131 | -135 |

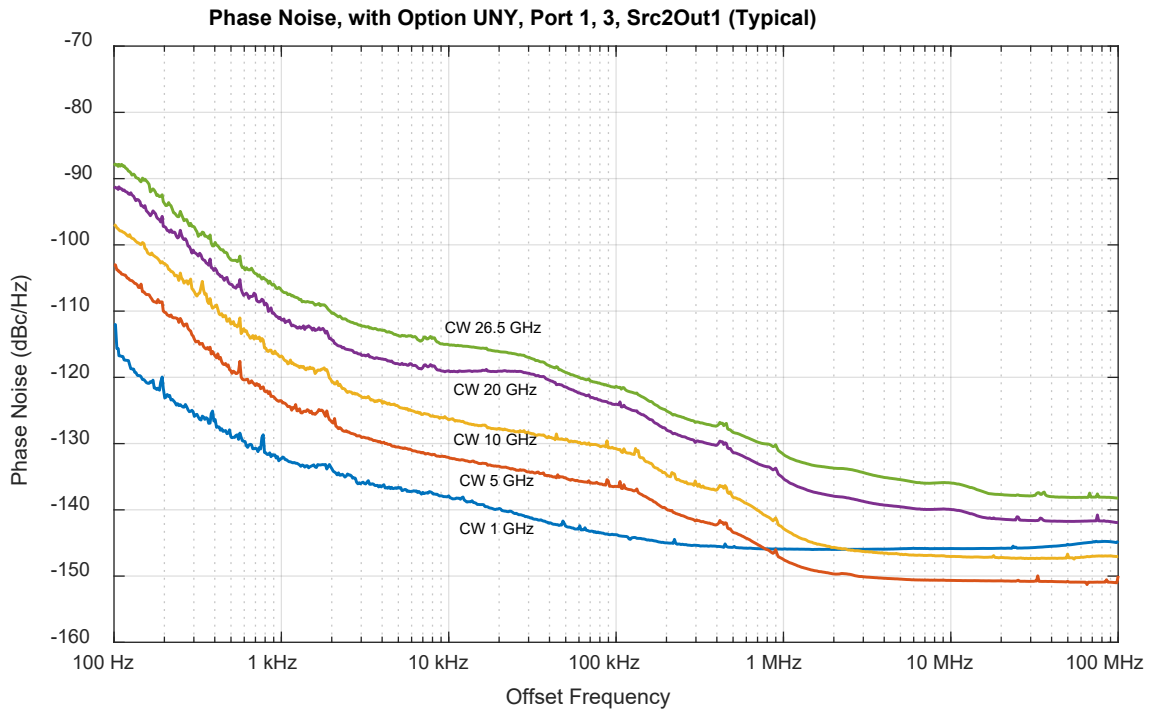
Table 13b. Phase Noise (dBc/Hz), Option 210, 410, with UNY, Port 2, 4 - Typical

| CW Frequency | 100 Hz Offset | 1 kHz Offset | 10 kHz Offset | 100 kHz Offset | 1 MHz Offset | 10 MHz Offset |
|--------------|---------------|--------------|---------------|----------------|--------------|---------------|
| 1 GHz | -111 | -121 | -132 | -145 | -149 | -149 |
| 5 GHz | -103 | -122 | -128 | -134 | -145 | -149 |
| 10 GHz | -96 | -112 | -120 | -127 | -140 | -147 |
| 20 GHz | -90 | -108 | -116 | -123 | -134 | -139 |
| 26.5 GHz | -86 | -106 | -114 | -121 | -131 | -135 |

Table 13c. Phase Noise (dBc/Hz), All Options, with UNY, All Ports – Supplemental Performance Data

| CW Frequency | 100 Hz Offset | 1 kHz Offset | 10 kHz Offset | 100 kHz Offset | 1 MHz Offset | 10 MHz Offset |
|--------------|---------------|--------------|---------------|----------------|--------------|---------------|
| 43.5 GHz | -82 | -106 | -113 | -117 | -129 | -135 |
| 50 GHz | -81 | -101 | -109 | -116 | -127 | -132 |

Phase Noise with Option UNY (Typical)



Phase Noise with Option UNY (Supplemental Performance Data)

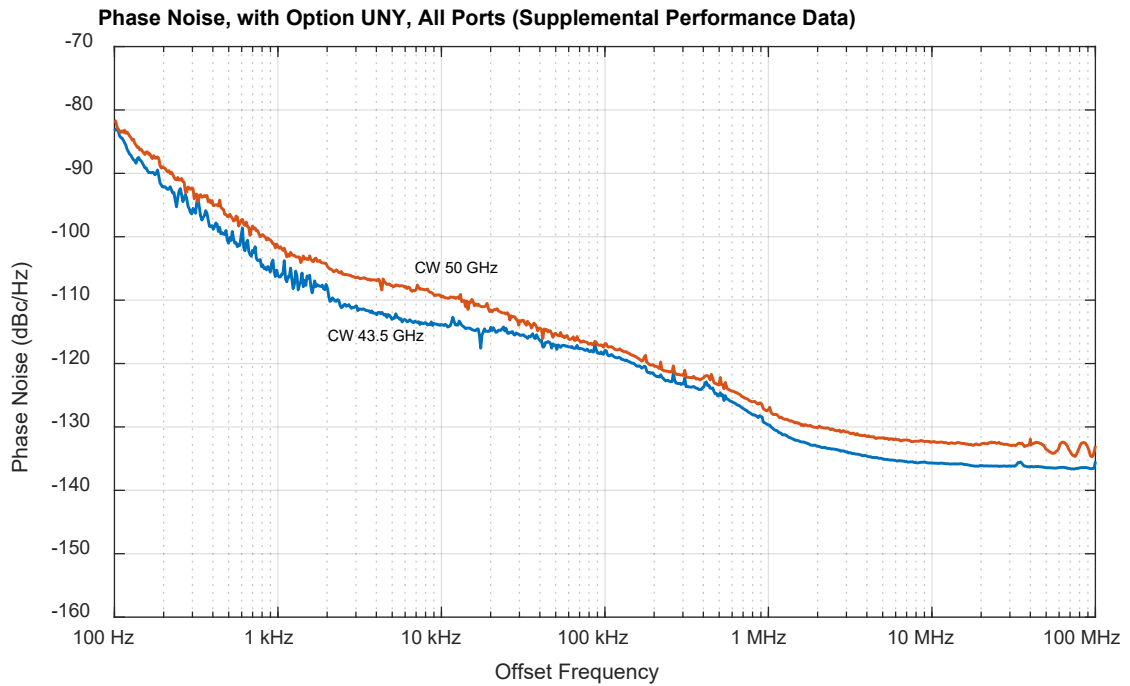


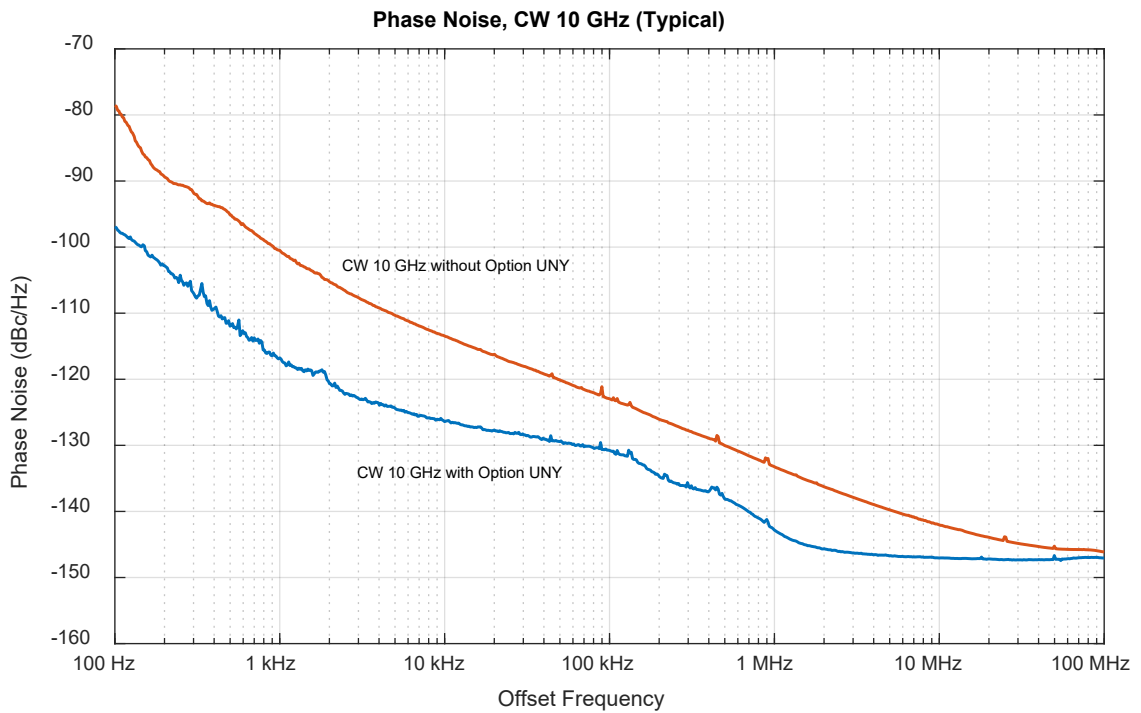
Table 13d. Phase Noise (dBc/Hz), Option 210, 410, without UNY, All Ports – Typical

| CW Frequency | 100 Hz Offset | 1 kHz Offset | 10 kHz Offset | 100 kHz Offset | 1 MHz Offset | 10 MHz Offset |
|--------------|---------------|--------------|---------------|----------------|--------------|---------------|
| 1 GHz | -94 | -116 | -130 | -141 | -145 | -146 |
| 5 GHz | -83 | -106 | -119 | -128 | -139 | -147 |
| 10 GHz | -78 | -100 | -113 | -122 | -133 | -142 |
| 20 GHz | -72 | -94 | -107 | -116 | -127 | -135 |
| 26.5 GHz | -67 | -90 | -104 | -114 | -124 | -132 |

Table 13e. Phase Noise (dBc/Hz), All Options, without UNY, All Ports – Supplemental Performance Data

| CW Frequency | 100 Hz Offset | 1 kHz Offset | 10 kHz Offset | 100 kHz Offset | 1 MHz Offset | 10 MHz Offset |
|--------------|---------------|--------------|---------------|----------------|--------------|---------------|
| 43.5 GHz | -70 | -90 | -103 | -112 | -122 | -130 |
| 50 GHz | -66 | -86 | -101 | -111 | -121 | -130 |

Phase Noise, CW 10 GHz, with Option UNY and without Option UNY



Test Port Input

Table 14. Test Port Noise Floor (dBm) @ 10 Hz IFBW, Option 210, 410

Total average (rms) noise power calculated as the mean value of a linear magnitude trace expressed in dBm. May typically be degraded at particular frequencies below 500 MHz due to spurious receiver residuals.

| Description | Specification | | Typical | |
|--------------------|---------------|--------|---------|--------|
| | N5224B | N5225B | N5224B | N5225B |
| 10 MHz to 50 MHz | -70 | -70 | -75 | -75 |
| 50 MHz to 100 MHz | -85 | -85 | -91 | -91 |
| 100 MHz to 250 MHz | -95 | -95 | -100 | -100 |
| 250 MHz to 500 MHz | -102 | -102 | -107 | -107 |
| 500 MHz to 1 GHz | -106 | -106 | -112 | -112 |
| 1 GHz to 10 GHz | -114 | -114 | -118 | -118 |
| 10 GHz to 26.5 GHz | -114 | -114 | -120 | -120 |
| 26.5 GHz to 35 GHz | -110 | -110 | -116 | -116 |
| 35 GHz to 40 GHz | -108 | -108 | -116 | -116 |
| 40 GHz to 43.5 GHz | -108 | -108 | -114 | -114 |
| 43.5 GHz to 50 GHz | -- | -109 | -- | -116 |

Table 15a. 0.1 dB Receiver Compression at Test Port (dBm), Option 210, 410 - Typical

| Description | N5224B | N5225B |
|--------------------|--------|--------|
| 10 MHz to 100 MHz | 15 | 15 |
| 100 MHz to 40 GHz | 12 | 12 |
| 40 GHz to 43.5 GHz | 10 | 10 |
| 43.5 GHz to 50 GHz | -- | 10 |

Table 15b. Receiver Compression at Test Power - Specification

| Description | Test Port Power (dBm) | Receiver Compression | |
|--------------------------------|-----------------------|----------------------|-----------------|
| | Option 210, 410 | Magnitude (dB) | Phase (degrees) |
| 10 MHz to 500 MHz ¹ | -- | -- | -- |
| 500 MHz to 10 GHz | 8 | 0.11 | 0.60 |
| 10 GHz to 20 GHz | 8 | 0.11 | 0.65 |
| 20 GHz to 26.5 GHz | 8 | 0.12 | 0.7 |
| 26.5 GHz to 30 GHz | 8 | 0.13 | 0.8 |
| 30 GHz to 35 GHz | 5 | 0.13 | 0.7 |
| 35 GHz to 40 GHz | 3 | 0.14 | 0.7 |
| 40 GHz to 43.5 GHz | 2 | 0.14 | 0.75 |
| 43.5 GHz to 47 GHz | 2 | 0.14 | 1.25 |
| 47 GHz to 50 GHz | 2 | 0.14 | 1.25 |

¹Test port receiver compression at specified input levels below 500 MHz due to coupler roll off in this frequency range.

Table 16. Trace Noise Magnitude (dB rms)

Ratioed measurement, nominal power at test port.

| Description | Specification | Typical | | |
|----------------------|---------------|------------|--------------|--------------|
| | 1 kHz IFBW | 1 kHz IFBW | 100 kHz IFBW | 600 kHz IFBW |
| 10 MHz to 50 MHz | 0.200 | 0.071 | 0.667 | 1.612 |
| 50 MHz to 100 MHz | 0.020 | 0.009 | 0.088 | 0.209 |
| 100 MHz to 500 MHz | 0.020 | 0.004 | 0.040 | 0.098 |
| 500 MHz to 1 GHz | 0.003 | 0.001 | 0.009 | 0.022 |
| 1 GHz to 26.5 GHz | 0.003 | 0.001 | 0.006 | 0.015 |
| 26.5 GHz to 43.5 GHz | 0.003 | 0.001 | 0.009 | 0.021 |
| 43.5 GHz to 50 GHz | 0.004 | 0.002 | 0.007 | 0.018 |

Table 17. Trace Noise Phase (deg rms)

Ratioed measurement, nominal power at test port.

| Description | Specification | Typical | | |
|----------------------|---------------|------------|--------------|--------------|
| | | 1 kHz IFBW | 100 kHz IFBW | 600 kHz IFBW |
| 10 MHz to 50 MHz | 1.000 | 0.485 | 4.681 | 11.310 |
| 50 MHz to 100 MHz | 1.000 | 0.062 | 0.614 | 1.456 |
| 100 MHz to 500 MHz | 0.500 | 0.029 | 0.276 | 0.680 |
| 500 MHz to 1 GHz | 0.020 | 0.006 | 0.061 | 0.149 |
| 1 GHz to 26.5 GHz | 0.020 | 0.008 | 0.040 | 0.100 |
| 26.5 GHz to 43.5 GHz | 0.030 | 0.014 | 0.067 | 0.159 |
| 43.5 GHz to 50 GHz | 0.030 | 0.015 | 0.061 | 0.142 |

Table 18. Reference Level Magnitude, Option 210, 410 - Specification

| Description | Magnitude (dB) | Phase (degrees) |
|-------------|----------------|-----------------|
| Range | +/- 500 | +/- 500 |
| Resolution | 0.001 | 0.01 |

Table 19a. Stability vs. Temperature, Option 210, 410 - Typical

| Description | Magnitude (dB/°C) | Phase (°/°C) |
|--------------------|-------------------|--------------|
| 10 MHz to 50 MHz | 0.020 | 0.200 |
| 50 MHz to 3.2 GHz | 0.010 | 0.100 |
| 3.2 GHz to 10 GHz | 0.010 | 0.200 |
| 10 GHz to 16 GHz | 0.010 | 0.250 |
| 16 GHz to 20 GHz | 0.015 | 0.300 |
| 20 GHz to 26.5 GHz | 0.015 | 0.400 |
| 26.5 GHz to 35 GHz | 0.020 | 0.600 |
| 35 GHz to 43.5 GHz | 0.020 | 0.650 |
| 43.5 GHz to 47 GHz | 0.025 | 0.700 |
| 47 GHz to 50 GHz | 0.027 | 0.750 |

Table 19b. Stability vs. Time, Option 210, 410 – Specification

The specifications below are observations of the maximum drift performance over +/- 0.5 °C and a period of 24 hours subsequent to a 48 hours warm up period, with ideal load for reflections and ideal thru for transmission measurements.

| Description | Magnitude (dB/24 hours) | | |
|--------------------------------|-------------------------|--------------------|--|
| | S11, S22, S33, S44 | S21, S12, S43, S34 | S31, S13, S41, S14, S42, S24, S32, S23 |
| 10 MHz to 12 MHz ¹ | -52 | 0.025 | 0.025 |
| 12 MHz to 500 MHz ¹ | -60 | 0.013 | 0.018 |
| 500 MHz to 3.2 GHz | -65 | 0.010 | 0.014 |
| 3.2 GHz to 10 GHz | -65 | 0.012 | 0.017 |
| 10 GHz to 13.5 GHz | -65 | 0.019 | 0.027 |
| 13.5 GHz to 16 GHz | -65 | 0.019 | 0.027 |
| 16 GHz to 20 GHz | -65 | 0.022 | 0.031 |
| 20 GHz to 24 GHz | -65 | 0.028 | 0.040 |
| 24 GHz to 26.5 GHz | -65 | 0.028 | 0.040 |
| 26.5 GHz to 32 GHz | -60 | 0.035 | 0.049 |
| 32 GHz to 40 GHz | -60 | 0.045 | 0.064 |
| 40 GHz to 43.5 GHz | -60 | 0.055 | 0.078 |
| 43.5 GHz to 47 GHz | -60 | 0.055 | 0.078 |
| 47 GHz to 50 GHz | -60 | 0.059 | 0.083 |

¹ Performance may be degraded at frequencies below 500 MHz due to spurious receiver residuals.

Table 20. Damage Input Level, All ports

| Description | Option 210, 410 |
|-------------|-----------------|
| RF, DC | 27 dBm, 40 V |

Phase Noise Measurement Performance (with S930317B phase noise measurement application) - Preliminary¹

- Offset frequency range: 0.1 Hz to 10 MHz
- Sweep speed (typical): 34 seconds (1 Hz to 10 MHz offset in Normal mode)

Table 21a. Absolute Phase Noise Sensitivity (dBc/Hz), in Best mode - Supplemental Performance Data

Input Power level: +5 dBm (-5 dBm at 50 GHz)

| Phase Noise | Offset Frequency | | | | | | | | |
|-----------------|------------------|-------|--------|-------|--------|---------|---------|-------|--------|
| Input Frequency | 1 Hz | 10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 300 kHz | 1 MHz | 10 MHz |
| 1 GHz | -55 | -88 | -112 | -127 | -132 | -134 | -134 | -134 | -134 |
| 10 GHz | -36 | -69 | -97 | -117 | -124 | -130 | -132 | -136 | -137 |
| 20 GHz | -31 | -64 | -90 | -111 | -120 | -124 | -125 | -132 | -134 |
| 40 GHz | -23 | -58 | -84 | -104 | -113 | -117 | -123 | -125 | -129 |
| 50 GHz | -18 | -54 | -81 | -100 | -109 | -113 | -116 | -121 | -123 |

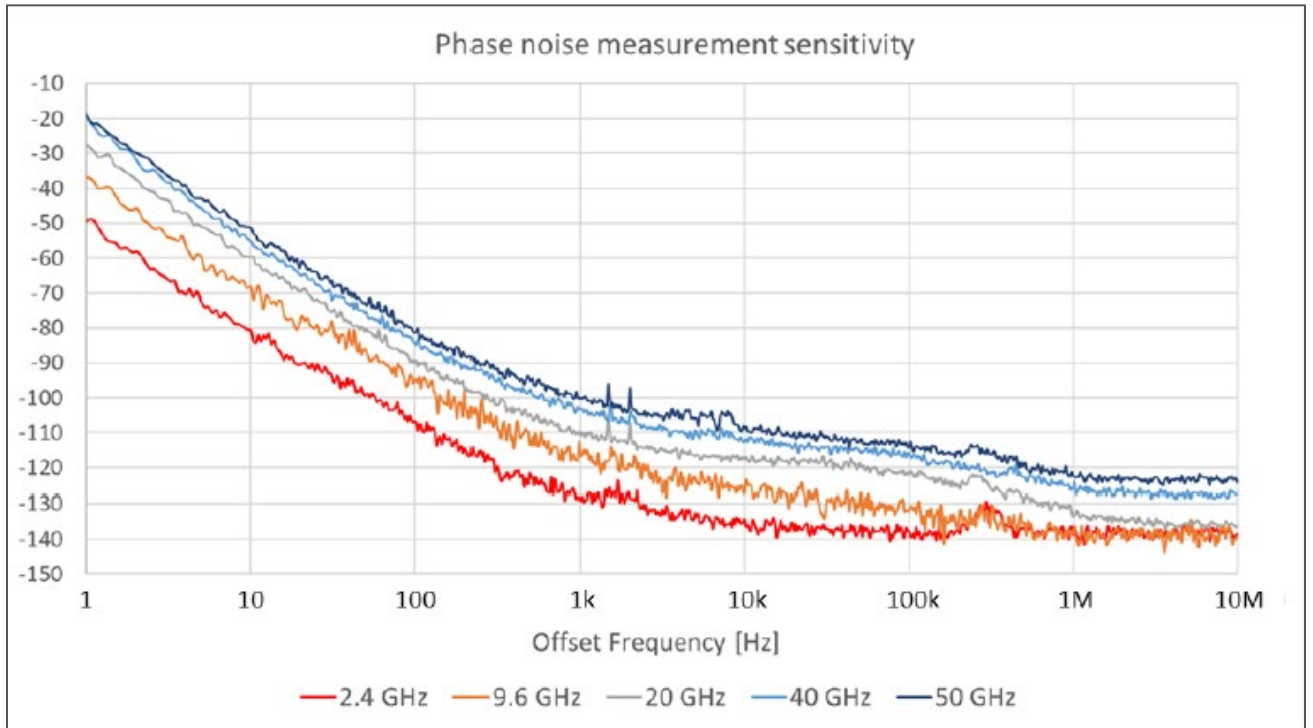
Table 21b. Absolute AM Noise Sensitivity (dBc/Hz), in Best mode - Supplemental Performance Data

Input Power level: +5 dBm (-5 dBm at 50 GHz)

| AM Noise | Offset Frequency | | | | | | | | |
|-----------------|------------------|-------|--------|-------|--------|---------|---------|-------|--------|
| Input Frequency | 1 Hz | 10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 300 kHz | 1 MHz | 10 MHz |
| 1 GHz | -96 | -104 | -110 | -119 | -128 | -132 | -132 | -135 | -137 |
| 10 GHz | -97 | -104 | -110 | -118 | -128 | -134 | -135 | -138 | -139 |
| 20 GHz | -96 | -104 | -112 | -116 | -125 | -132 | -129 | -136 | -136 |
| 40 GHz | -93 | -102 | -109 | -114 | -123 | -127 | -130 | -130 | -132 |
| 50 GHz | -91 | -96 | -105 | -114 | -119 | -122 | -117 | -125 | -122 |

¹ The input frequency in the sensitivity tables in this section is limited to the highest frequency of the PNA model.

Absolute Phase Noise Sensitivity (dBc/Hz) - Supplemental Performance Data



Single-Channel Residual Noise Measurement for Frequency Converting Devices²

Table 21c. Single-Channel Residual Phase Noise Sensitivity (dBc/Hz), with Option UNY in Best mode - Supplemental Performance Data

Input Power level: +10 dBm (+6 dBm at 40 GHz, -2 dBm at 50 GHz)

| Residual Phase Noise | Offset Frequency | | | | | | | | |
|----------------------|------------------|------|-------|--------|-------|--------|---------|---------|-------|
| | Input Frequency | 1 Hz | 10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 300 kHz | 1 MHz |
| 1 GHz | -102 | -110 | -115 | -123 | -131 | -136 | -136 | -137 | -137 |
| 10 GHz | -92 | -99 | -105 | -113 | -122 | -131 | -134 | -139 | -140 |
| 20 GHz | -83 | -93 | -100 | -112 | -118 | -125 | -124 | -132 | -136 |
| 40 GHz | -78 | -85 | -93 | -106 | -110 | -122 | -126 | -128 | -129 |
| 50 GHz | -75 | -81 | -91 | -102 | -110 | -120 | -119 | -125 | -125 |

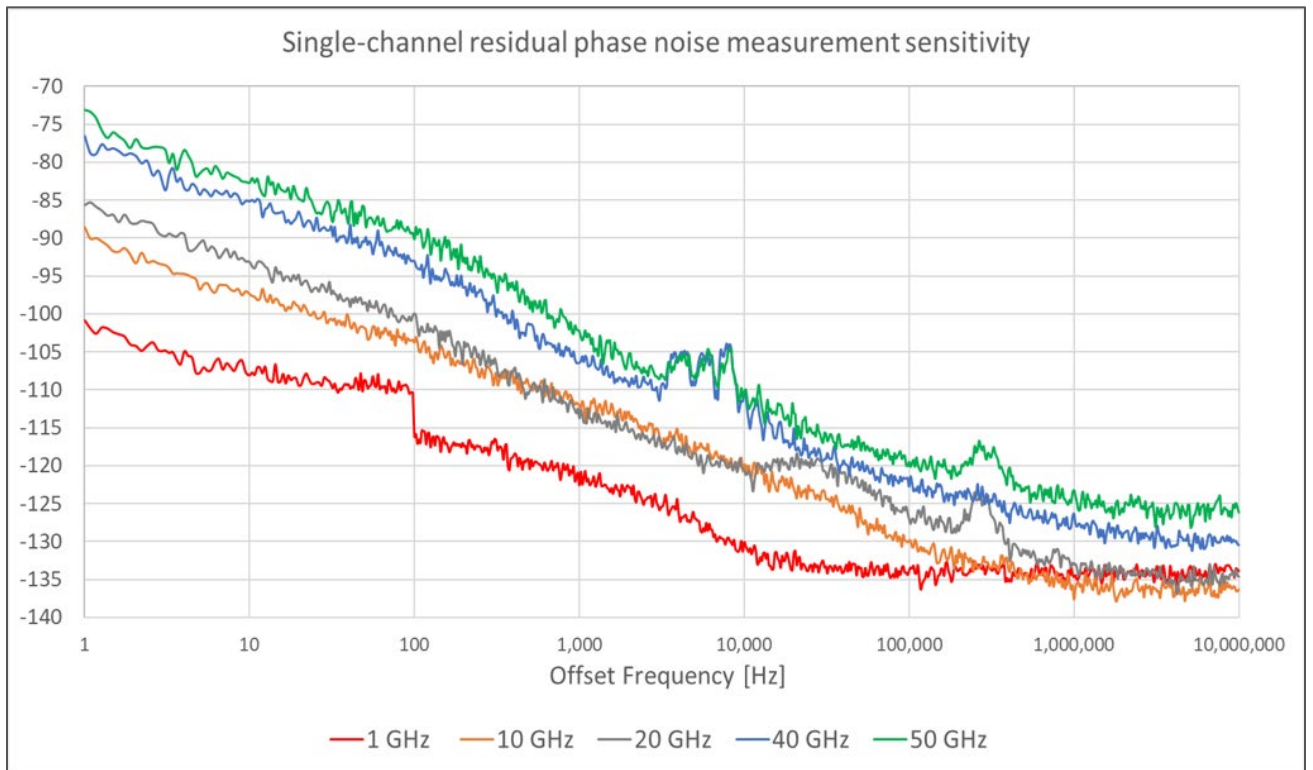
Table 21d. Single-Channel Residual AM Noise Sensitivity (dBc/Hz), with Option UNY in Best mode - Supplemental Performance Data

Input Power level: +10 dBm (+6 dBm at 40 GHz, -2 dBm at 50 GHz)

| Residual AM Noise | Offset Frequency | | | | | | | | |
|-------------------|------------------|------|-------|--------|-------|--------|---------|---------|-------|
| | Input Frequency | 1 Hz | 10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 300 kHz | 1 MHz |
| 1 GHz | -97 | -104 | -112 | -120 | -117 | -128 | -130 | -134 | -138 |
| 10 GHz | -97 | -106 | -111 | -120 | -121 | -129 | -134 | -137 | -142 |
| 20 GHz | -99 | -104 | -112 | -120 | -123 | -120 | -123 | -130 | -136 |
| 40 GHz | -96 | -102 | -110 | -117 | -118 | -128 | -132 | -131 | -133 |
| 50 GHz | -91 | -99 | -109 | -114 | -120 | -125 | -118 | -125 | -127 |

² The phase or AM noise of the DUT output signal is not measured. The measurement can be done when the phase or AM noise of the signal generated by the DUT is larger than that of the DUT input signal supplied by the PNA internal signal source.

Single-Channel Residual Phase Noise Sensitivity (dBc/Hz) - Supplemental Performance Data



2-Channel Residual Noise Measurement for Non-Frequency Converting Devices³

Table 21e. 2-Channel Residual Phase Noise Sensitivity (dBc/Hz), with Option UNY in Best mode - Supplemental Performance Data

Input Power level: +10 dBm (+6 dBm at 40 GHz, -3 dBm at 50 GHz)

| Residual Phase Noise | Offset Frequency | | | | | | | | |
|----------------------|------------------|------|-------|--------|-------|--------|---------|---------|-------|
| | Input Frequency | 1 Hz | 10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 300 kHz | 1 MHz |
| 1 GHz | -107 | -116 | -127 | -134 | -132 | -134 | -131 | -133 | -132 |
| 10 GHz | -101 | -110 | -120 | -126 | -134 | -135 | -134 | -138 | -136 |
| 20 GHz | -99 | -105 | -113 | -120 | -128 | -131 | -129 | -134 | -135 |
| 40 GHz | -93 | -101 | -109 | -115 | -121 | -124 | -125 | -126 | -127 |
| 50 GHz | -90 | -99 | -106 | -113 | -117 | -118 | -119 | -120 | -120 |

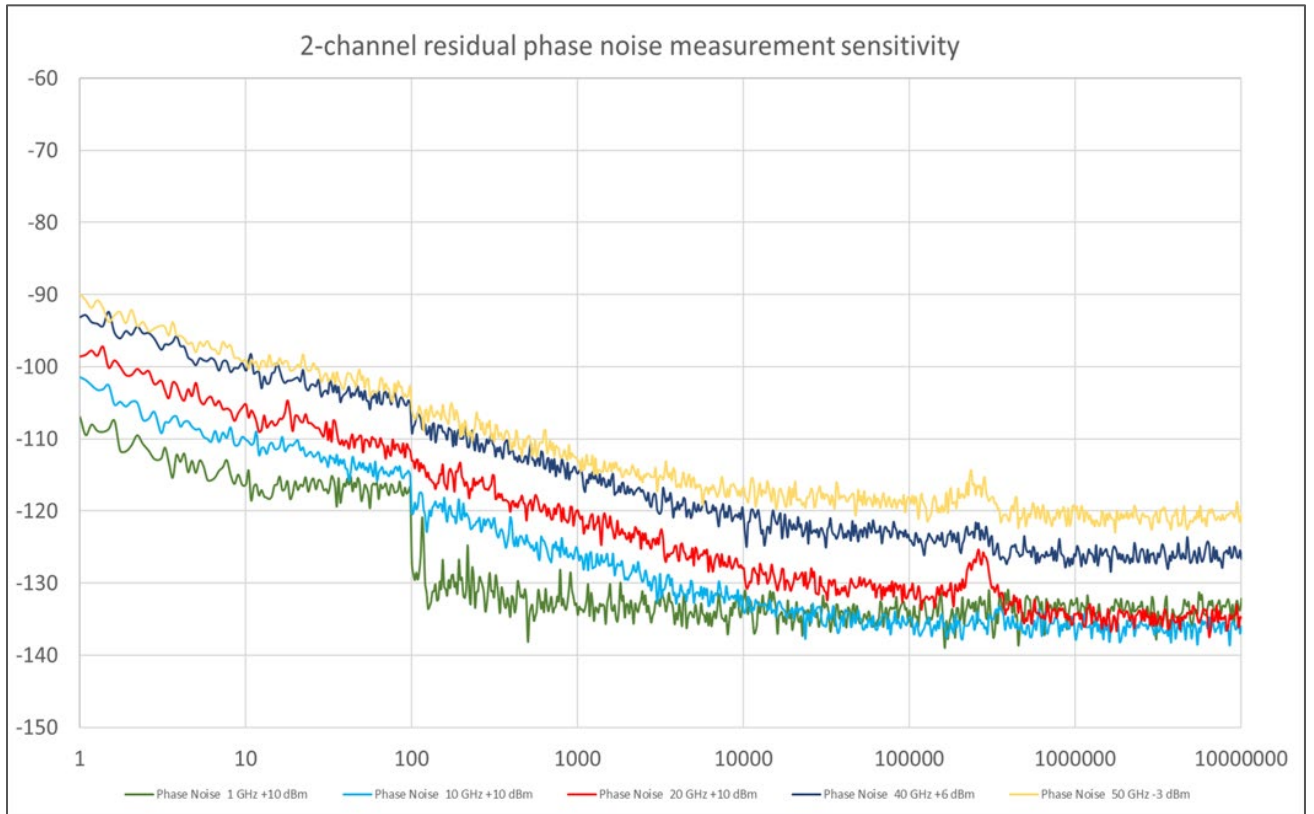
Table 21f. 2-Channel Residual AM Noise Sensitivity (dBc/Hz), with Option UNY in Best mode - Supplemental Performance Data

Input Power level: +10 dBm (+6 dBm at 40 GHz, -3 dBm at 50 GHz)

| Residual AM Noise | Offset Frequency | | | | | | | | |
|-------------------|------------------|------|-------|--------|-------|--------|---------|---------|-------|
| | Input Frequency | 1 Hz | 10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 300 kHz | 1 MHz |
| 1 GHz | -99 | -106 | -109 | -120 | -131 | -133 | -138 | -137 | -134 |
| 10 GHz | -95 | -105 | -113 | -121 | -130 | -134 | -136 | -139 | -139 |
| 20 GHz | -96 | -104 | -113 | -120 | -129 | -128 | -129 | -136 | -136 |
| 40 GHz | -98 | -107 | -112 | -118 | -120 | -127 | -129 | -130 | -131 |
| 50 GHz | -93 | -102 | -110 | -115 | -120 | -121 | -119 | -122 | -122 |

³ Both the phase or AM noise of the DUT input signal and that of the DUT output signal are measured.

2-Channel Residual Phase Noise Sensitivity (dBc/Hz) - Supplemental Performance Data



Dynamic Accuracy

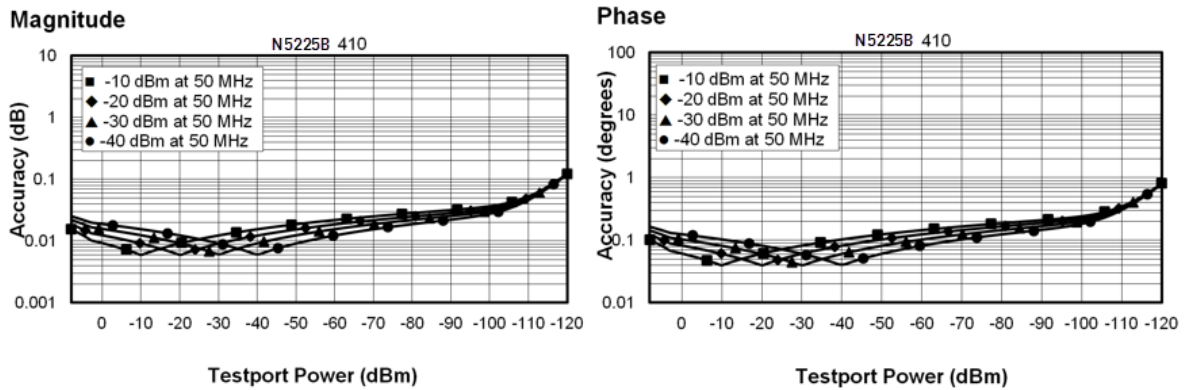
Dynamic accuracy is verified with the following measurements:

Compression over frequency

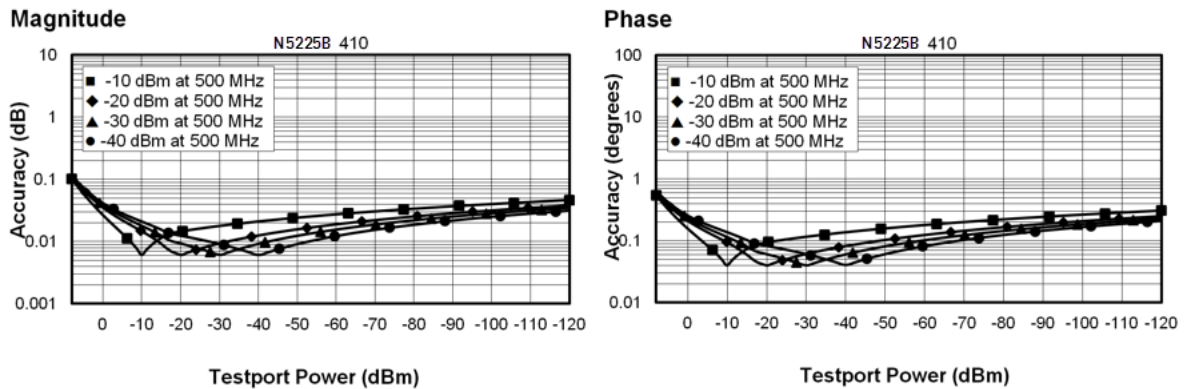
IF linearity at a single frequency of 99.6 MHz or 1.998765 GHz using a reference level of -20 dBm for an input power range of 0 to -60 dBm. For values below -60 dBm, refer to [VNA Receiver Dynamic Accuracy Specifications and Uncertainties](#).

Table 22. N5224B and N5225B Dynamic Accuracy

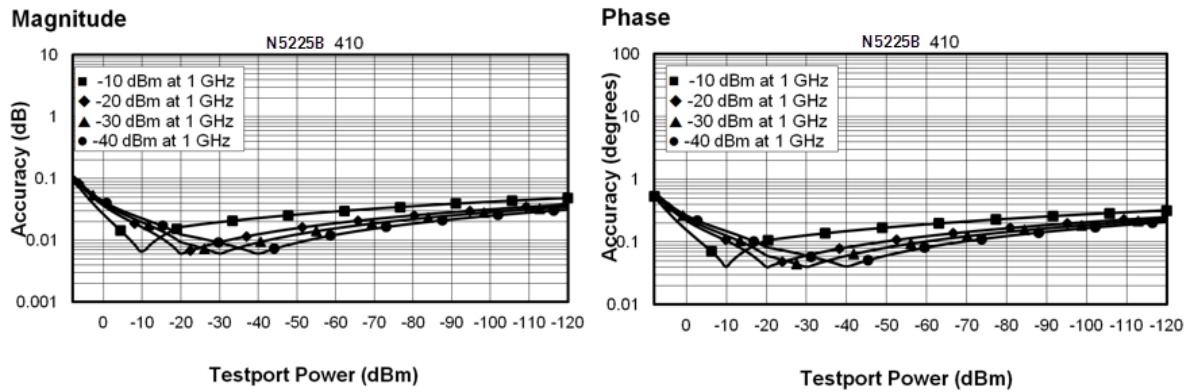
N5224B/25B Dynamic Accuracy, 50 MHz – Specification



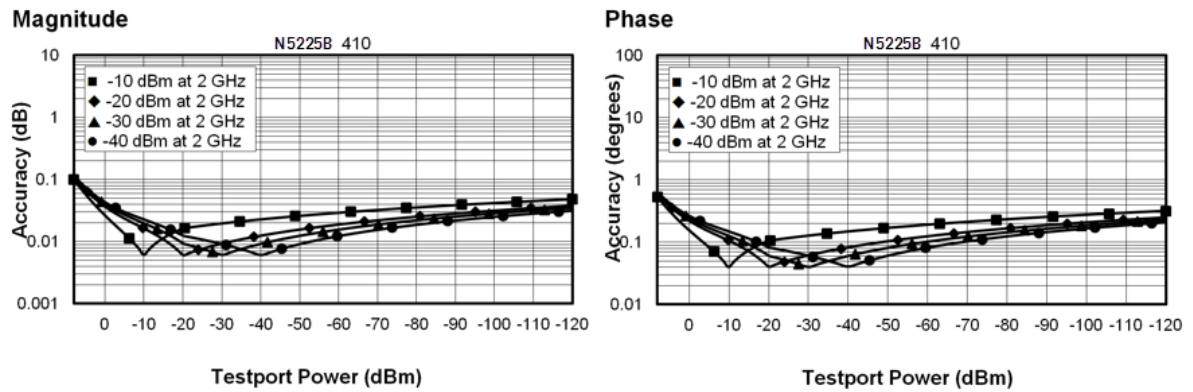
N5224B/25B Dynamic Accuracy, 500 MHz – Specification



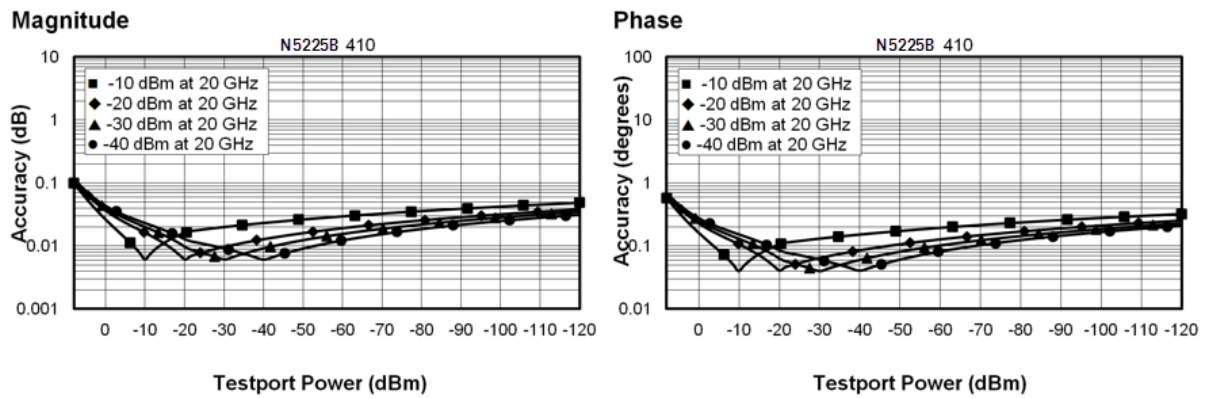
N5224B/25B Dynamic Accuracy, 1 GHz – Specification



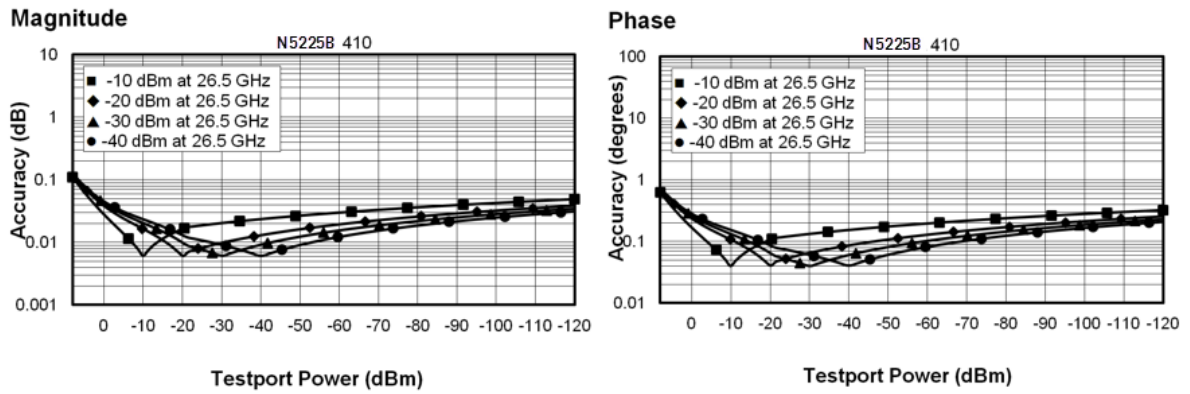
N5224B/25B Dynamic Accuracy, 2 GHz – Specification



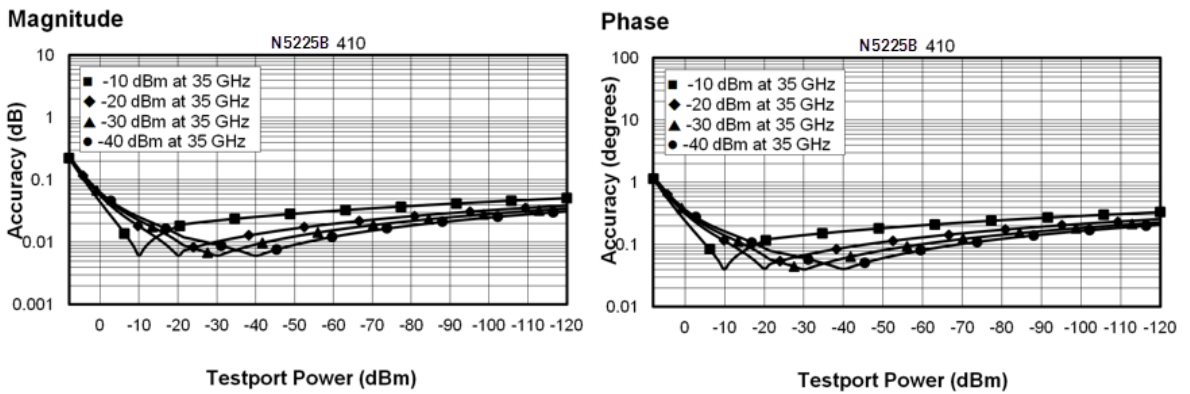
N5224B/25B Dynamic Accuracy, 20 GHz – Specification



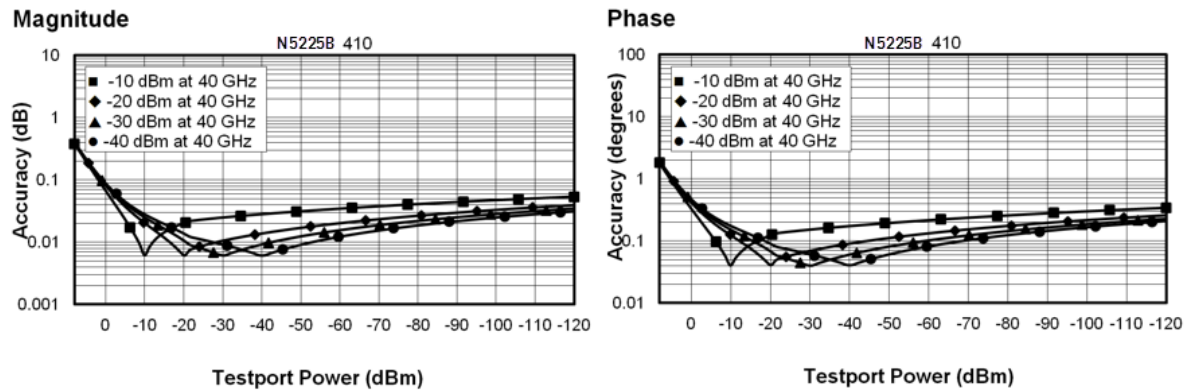
N5224B/25B Dynamic Accuracy, 26.5 GHz – Specification



N5224B/25B Dynamic Accuracy, 35 GHz – Specification



N5224B/25B Dynamic Accuracy, 40 GHz – Specification



N5224B/25B Dynamic Accuracy, 50 GHz – Specification

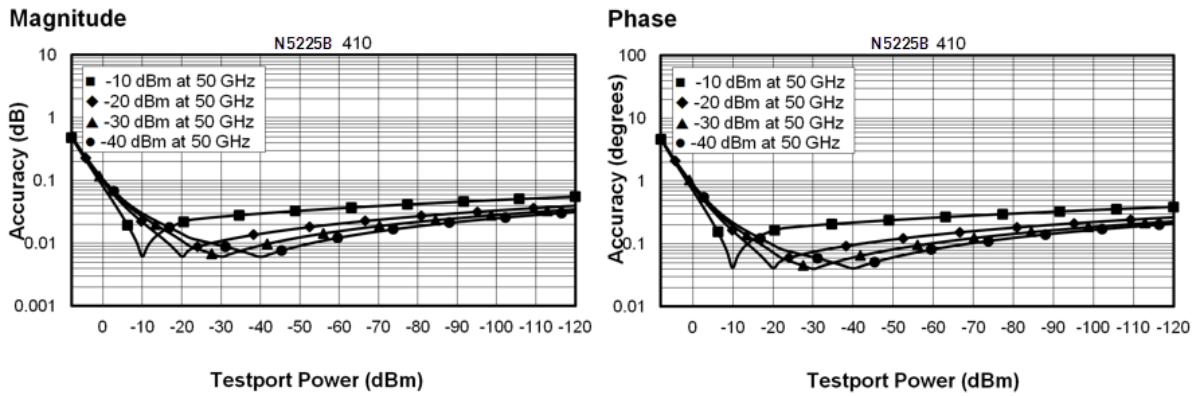


Table 23. Group Delay – Typical

Group delay is computed by measuring the phase change within a specified frequency step (determined by the frequency span and the number of points per sweep). In general, the following formula can be used to determine the accuracy, in seconds, of specific group delay measurement:

$$\pm \text{Phase Accuracy (deg)} / [360 \times \text{Aperture (Hz)}]$$

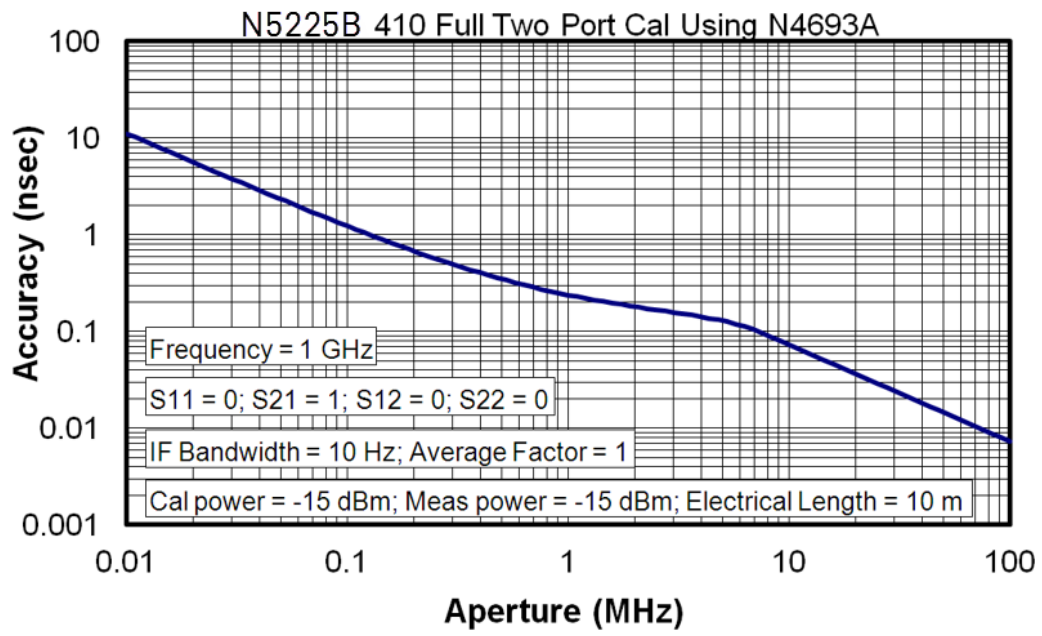
Depending on the aperture and device length, the phase accuracy used is either incremental phase accuracy or worst-case phase accuracy

| Description | Typical Performance |
|-----------------------|--|
| Aperture (selectable) | (frequency span)/(number of points -1) |
| Maximum Aperture | 20% of frequency span |
| Range | 0.5 x (1/minimum aperture) |
| Maximum Delay | Limited to measuring no more than 180° of phase change within the minimum aperture.) |

The following graphs show characteristic group delay accuracy with full 2-port calibration and a 10 Hz IF bandwidth. Insertion loss is assumed to be < 2 dB and electrical length to be ten meters.

For any S_{ij} Group Delay measurement, $S_{ii} = 0$, $S_{ij} = 1$, $S_{ji} = 0$, $S_{kl} = 0$ for all $kl \neq ij$

Group Delay (Typical)



General Information

- [Miscellaneous Information](#)
- [Front Panel](#)
- [Rear Panel](#)
- [Environment and Dimensions](#)

Table 24. Miscellaneous Information

| Description | Supplemental Information | |
|---------------------------|--|---|
| System IF Bandwidth Range | 1 Hz to 15 MHz, nominal | |
| CPU | For the latest information on CPUs and associated hard drives, visit: PNA Hard Drives and CPUs (keysight.com) | |
| LXI | CPU version 7.0, 8.0 | CPU version 9.0 |
| | Class C | LXI 1.5 Extended Functions: HiSLIP; VSI-11 Discovery and Identification |

Table 25. Front Panel Information, Option 210, 410

| Description | Typical Performance |
|--|----------------------------------|
| RF Connectors | |
| Type | 2.4 mm (male), 50 ohm, (nominal) |
| Center Pin Recession | 0.002 in. (characteristic) |
| USB 2.0 Ports - Primary (4 ports) | |
| Standard | Compatible with USB 2.0 |
| Connector | USB Type-A female |

| Display | |
|----------------|---|
| Size | 31 cm (12.1 in) diagonal color active matrix LCD; 1280 (horizontal) X 800 (vertical) resolution |
| Refresh Rate | Vertical 60 Hz; Horizontal 49.31 kHz |
| Pixels | Any of the following would cause a display to be considered faulty: <ul style="list-style-type: none"> • A complete row or column consists of “stuck” or “dark” pixels. • More than six “stuck on” pixels (but not more than three green) or more than 0.002% of the total pixels are within the LCD specifications. • More than twelve “dark” pixels (but no more than seven of the same color) or more than 0.004% of the total pixels are within the LCD specifications. • Two or more consecutive "stuck on" pixels or three or more consecutive "dark" pixel (but no more than one set of two consecutive dark pixels). • “Stuck on” pixels or more than two “dark” pixels less than 6.5 mm apart (excluding consecutive pixels). |

Table 25. (Continued) Front Panel Information, Option 210, 410

| Description | Typical Performance |
|---------------------------|-------------------------------------|
| Display Range | |
| Magnitude | +/-2500 dB (at 500 dB/div), max |
| Phase | +/-2500° (at 500 degrees/div), max |
| Polar | 10 pUnits, min 10,000 Units, max |
| Display Resolution | |
| Magnitude | 0.001 dB/div, min |
| Phase | 0.01°/div, min |
| Marker Resolution | |
| Magnitude | 0.001 dB, min |
| Phase | 0.01°, min |
| Polar | 10 pUnit, min |

Table 26. Rear Panel Information, Option 210, 410

| Description | Typical Performance |
|-----------------------------|---|
| 10 MHz Reference In | |
| Connector | BNC, female |
| Input Frequency | 10 MHz \pm 1 ppm, 100 MHz \pm 1 ppm |
| Input Level | 10 MHz: -15 dBm to +20 dBm 100 MHz: -10 dBm to +20 dBm |
| Input Impedance | 50 Ω , nom. |
| 10 MHz Reference Out | |
| Connector | BNC, female |
| Output Frequency | 10 MHz \pm 0.7 ppm, 100 MHz \pm 0.7 ppm |
| Signal Type | Sine Wave |
| Output Level | +10 dBm \pm 4 dB into 50 Ω |
| Output Impedance | 50 Ω , nominal |
| Harmonics | <-40 dBc, typical |

Table 26. (Continued) Rear Panel Information, Option 210, 410

| Description | Typical Performance |
|---------------------------|--|
| External IF Inputs | |
| Function | Allows use of external IF signals from remote mixers, bypassing the PNA's first converters |
| Connectors | SMA (female); A, B, C, D, R (4-port); A, B, R1, R2 (2-port) |
| Input Frequency | |
| Normal IF path | RF < 53 MHz: IF = 826.446 KHz RF \geq 53 MHz: IF = 7.438 MHz |
| Narrowband IF path | IF = 10.70 MHz |
| Input Impedance | 50 Ω |
| RF Damage Level | +23 dBm |
| DC Damage Level | 5.5 VDC |
| 0.1 dB Compression Point | |
| Normal IF path | -9.0 dBm at 7.438 MHz |
| Narrowband IF path | -17 dBm at 10.70 MHz |

| Pulse Inputs (IF Gates) | |
|--|--|
| Function | Internal receiver gates used for point-in-pulse and pulse-profile measurements |
| Connectors | 15-pin mini D-sub |
| Input Impedance | 1 K Ohm |
| Minimum Pulse Width, Source Modulators | 33 ns |
| Minimum Pulse Width, Receiver Gates | 20 ns |
| DC Damage Level | 5.5 VDC |
| Drive Voltage | 0 V (off), +3.3 V (on), nominal |
| RF Pulse Modulator Input (Source Modulator) | |
| On/Off Ratio | |
| 10 MHz to 3.2 GHz | -64 |
| 3.2 GHz to 50 GHz | -80 |
| Pulse Period | |
| Minimum | 33 ns |
| Maximum | 70 s |

Table 26. (Continued) Rear Panel Information, Option 210, 410

| Description | Typical Performance |
|---------------------------------|--------------------------------|
| Pulse Outputs | |
| Voltage (TTL) | High: 3.3V to 3.5V Low: <1V |
| Impedance | 50 Ohm |
| External Test Set Driver | |
| Function | Used for driving remote mixers |
| Connections | 3.5 mm (female) |
| RF Output Frequency Range | 3.2 GHz to 19 GHz |
| LO Output Frequency Range | 0.01 GHz to 26.5 GHz |

| Rear Panel LO Power | | |
|----------------------------|-----------------------------------|-----------------------------------|
| | Upper Limit, Typical (dBm) | Lower Limit, Typical (dBm) |
| 10 MHz to 1.7 GHz | -- | -- |
| 1.7 GHz to 6.78 GHz | 5 | -3 |
| 6.78 GHz to 15.4 GHz | 0 | -6 |
| 15.4 GHz to 26.5 GHz | 4 | -5 |
| Rear Panel RF Power | | |
| | Upper Limit, Typical (dBm) | Lower Limit, Typical (dBm) |
| 3.2 GHz to 19 GHz | -3 | -8 |

Table 26. (Continued) Rear Panel Information, Option 210, 410

| Description | Typical Performance | |
|------------------------|---|---|
| Trigger Inputs/Outputs | BNC(f), TTL/CMOS compatible | |
| Test Set IO | 25-pin D-Sub connector, available for external test set control | |
| Power IO | 9-pin D-Sub, female; analog and digital IO | |
| Handler IO | 36-pin parallel I/O port; all input/output signals are default set to negative logic; can be reset to positive logic via GPIB command | |
| Pulse I/O | 15-pin D connector provides access to Pulse Modulators and Generators | |
| GPIB | Two ports - dedicated controller and dedicated talker/listener. 24-pin D-sub (Type D-24), female; compatible with IEEE-488 | |
| CPU Version | CPU version 7.0, 8.0 | CPU version 9.0 |
| PCIe | Cabled PCIe x4 connector is a 4-lane slot | N/A |
| USB Ports | Two SuperSpeed USB ports (900 mA each), one USB port below LAN connector, and one USB device port. There are also four USB ports (500 mA each) on the front panel. The total current limit for all rear panel USB ports is 2.3 amps. The total current limit for all front panel USB ports is 2 amps. | Four SuperSpeed USB ports (900 mA each) and one USB device port. There are also four USB ports (500 mA each) on the front panel. The total current limit for all rear panel USB ports is 3.6 amps. The total current limit for all front panel USB ports is 2 amps. |

| | | |
|--------------------|--|---|
| USB-C (Host) | N/A | Two USB-C connectors with support for USB-3.1 (max Power Delivery of 5V@1A), Thunderbolt3 (max Power Delivery of 5V@1A) ¹ , and Display Port (port TB1 only) |
| LAN | 10/100/1000 BaseT Ethernet, 8-pin configuration; auto selects between the data rates | 1G port; 1G and 10G ports; 10GBASE-T, Ethernet, 8-pin configuration; auto selects between the data rates. Works with Cat6/Cat7 cable. |
| VGA Video Output | 15-pin mini D-Sub; Drives VGA compatible monitors | N/A |
| Mini DisplayPort | Miniature DisplayPort connector for connection to external displays | N/A |
| DisplayPort | N/A | Standard DisplayPort connector for connection to external displays |
| Line Power | | |
| Frequency, Voltage | 50/60/400 Hz for 100 to 120 VAC 50/60 Hz for 220 to 240 VAC | |
| | Power supply is auto switching | |
| Max | 575 watts | |

¹ High power devices require external power supply

Table 27. Analyzer Dimensions and Weight

All models are shipped with handles.

| Cabinet Dimensions | Metric (mm) | Imperial (inches) |
|---|-------------|-------------------|
| Height | | |
| Without bottom feet: ¹ EIA RU = 6 | 266.1 | 10.5 |
| With bottom feet | 279.1 | 11.0 |
| Width | | |
| Without handles or rack-mount flanges | 425.6 | 16.8 |
| With handles, without rack-mount flanges | 458.7 | 18.1 |
| With handles and rack-mount flanges | 482.9 | 19.0 |
| Depth | | |
| Without front and rear panel hardware | 582.3 | 22.9 |
| With front and rear panel hardware, handles | 649.6 | 25.6 |

¹Electronics Industry Association rack units. 1 RU = 1.75 in.

| Weight (nominal) | Net | Shipping |
|---------------------------|-----------------|------------------|
| 2-port model (Option 210) | 39.1 kg (86 lb) | 55 kg (121 lb) |
| 4-port model (Option 410) | 41.8 kg (92 lb) | 58.2 kg (128 lb) |

Regulatory and Environmental Information

For Regulatory and Environmental information, refer to the PNA Series Installation and Quick Start Guide, located online at <http://literature.cdn.keysight.com/litweb/pdf/E8356-90001.pdf>.

Measurement Throughput Summary

- Typical Cycle Time for Measurement Completion
- Cycle Time vs. IF Bandwidth
- Cycle Time vs. Number of Points
- Data Transfer Time

Cycle time Includes sweep time, retrace time and band-crossing time. Analyzer display turned off with DISPLAY:ENABLE OFF. Add 21 ms for display on. Data for one trace (S₁₁) measurement.

Table 28a. Typical Cycle Time (ms) for Measurement Completion, All Models and Options

| Sweep Range | IF Bandwidth | | Number of Points | | | | |
|------------------|--------------|-------------|------------------|-------|-------|-------|-------|
| | | | 201 | 401 | 1601 | 16001 | 32001 |
| 9 GHz to 10 GHz | 600 kHz | Uncorrected | 3.7 | 4.1 | 8.1 | 53.9 | 104.2 |
| | | 2-Port cal | 9.1 | 9.7 | 18.4 | 108.8 | 209.8 |
| | 10 kHz | Uncorrected | 27.9 | 53.3 | 201.8 | 2034 | 3976 |
| | | 2-Port cal | 55.9 | 105.7 | 416 | 3978 | 7954 |
| | 1 kHz | Uncorrected | 201.3 | 399 | 1599 | 15816 | 31621 |
| | | 2-Port cal | 403 | 798 | 3172 | 31622 | 63374 |
| 10 GHz to 20 GHz | 600 kHz | Uncorrected | 12.7 | 12.9 | 13.9 | 58.7 | 114.2 |
| | | 2-Port cal | 26.1 | 28.5 | 31.4 | 127.2 | 218.5 |
| | 10 kHz | Uncorrected | 46.7 | 83.3 | 206 | 1995 | 3986 |
| | | 2-Port cal | 86.4 | 162.5 | 416 | 3987 | 7961 |
| | 1 kHz | Uncorrected | 204.3 | 402 | 1588 | 15816 | 31648 |
| | | 2-Port cal | 408 | 804 | 3193 | 31629 | 63382 |

Table 28b. N5224B/25B Typical Cycle Time (ms) for Full-Span Measurement Completion

| 10 MHz to 13.5 GHz | | Number of Points | | | | |
|--------------------|-------------|------------------|-------|------|-------|-------|
| IF Bandwidth | | 201 | 401 | 1601 | 16001 | 32001 |
| 600 kHz | Uncorrected | 33.2 | 45.8 | 68.4 | 99 | 151.2 |
| | 2-Port cal | 63.7 | 92.3 | 149 | 199 | 300 |
| 10 kHz | Uncorrected | 56.6 | 97.1 | 342 | 2207 | 4249 |
| | 2-Port cal | 113.3 | 194.2 | 680 | 4408 | 8494 |
| 1 kHz | Uncorrected | 222.5 | 419 | 1613 | 15947 | 31875 |
| | 2-Port cal | 443 | 851 | 3226 | 31893 | 64016 |

Table 28c. N5224B/25B Typical Cycle Time (ms) for Full-Span Measurement Completion

| 10 MHz to 26.5 GHz | | Number of Points | | | | |
|--------------------|-------------|------------------|-------|-------|-------|-------|
| IF Bandwidth | | 201 | 401 | 1601 | 16001 | 32001 |
| 600 kHz | Uncorrected | 32.7 | 45 | 73.9 | 105.3 | 152.8 |
| | 2-Port cal | 67.3 | 91 | 144.5 | 203 | 304.3 |
| 10 kHz | Uncorrected | 57.2 | 97.5 | 334 | 2195 | 4268 |
| | 2-Port cal | 117.1 | 207.5 | 670 | 4361 | 8537 |
| 1 kHz | Uncorrected | 217.8 | 418 | 1647 | 15934 | 31847 |
| | 2-Port cal | 436 | 836 | 3252 | 31881 | 63823 |

Table 29. Cycle Time vs. IF Bandwidth - Typical

Applies to the Preset condition (201 points, correction off) except for the following changes:

- CF = 10 GHz
- Span = 100 MHz
- Display off (add 21 ms for display on)

Cycle time includes sweep and retrace time.

| Description | | N5224A/25A | |
|--------------------|-----------------|--------------------------------|--|
| IF Bandwidth (Hz) | Cycle Time (ms) | Trace Noise Magnitude (dB rms) | |
| 600,000 | 2.3 | 0.005 | |
| 100,000 | 3.3 | 0.0024 | |
| 30,000 | 6.9 | 0.0017 | |
| 10,000 | 26.8 | 0.0014 | |
| 3,000 | 71.9 | 0.001 | |
| 1,000 | 202.5 | 0.0008 | |
| 300 | 624 | 0.0006 | |
| 100 | 1799 | 0.0005 | |
| 30 | 5955 | 0.0005 | |
| 10 | 17804 | 0.0005 | |
| 3 | 59246 | 0.0004 | |

Table 30. Cycle Time vs. Number of Points - Typical

Applies to the Preset condition (correction off) except for the following changes:

- CF = 10 GHz
- Span = 100 MHz
- Display off (add 21 ms for display on)

Cycle time includes sweep and retrace time.

| Description | IF Bandwidth (Hz) | | | |
|-------------|-------------------|--------|--------|---------|
| | 1,000 | 10,000 | 30,000 | 600,000 |
| 3 | 4.7 | 2.2 | 1.9 | 1.7 |
| 11 | 12.6 | 3.7 | 2.9 | 2.1 |
| 51 | 53.6 | 8.6 | 3 | 1.8 |
| 101 | 101.7 | 14.3 | 4.3 | 2.6 |
| 201 | 208.8 | 27.5 | 8 | 2.4 |
| 401 | 398 | 51.6 | 11.9 | 3 |
| 801 | 795 | 104.9 | 24.8 | 4.3 |
| 1,601 | 1584 | 200.8 | 41.9 | 7 |
| 6,401 | 6327 | 797 | 167 | 24.1 |
| 16,001 | 15811 | 1989 | 401 | 52.9 |
| 32,001 | 31628 | 3976 | 800 | 103.2 |

Table 31. Data Transfer Time (ms) – Typical

NOTE The following was measured on a unit with Synthesizer 6.

Measured with the analyzer display off.

Values will increase slightly if the analyzer display is on.

| Description | Number of Points | | | | |
|---|------------------|------|------|--------|--------|
| | 201 | 401 | 1601 | 16,001 | 32,001 |
| SCPI over GPIB (Program executed on external PC ²) | | | | | |
| 32-bit floating point | 4.6 | 9.3 | 38 | 352 | 720 |
| 64-bit floating point | 9.4 | 18.8 | 73.4 | 730 | 1455 |
| ASCII | 36.7 | 72.5 | 288 | 2882 | 5762 |
| SCPI over SICL/LAN or TCP/IP Socket¹ (Program executed in the analyzer) | | | | | |
| 32-bit floating point | <1 | <1 | <1 | 1.2 | 2.4 |
| 64-bit floating point | <1 | <1 | <1 | 2.3 | 4.6 |
| ASCII | 2.1 | 4 | 15 | 148 | 295 |
| COM¹ (Program executed in the analyzer) | | | | | |
| 32-bit floating point | <1 | <1 | <1 | <1 | <1 |
| Variant type | <1 | <1 | 1.4 | 12.4 | 25.5 |
| DCOM over LAN¹ (Program executed on external PC) | | | | | |
| 32-bit floating point | <1 | <1 | <1 | 2.3 | 4.4 |
| Variant type | <1 | 1.6 | 5.3 | 52 | 105.5 |

¹ Values are for real and imaginary pairs, with the analyzer display off, using Gigabit Ethernet.

NOTE Specifications for Recall & Sweep Speed are not provided for the N522xB analyzers.

Test Set Block Diagrams

NOTE For best readability, use a color printer for printing the following graphics.

Legend

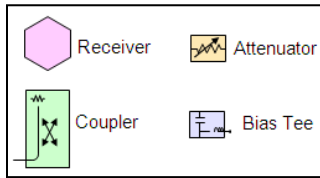


Figure 1. N5224B and N5225B Option 210 (2-port metrology configuration)

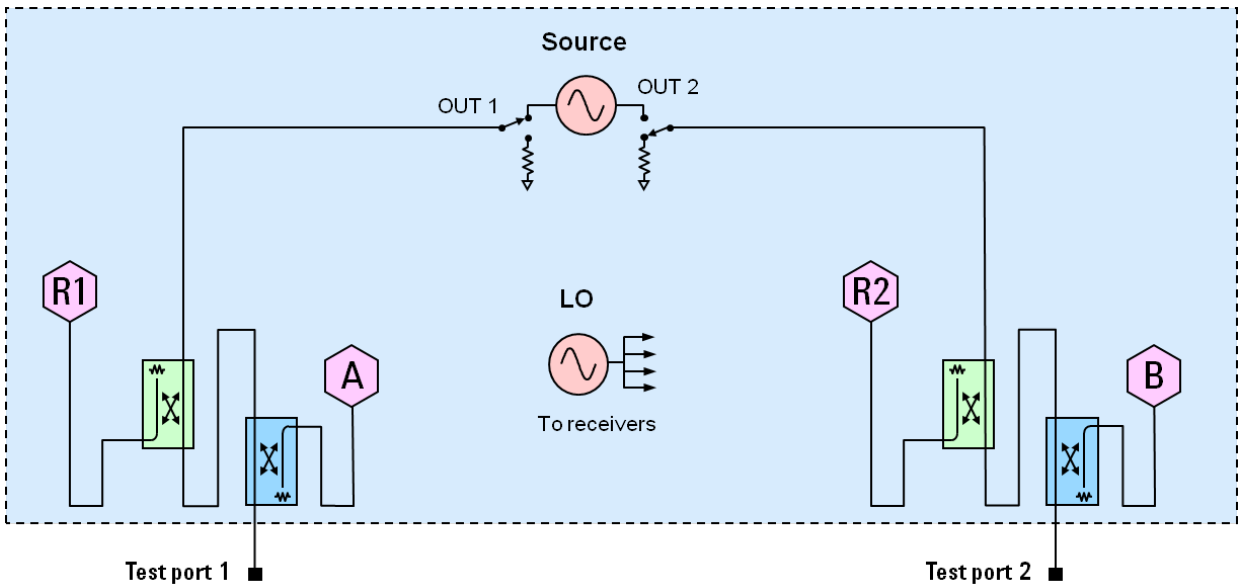


Figure 2. N5224B and N5225B Option 410 (4-port metrology configuration)

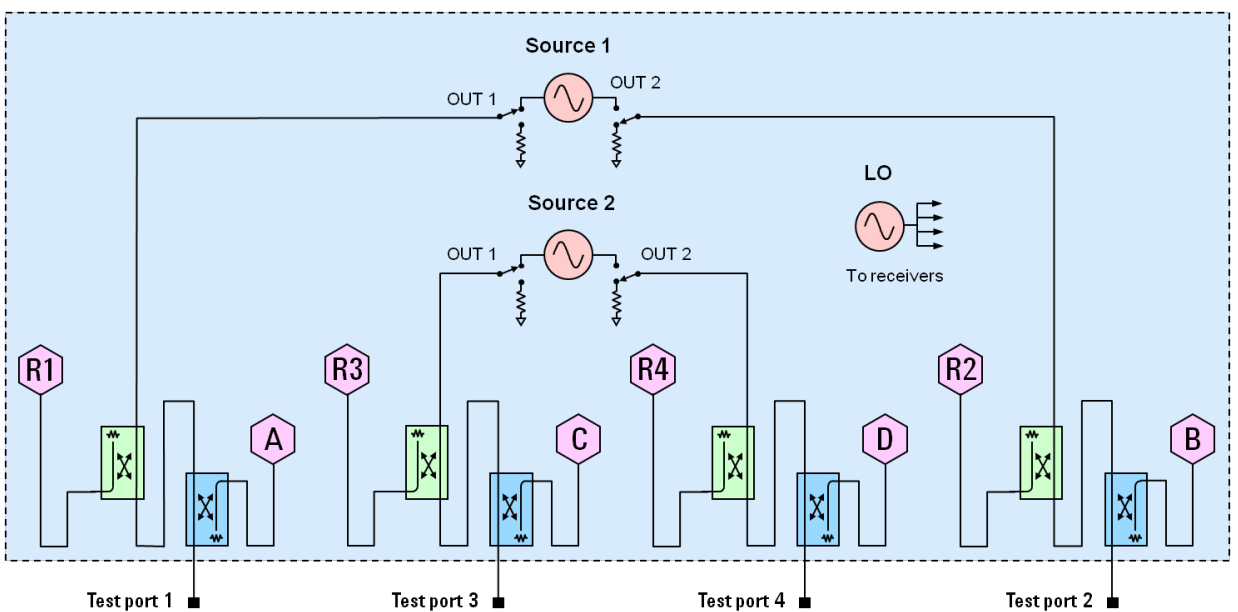
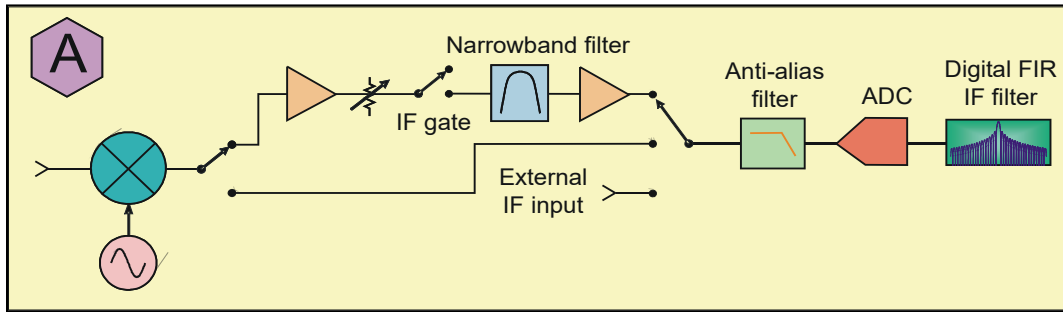


Figure 3. Receiver Block Diagram





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