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# Keysight 2-Port and 4-Port PNA Network Analyzer

N5221B 900 Hz to 13.5 GHz

N5222B 900 Hz to 26.5 GHz

(for synthesizer revision 7)

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This is a complete list of the technical specifications for the N5221B and N5222B PNA Series network analyzers with the following options (see block diagrams at the end of this document):

## 2-Port Models

**Option 200** - 2-port base model with standard test set.

**Option 201** - To base model, adds front-panel jumpers and R1 receiver switch.

**Option 217** - To base model, adds front-panel jumpers, R1 receiver switch, and source and receiver attenuators (extended power range).

**Option 219** - To base model, adds front-panel jumpers, R1 receiver switch, source and receiver attenuators (extended power range), and bias-tees.

## 4-Port Models

**Option 400** - 4-port base model with standard test set.

**Option 401** - To base model, adds front-panel jumpers and R1 receiver switch.

**Option 417** - To base model, adds front-panel jumpers, R1 receiver switch, and source and receiver attenuators (extended power range).

**Option 419** - To base model, adds front-panel jumpers, R1 receiver switch, source and receiver attenuators (extended power range), and bias-tees.

**Table 1. Low Frequency Extension (LFE) Options**

| Option        | Description                                                                                                                                                                                          |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2-Port Models |                                                                                                                                                                                                      |
| 205           | 2-port standard test set (includes six front-panel access loops), R1 receiver switch, and low frequency extension (LFE) hardware.                                                                    |
| 220           | 2-port standard test set (includes six front-panel access loops), R1 receiver switch, source and receiver attenuators (extended power range), bias-tees, and low frequency extension (LFE) hardware. |
| 4-Port Models |                                                                                                                                                                                                      |
| 405           | 4-port standard test set (includes six front-panel access loops), R1 receiver switch, and low frequency extension (LFE) hardware.                                                                    |
| 420           | 4-port standard test set (includes six front-panel access loops), R1 receiver switch, source and receiver attenuators (extended power range), bias-tees, and low frequency extension (LFE) hardware. |

## Notes

This document provides technical specifications for the 85052B calibration kit, N4691B ECal module, and N4433A ECal module.

Please download our free Uncertainty Calculator from [http://www.keysight.com/find/na\\_calculator](http://www.keysight.com/find/na_calculator) to generate the curves for your calibration kit and PNA setup.

For all tables in this document, 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  $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  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):** A performance parameter that is tested on a minimal set of products during design validation. It does not include guardbands, and is not covered by the product warranty.

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

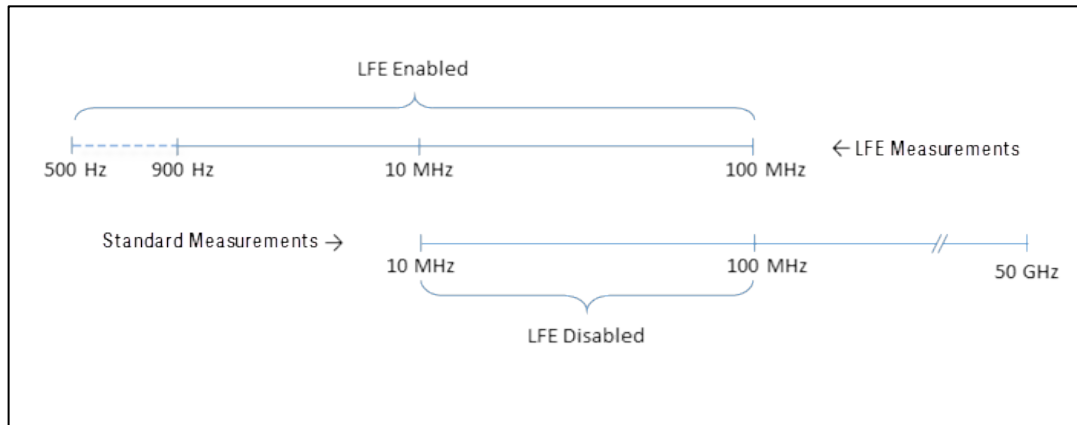
**Corrected (residual):** Indicates performance after error correction (calibration). It is determined by the quality of calibration standards and how well "known" they are, plus system repeatability, stability, and noise.

**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.



**Standard and LFE measurements:** With an LFE option, which adds low frequency extension (LFE) hardware, the LFE measurement range overlaps with the standard measurement range from 10 MHz to 100 MHz. With LFE Enabled, measurements from 500 Hz to 100 MHz use LFE hardware. With LFE Disabled, measurements from 10 MHz to 100 MHz use standard hardware. To measure below 10 MHz, LFE must be enabled. All measurements above 100 MHz use standard hardware, regardless of the LFE Enabled/Disabled setting.



## Dynamic Range

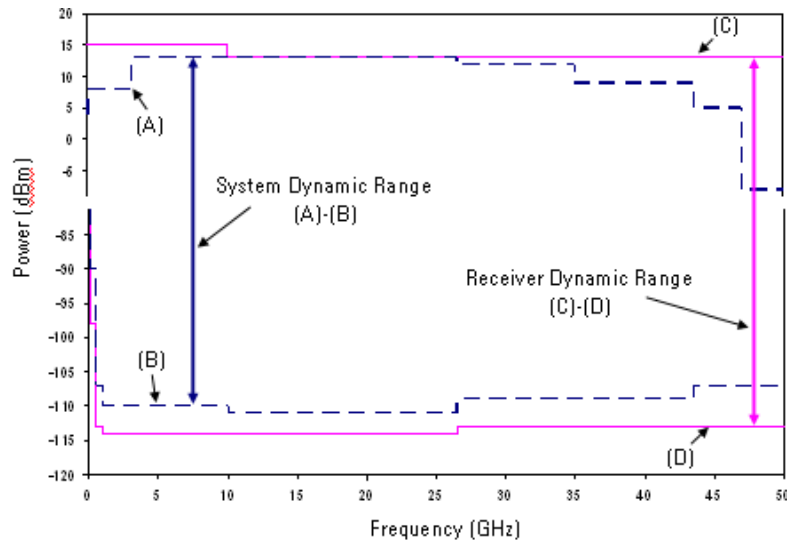
The specifications in this section apply for measurements made with the N5221B and N5222B PNA network analyzers with the following conditions:

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

**System Dynamic Range** is defined as the measured source maximum output power (A) minus the measured noise floor (B).

**Extended Dynamic Range at Direct Access Input** is defined as the system dynamic range (typical) less the nominal loss associated with the test port coupler.

**Receiver Dynamic Range** is defined as the typical test port 0.1 dB compression (C) minus the typical noise floor (D).



## System Dynamic Range

**Table 2. System Dynamic Range at Test Port (dB), Options 200 or 400**

| Description        | Specification <sup>1</sup> |                         | Typical                 |                         |
|--------------------|----------------------------|-------------------------|-------------------------|-------------------------|
|                    | Ports <sup>2</sup> 1, 3    | Ports <sup>2</sup> 2, 4 | Ports <sup>2</sup> 1, 3 | Ports <sup>2</sup> 2, 4 |
| 10 MHz to 50 MHz   | 102                        | 100                     | 109                     | 107                     |
| 50 MHz to 100 MHz  | 120                        | 118                     | 126                     | 125                     |
| 100 MHz to 500 MHz | 126                        | 129                     | 136                     | 136                     |
| 500 MHz to 2 GHz   | 135                        | 135                     | 142                     | 143                     |
| 2 GHz to 3.2 GHz   | 132                        | 133                     | 140                     | 141                     |
| 3.2 GHz to 10 GHz  | 137                        | 135                     | 144                     | 142                     |
| 10 GHz to 13.5 GHz | 136                        | 134                     | 143                     | 141                     |
| 13.5 GHz to 16 GHz | 135                        | 132                     | 143                     | 140                     |
| 16 GHz to 20 GHz   | 134                        | 130                     | 142                     | 137                     |
| 20 GHz to 24 GHz   | 130                        | 127                     | 138                     | 135                     |
| 24 GHz to 26.5 GHz | 128                        | 123                     | 138                     | 133                     |

<sup>1</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

<sup>2</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

**Table 3. System Dynamic Range at Test Port (dB), Options 201 or 401**

| Description        | Specification <sup>1</sup> |                         | Typical (dB)            |                         |
|--------------------|----------------------------|-------------------------|-------------------------|-------------------------|
|                    | Ports <sup>2</sup> 1, 3    | Ports <sup>2</sup> 2, 4 | Ports <sup>2</sup> 1, 3 | Ports <sup>2</sup> 2, 4 |
| 10 MHz to 50 MHz   | 102                        | 99                      | 109                     | 107                     |
| 50 MHz to 100 MHz  | 120                        | 118                     | 126                     | 125                     |
| 100 MHz to 500 MHz | 126                        | 124                     | 136                     | 135                     |
| 500 MHz to 2 GHz   | 135                        | 135                     | 142                     | 143                     |
| 2 GHz to 3.2 GHz   | 132                        | 134                     | 140                     | 141                     |
| 3.2 GHz to 10 GHz  | 136                        | 134                     | 143                     | 141                     |
| 10 GHz to 13.5 GHz | 135                        | 132                     | 143                     | 140                     |
| 13.5 GHz to 16 GHz | 134                        | 131                     | 142                     | 139                     |
| 16 GHz to 20 GHz   | 133                        | 129                     | 141                     | 136                     |
| 20 GHz to 24 GHz   | 128                        | 126                     | 137                     | 134                     |
| 24 GHz to 26.5 GHz | 127                        | 122                     | 137                     | 132                     |

<sup>1</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

<sup>2</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

**Table 4. System Dynamic Range at Test Port (dB), Options 217 or 417**

| Description        | Specification <sup>1</sup> |                         | Typical (dB)            |                         |
|--------------------|----------------------------|-------------------------|-------------------------|-------------------------|
|                    | Ports <sup>2</sup> 1, 3    | Ports <sup>2</sup> 2, 4 | Ports <sup>2</sup> 1, 3 | Ports <sup>2</sup> 2, 4 |
| 10 MHz to 50 MHz   | 103                        | 100                     | 109                     | 107                     |
| 50 MHz to 100 MHz  | 120                        | 118                     | 126                     | 125                     |
| 100 MHz to 500 MHz | 126                        | 125                     | 136                     | 135                     |
| 500 MHz to 2 GHz   | 135                        | 136                     | 142                     | 143                     |
| 2 GHz to 3.2 GHz   | 133                        | 135                     | 140                     | 142                     |
| 3.2 GHz to 10 GHz  | 134                        | 133                     | 142                     | 141                     |
| 10 GHz to 13.5 GHz | 133                        | 131                     | 142                     | 139                     |
| 13.5 GHz to 16 GHz | 132                        | 131                     | 141                     | 139                     |
| 16 GHz to 20 GHz   | 134                        | 130                     | 142                     | 137                     |
| 20 GHz to 24 GHz   | 129                        | 126                     | 137                     | 133                     |
| 24 GHz to 26.5 GHz | 124                        | 118                     | 134                     | 128                     |

<sup>1</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

<sup>2</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

**Table 5. System Dynamic Range at Test Port (dB), Options 219 or 419**

| Description        | Specification <sup>1</sup> |                         | Typical (dB)            |                         |
|--------------------|----------------------------|-------------------------|-------------------------|-------------------------|
|                    | Ports <sup>2</sup> 1, 3    | Ports <sup>2</sup> 2, 4 | Ports <sup>2</sup> 1, 3 | Ports <sup>2</sup> 2, 4 |
| 10 MHz to 50 MHz   | 101                        | 99                      | 108                     | 106                     |
| 50 MHz to 100 MHz  | 118                        | 117                     | 125                     | 124                     |
| 100 MHz to 500 MHz | 124                        | 124                     | 135                     | 135                     |
| 500 MHz to 2 GHz   | 135                        | 134                     | 141                     | 141                     |
| 2 GHz to 3.2 GHz   | 133                        | 134                     | 140                     | 141                     |
| 3.2 GHz to 10 GHz  | 135                        | 133                     | 143                     | 141                     |
| 10 GHz to 13.5 GHz | 133                        | 131                     | 142                     | 139                     |
| 13.5 GHz to 16 GHz | 133                        | 130                     | 141                     | 138                     |
| 16 GHz to 20 GHz   | 134                        | 129                     | 141                     | 136                     |
| 20 GHz to 24 GHz   | 128                        | 125                     | 136                     | 133                     |
| 24 GHz to 26.5 GHz | 123                        | 117                     | 133                     | 128                     |

<sup>1</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

<sup>2</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

**Table 6. System Dynamic Range at Test Port (dB), Options 205 or 405**

| Description                    | Specification <sup>3</sup> |                         | Typical (dB)            |                         |
|--------------------------------|----------------------------|-------------------------|-------------------------|-------------------------|
|                                | Ports <sup>2</sup> 1, 3    | Ports <sup>2</sup> 2, 4 | Ports <sup>2</sup> 1, 3 | Ports <sup>2</sup> 2, 4 |
| 10 MHz to 50 MHz <sup>1</sup>  | 96                         | 93                      | 103                     | 100                     |
| 50 MHz to 100 MHz <sup>1</sup> | 116                        | 115                     | 122                     | 122                     |
| 100 MHz to 500 MHz             | 125                        | 121                     | 132                     | 132                     |
| 500 MHz to 2 GHz               | 130                        | 132                     | 137                     | 140                     |
| 2 GHz to 3.2 GHz               | 130                        | 131                     | 139                     | 139                     |
| 3.2 GHz to 10 GHz              | 131                        | 133                     | 140                     | 140                     |
| 10 GHz to 13.5 GHz             | 131                        | 131                     | 140                     | 139                     |
| 13.5 GHz to 16 GHz             | 130                        | 129                     | 140                     | 137                     |
| 16 GHz to 20 GHz               | 130                        | 128                     | 139                     | 135                     |
| 20 GHz to 24 GHz               | 126                        | 124                     | 135                     | 132                     |
| 24 GHz to 26.5 GHz             | 126                        | 121                     | 135                     | 130                     |

<sup>1</sup> With Option 205, 405 installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

<sup>2</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

<sup>3</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

**Table 7. System Dynamic Range at Test Port (dB), Options 220 or 420**

| Description                    | Specification <sup>3</sup> |                         | Typical (dB)            |                         |
|--------------------------------|----------------------------|-------------------------|-------------------------|-------------------------|
|                                | Ports <sup>2</sup> 1, 3    | Ports <sup>2</sup> 2, 4 | Ports <sup>2</sup> 1, 3 | Ports <sup>2</sup> 2, 4 |
| 10 MHz to 50 MHz <sup>1</sup>  | 94                         | 92                      | 102                     | 100                     |
| 50 MHz to 100 MHz <sup>1</sup> | 114                        | 113                     | 121                     | 120                     |
| 100 MHz to 500 MHz             | 120                        | 120                     | 131                     | 131                     |
| 500 MHz to 2 GHz               | 132                        | 131                     | 138                     | 138                     |
| 2 GHz to 3.2 GHz               | 130                        | 131                     | 137                     | 138                     |
| 3.2 GHz to 10 GHz              | 133                        | 131                     | 141                     | 139                     |
| 10 GHz to 13.5 GHz             | 131                        | 129                     | 140                     | 137                     |
| 13.5 GHz to 16 GHz             | 131                        | 128                     | 139                     | 136                     |
| 16 GHz to 20 GHz               | 132                        | 127                     | 139                     | 134                     |
| 20 GHz to 24 GHz               | 126                        | 123                     | 134                     | 131                     |
| 24 GHz to 26.5 GHz             | 121                        | 115                     | 131                     | 126                     |

<sup>1</sup> With Option 220, 420 installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

<sup>3</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

**Table 8. System Dynamic Range at Test Port (dB), All LFE Options (LFE Enabled)**

| Description       | Specification <sup>1</sup> |            | Typical    |            |
|-------------------|----------------------------|------------|------------|------------|
|                   | Ports 1, 3                 | Ports 2, 4 | Ports 1, 3 | Ports 2, 4 |
| 500 Hz to 900 Hz  | --                         | --         | 105        | 105        |
| 900 Hz to 1 kHz   | 100                        | 102        | 109        | 110        |
| 1 kHz to 10 kHz   | 103                        | 105        | 110        | 111        |
| 10 kHz to 100 kHz | 113                        | 115        | 120        | 121        |
| 100 kHz to 1 MHz  | 120                        | 121        | 124        | 125        |
| 1 MHz to 5 MHz    | 121                        | 122        | 126        | 127        |
| 5 MHz to 10 MHz   | 112                        | 114        | 118        | 119        |
| 10 MHz to 50 MHz  | 110                        | 112        | 116        | 117        |
| 50 MHz to 100 MHz | 110                        | 112        | 116        | 117        |

<sup>1</sup> Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

## Extended Dynamic Range

**Table 9. Extended Dynamic Range at Direct Receiver Access Input (dB) - Typical**

| Description        | Options 201, 401        |                         | Options 217, 417        |                         |
|--------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|                    | Ports <sup>1</sup> 1, 3 | Ports <sup>1</sup> 2, 4 | Ports <sup>1</sup> 1, 3 | Ports <sup>1</sup> 2, 4 |
| 10 MHz to 50 MHz   | 153                     | 151                     | 153                     | 151                     |
| 50 MHz to 100 MHz  | 152                     | 151                     | 152                     | 151                     |
| 100 MHz to 500 MHz | 156                     | 155                     | 156                     | 155                     |
| 500 MHz to 2 GHz   | 157                     | 158                     | 157                     | 158                     |
| 2 GHz to 3.2 GHz   | 155                     | 156                     | 155                     | 157                     |
| 3.2 GHz to 10 GHz  | 158                     | 156                     | 157                     | 156                     |
| 10 GHz to 13.5 GHz | 158                     | 155                     | 157                     | 154                     |
| 13.5 GHz to 16 GHz | 157                     | 154                     | 156                     | 154                     |
| 16 GHz to 20 GHz   | 156                     | 151                     | 157                     | 152                     |
| 20 GHz to 24 GHz   | 152                     | 149                     | 152                     | 148                     |
| 24 GHz to 26.5 GHz | 152                     | 147                     | 149                     | 143                     |

<sup>1</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

**Table 10. Extended Dynamic Range at Direct Receiver Access Input (dB) - Typical**

| Description        | Option 219, 419         |                         | Option 220, 420         |                         | Options 205, 405        |                         |
|--------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
|                    | Ports <sup>1</sup> 1, 3 | Ports <sup>1</sup> 2, 4 | Ports <sup>1</sup> 1, 3 | Ports <sup>1</sup> 2, 4 | Ports <sup>1</sup> 1, 3 | Ports <sup>1</sup> 2, 4 |
| 10 MHz to 50 MHz   | 152                     | 150                     | 145                     | 143                     | 147                     | 144                     |
| 50 MHz to 100 MHz  | 151                     | 150                     | 147                     | 146                     | 148                     | 148                     |
| 100 MHz to 500 MHz | 155                     | 155                     | 151                     | 151                     | 152                     | 152                     |
| 500 MHz to 2 GHz   | 156                     | 156                     | 153                     | 153                     | 152                     | 155                     |
| 2 GHz to 3.2 GHz   | 155                     | 156                     | 152                     | 153                     | 154                     | 154                     |
| 3.2 GHz to 10 GHz  | 158                     | 156                     | 156                     | 154                     | 155                     | 155                     |
| 10 GHz to 13.5 GHz | 157                     | 154                     | 155                     | 152                     | 155                     | 154                     |
| 13.5 GHz to 16 GHz | 156                     | 153                     | 154                     | 151                     | 155                     | 152                     |
| 16 GHz to 20 GHz   | 156                     | 151                     | 154                     | 149                     | 154                     | 150                     |
| 20 GHz to 24 GHz   | 151                     | 148                     | 149                     | 146                     | 150                     | 147                     |
| 24 GHz to 26.5 GHz | 148                     | 143                     | 146                     | 141                     | 150                     | 145                     |

<sup>1</sup> Either port can be used as the source port. Any other port can be used as the receiver port.

## Receiver Dynamic Range

**Table 11. Receiver Dynamic Range (dB), All Options**

| Description                    | Typical |
|--------------------------------|---------|
| 10 MHz to 50 MHz <sup>1</sup>  | 103     |
| 50 MHz to 100 MHz <sup>1</sup> | 118     |
| 100 MHz to 500 MHz             | 122     |
| 500 MHz to 2 GHz               | 130     |
| 2 GHz to 13.5 GHz              | 131     |
| 13.5 GHz to 20 GHz             | 132     |
| 20 GHz to 24 GHz               | 128     |
| 24 GHz to 26.5 GHz             | 126     |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

**Table 12. Receiver Dynamic Range (dB), All Ports, All LFE Options (LFE Enabled)**

| Description       | Typical |
|-------------------|---------|
| 500 Hz to 900 Hz  | 106     |
| 900 Hz to 1 kHz   | 109     |
| 1 kHz to 10 kHz   | 109     |
| 10 kHz to 100 kHz | 118     |
| 100 kHz to 1 MHz  | 123     |
| 1 MHz to 5 MHz    | 123     |
| 5 MHz to 10 MHz   | 119     |
| 10 MHz to 50 MHz  | 120     |
| 50 MHz to 100 MHz | 120     |



## Corrected System Performance, All Options

Applies to the N5221B/2B Option 200, 201, 205, 217, 219, 220, 400, 401, 405, 417, 419, or 420 analyzers, 85131F flexible test port cable set, and a full 2-port calibration. Specification are valid for temperatures of  $23^{\circ}\pm 3^{\circ}\text{C}$  and  $< 1^{\circ}\text{C}$  deviation from the calibration temperature.

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  $k$

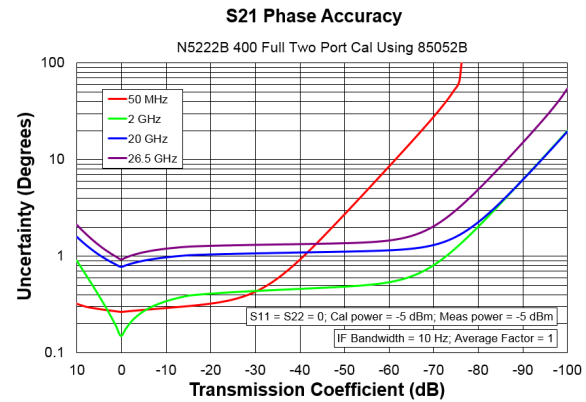
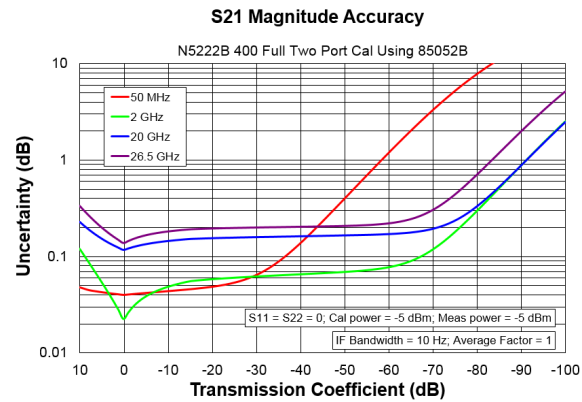
Please download our free Uncertainty Calculator from [http://www.keysight.com/find/na\\_calculator](http://www.keysight.com/find/na_calculator) for specifications for other calibration kits and measurement setups.

**Table 13. N5221B and N5222B with 85052B Calibration Kit**

| Description                  | Specification (dB)            |                                |                  |                   |                    |                    |
|------------------------------|-------------------------------|--------------------------------|------------------|-------------------|--------------------|--------------------|
|                              | 10 MHz to 50 MHz <sup>1</sup> | 50 MHz to 500 MHz <sup>1</sup> | 500 MHz to 2 GHz | 2 GHz to 13.5 GHz | 13.5 GHz to 20 GHz | 20 GHz to 26.5 GHz |
| Directivity                  | 48                            | 48                             | 48               | 44                | 44                 | 44                 |
| Source Match                 | 40                            | 40                             | 40               | 31                | 31                 | 31                 |
| Load Match                   | 48                            | 48                             | 48               | 44                | 44                 | 44                 |
| <b>Reflection Tracking</b>   |                               |                                |                  |                   |                    |                    |
| Mag                          | $\pm 0.003$                   | $\pm 0.003$                    | $\pm 0.003$      | $\pm 0.006$       | $\pm 0.006$        | $\pm 0.006$        |
| Phase (°)                    | $\pm 0.020$                   | $\pm 0.020$                    | $\pm 0.020$      | $\pm 0.040$       | $\pm 0.040$        | $\pm 0.040$        |
| <b>Transmission Tracking</b> |                               |                                |                  |                   |                    |                    |
| Mag                          | $\pm 0.034$                   | $\pm 0.017$                    | $\pm 0.017$      | $\pm 0.091$       | $\pm 0.104$        | $\pm 0.119$        |
| Phase (°)                    | $\pm 0.225$                   | $\pm 0.110$                    | $\pm 0.110$      | $\pm 0.602$       | $\pm 0.688$        | $\pm 0.788$        |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

## Transmission Uncertainty, All Options



## Reflection Uncertainty, All Options

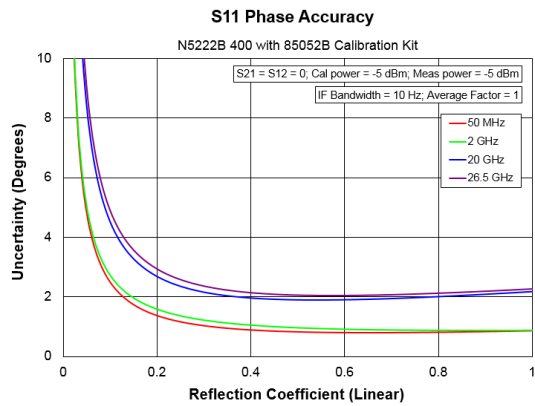
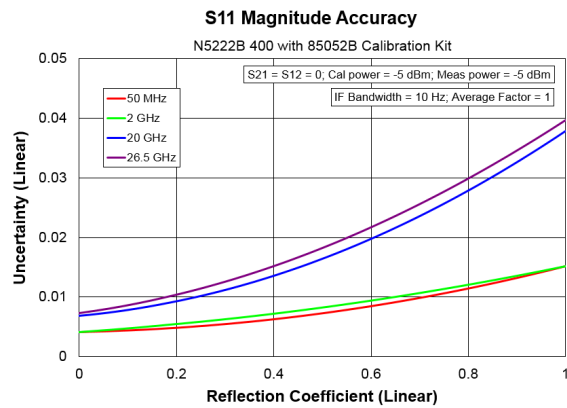
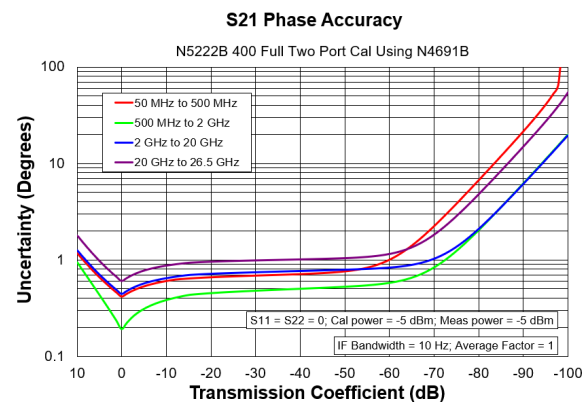
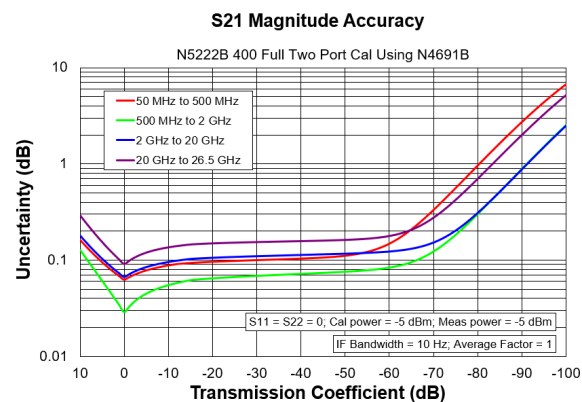


Table 14. N5221B and N5222B with N4691B 2-Port Electronic Calibration Module

| Description                  | Specification (dB)            |                                |                  |                   |                    |                    |
|------------------------------|-------------------------------|--------------------------------|------------------|-------------------|--------------------|--------------------|
|                              | 10 MHz to 50 MHz <sup>1</sup> | 50 MHz to 500 MHz <sup>1</sup> | 500 MHz to 2 GHz | 2 GHz to 13.5 GHz | 13.5 GHz to 20 GHz | 20 GHz to 26.5 GHz |
| Directivity                  | 46                            | 46                             | 52               | 46                | 46                 | 44                 |
| Source Match                 | 41                            | 41                             | 47               | 42                | 42                 | 40                 |
| Load Match                   | 39                            | 40                             | 46               | 40                | 40                 | 38                 |
| <b>Reflection Tracking</b>   |                               |                                |                  |                   |                    |                    |
| Mag                          | ±0.051                        | ±0.051                         | ±0.020           | ±0.041            | ±0.041             | ±0.051             |
| Phase (°)                    | ±0.34                         | ±0.34                          | ±0.14            | ±0.27             | ±0.27              | ±0.34              |
| <b>Transmission Tracking</b> |                               |                                |                  |                   |                    |                    |
| Mag                          | ±0.063                        | ±0.057                         | ±0.024           | ±0.054            | ±0.056             | ±0.072             |
| Phase (°)                    | ±0.42                         | ±0.38                          | ±0.16            | ±0.36             | ±0.37              | ±0.48              |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

## Transmission Uncertainty, All Options



## Reflection Uncertainty, All Options

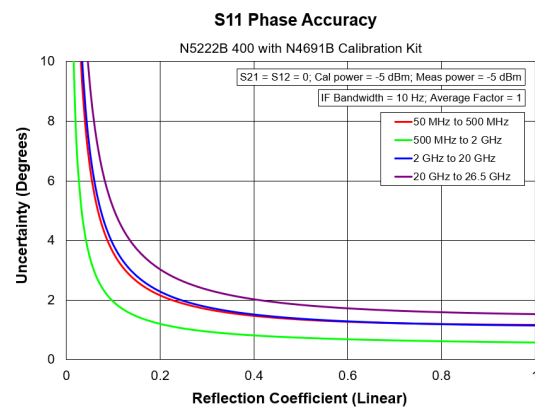
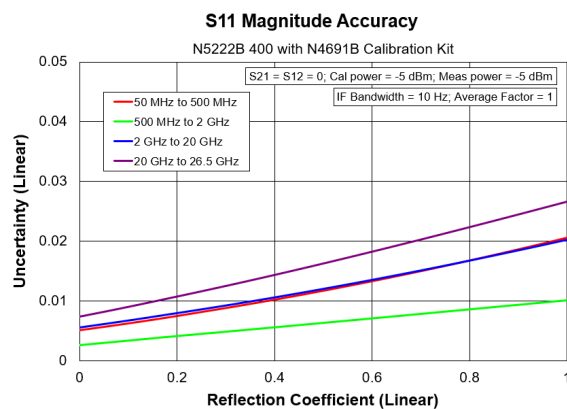
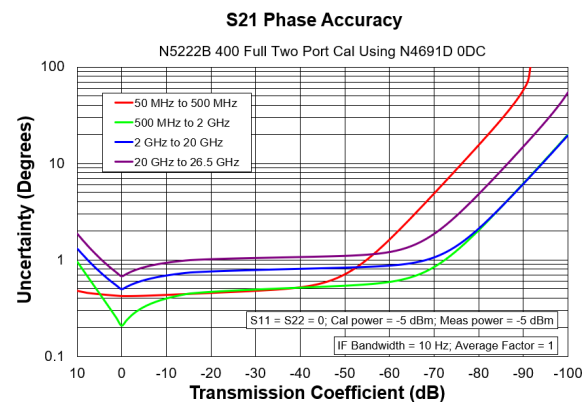
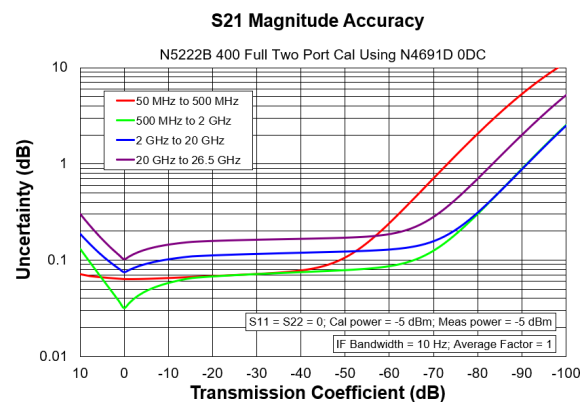


Table 15. N5221B and N5222B with N4691D 2-Port Electronic Calibration Module

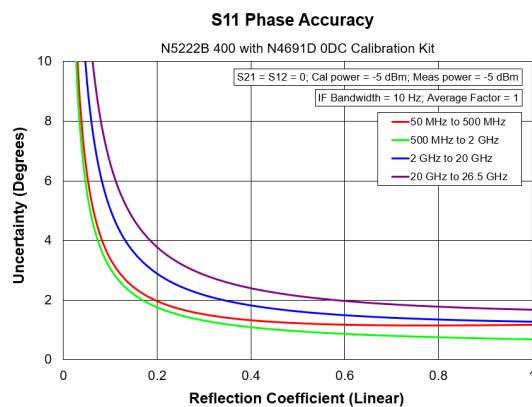
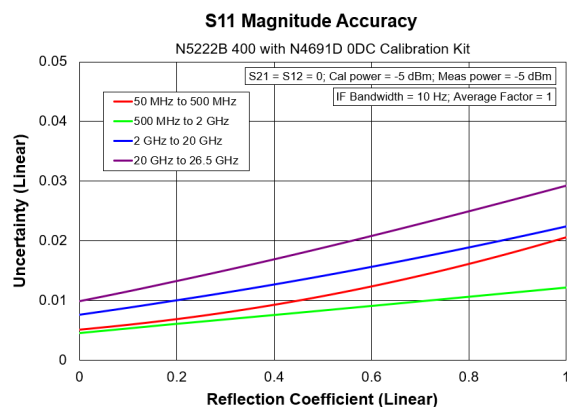
| Description                  | Specification (dB)            |                                |                  |                   |                    |                    |
|------------------------------|-------------------------------|--------------------------------|------------------|-------------------|--------------------|--------------------|
|                              | 10 MHz to 50 MHz <sup>1</sup> | 50 MHz to 500 MHz <sup>1</sup> | 500 MHz to 2 GHz | 2 GHz to 13.5 GHz | 13.5 GHz to 20 GHz | 20 GHz to 26.5 GHz |
| Directivity                  | 46                            | 46                             | 47               | 43                | 43                 | 41                 |
| Source Match                 | 41                            | 41                             | 47               | 42                | 42                 | 40                 |
| Load Match                   | 39                            | 40                             | 46               | 40                | 40                 | 38                 |
| <b>Reflection Tracking</b>   |                               |                                |                  |                   |                    |                    |
| Mag                          | ±0.051                        | ±0.051                         | ±0.020           | ±0.041            | ±0.041             | ±0.051             |
| Phase (°)                    | ±0.34                         | ±0.34                          | ±0.14            | ±0.27             | ±0.27              | ±0.34              |
| <b>Transmission Tracking</b> |                               |                                |                  |                   |                    |                    |
| Mag                          | ±0.063                        | ±0.057                         | ±0.026           | ±0.060            | ±0.062             | ±0.081             |
| Phase (°)                    | ±0.42                         | ±0.38                          | ±0.17            | ±0.40             | ±0.41              | ±0.54              |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

## Transmission Uncertainty, All Options



## Reflection Uncertainty, All Options



**Table 16. N5221B and N5222B with N4433A 4-Port Electronic Calibration Module**

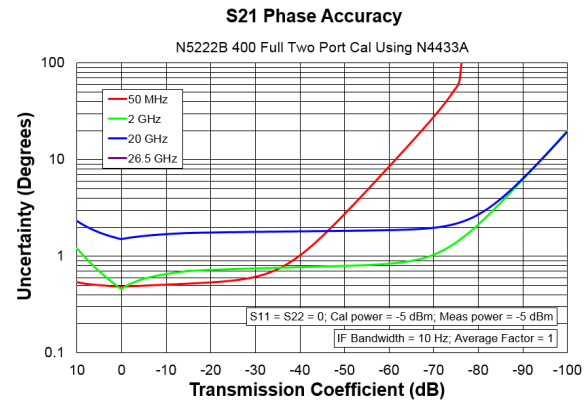
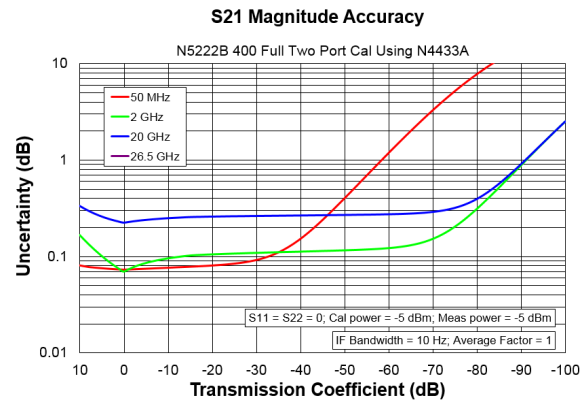
**NOTE**

Uncertainty curves for the N4433A are created using a 2-port calibration. Multiport uncertainties are not supported at this time.

| Description                  | Specification (dB)            |                                |                  |                   |                    |
|------------------------------|-------------------------------|--------------------------------|------------------|-------------------|--------------------|
|                              | 10 MHz to 50 MHz <sup>1</sup> | 50 MHz to 500 MHz <sup>1</sup> | 500 MHz to 2 GHz | 2 GHz to 13.5 GHz | 13.5 GHz to 20 GHz |
| Directivity                  | 50                            | 50                             | 50               | 45                | 40                 |
| Source Match                 | 42                            | 42                             | 42               | 37                | 31                 |
| Load Match                   | 40                            | 41                             | 41               | 35                | 29                 |
| <b>Reflection Tracking</b>   |                               |                                |                  |                   |                    |
| Mag                          | ±0.060                        | ±0.060                         | ±0.060           | ±0.100            | ±0.180             |
| Phase (°)                    | ±0.396                        | ±0.396                         | ±0.396           | ±0.660            | ±1.188             |
| <b>Transmission Tracking</b> |                               |                                |                  |                   |                    |
| Mag                          | ±0.068                        | ±0.064                         | ±0.064           | ±0.115            | ±0.210             |
| Phase (°)                    | ±0.447                        | ±0.421                         | ±0.421           | ±0.761            | ±1.387             |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 17.

## Transmission Uncertainty, All Options



## Reflection Uncertainty, All Options

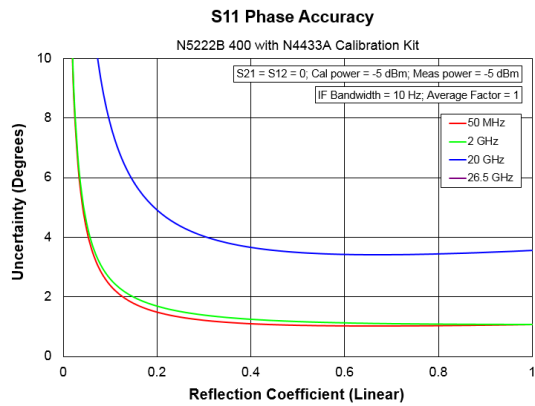
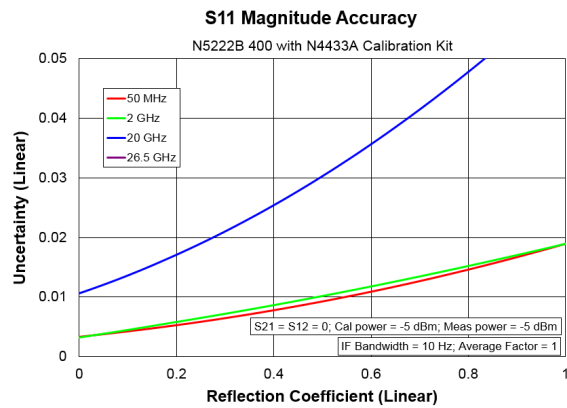


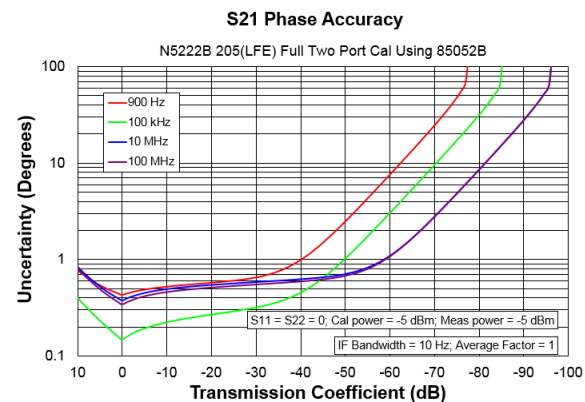
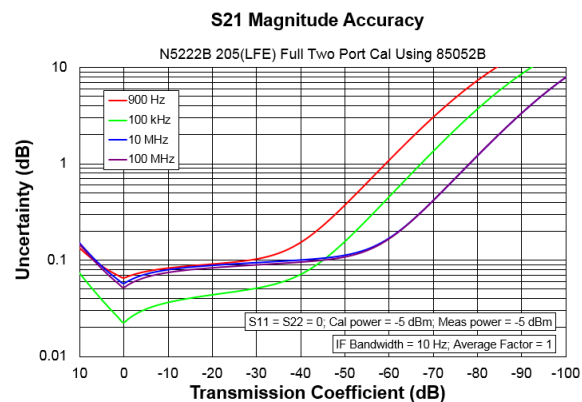
Table 17. N5221B and N5222B with 85052B Calibration Kit, All LFE Options (LFE Enabled)

| Description                  | Specification (dB) |                 |                |                 |                   |
|------------------------------|--------------------|-----------------|----------------|-----------------|-------------------|
|                              | 1 kHz to 10 kHz    | 10 kHz to 1 MHz | 1 MHz to 5 MHz | 5 MHz to 50 MHz | 50 MHz to 100 MHz |
| Directivity                  | 48                 | 48              | 48             | 48              | 48                |
| Source Match                 | 40                 | 40              | 40             | 40              | 40                |
| Load Match                   | 48                 | 48              | 48             | 48              | 48                |
| <b>Reflection Tracking</b>   |                    |                 |                |                 |                   |
| Mag                          | $\pm 0.003$        | $\pm 0.003$     | $\pm 0.003$    | $\pm 0.003$     | $\pm 0.003$       |
| Phase (°)                    | $\pm 0.020$        | $\pm 0.020$     | $\pm 0.020$    | $\pm 0.020$     | $\pm 0.020$       |
| <b>Transmission Tracking</b> |                    |                 |                |                 |                   |
| Mag                          | $\pm 0.055$        | $\pm 0.016$     | $\pm 0.050$    | $\pm 0.045$     | $\pm 0.045$       |
| Phase (°)                    | $\pm 0.361$        | $\pm 0.105$     | $\pm 0.333$    | $\pm 0.296$     | $\pm 0.296$       |

### Transmission Uncertainty, All LFE Options

**NOTE**

The plots are valid for all LFE options.



### Reflection Uncertainty, All LFE Options

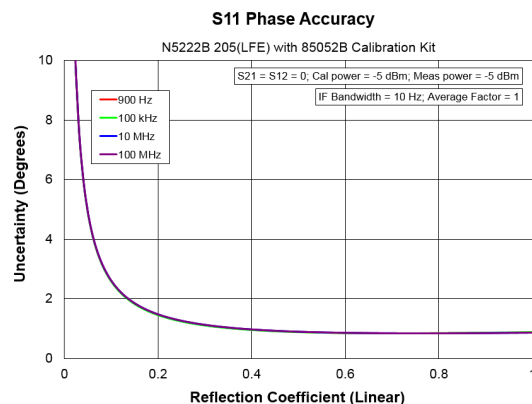
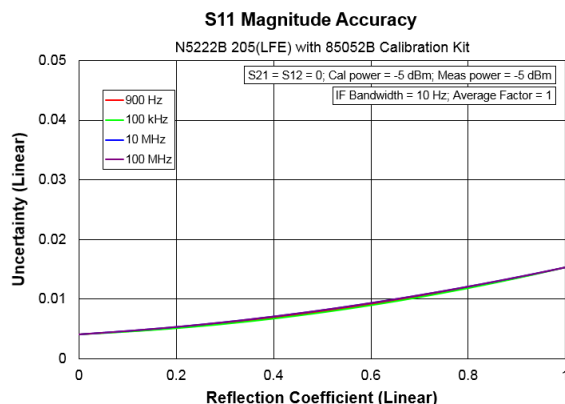


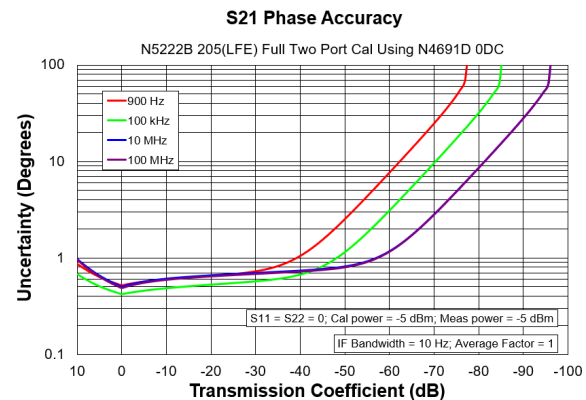
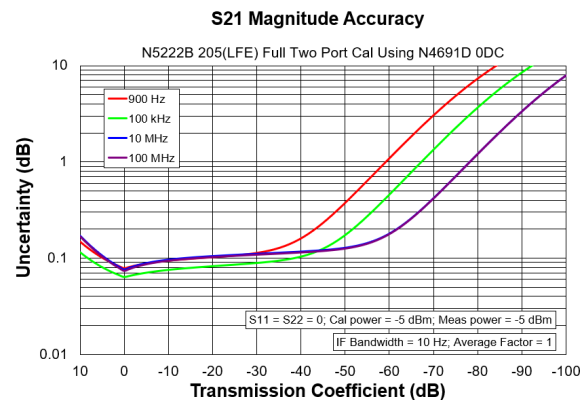
Table 18. N5221B and N5222B with N4691D Calibration Kit, All LFE Options (LFE Enabled)

| Description                  | Specification (dB) |                 |                |                 |                   |
|------------------------------|--------------------|-----------------|----------------|-----------------|-------------------|
|                              | 1 kHz to 10 kHz    | 10 kHz to 1 MHz | 1 MHz to 5 MHz | 5 MHz to 50 MHz | 50 MHz to 100 MHz |
| Directivity                  | 46                 | 46              | 46             | 46              | 46                |
| Source Match                 | 41                 | 41              | 41             | 41              | 41                |
| Load Match                   | 38                 | 40              | 39             | 39              | 39                |
| <b>Reflection Tracking</b>   |                    |                 |                |                 |                   |
| Mag                          | $\pm 0.051$        | $\pm 0.051$     | $\pm 0.051$    | $\pm 0.051$     | $\pm 0.051$       |
| Phase (°)                    | $\pm 0.34$         | $\pm 0.34$      | $\pm 0.34$     | $\pm 0.34$      | $\pm 0.34$        |
| <b>Transmission Tracking</b> |                    |                 |                |                 |                   |
| Mag                          | $\pm 0.070$        | $\pm 0.055$     | $\pm 0.063$    | $\pm 0.068$     | $\pm 0.066$       |
| Phase (°)                    | $\pm 0.46$         | $\pm 0.37$      | $\pm 0.42$     | $\pm 0.45$      | $\pm 0.44$        |

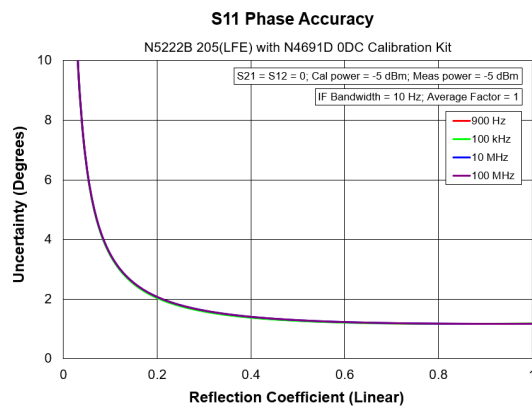
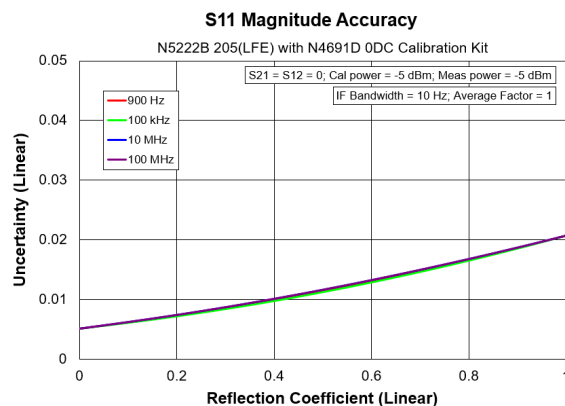
### Transmission Uncertainty, All LFE Options

**NOTE**

The plots are valid for all LFE options.



### Reflection Uncertainty, All LFE Options





## 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 19. Error Terms (dB), All Ports, All Options - Specifications**

| Description                    | Directivity  | Source Match | Load Match | Transmission Tracking | Reflection Tracking | Crosstalk |
|--------------------------------|--------------|--------------|------------|-----------------------|---------------------|-----------|
| 10 MHz to 50 MHz <sup>1</sup>  | 16 (16) [16] | 11 (9) [9]   | 11 (9) [9] | --                    | --                  | --        |
| 50 MHz to 3.2 GHz <sup>1</sup> | 24 (24) [24] | 18 (7) [7]   | 17 (7) [7] | --                    | --                  | --        |
| 3.2 GHz to 10 GHz              | 23 (22) [22] | 14 (9) [9]   | 13 (9) [9] | --                    | --                  | --        |
| 10 GHz to 16 GHz               | 16 (16) [16] | 12 (9) [9]   | 10 (9) [9] | --                    | --                  | --        |
| 16 GHz to 24 GHz               | 16 (16) [16] | 10 (6) [6]   | 9 (7) [6]  | --                    | --                  | --        |
| 24 GHz to 26.5 GHz             | 16 (16) [16] | 8 (6) [6]    | 8 (6) [6]  | --                    | --                  | --        |

( ) With option 205, 405 installed.

[ ] With option 220, 420 installed.

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 20.

**Table 20. Error Terms (dB), All Ports, All LFE Options (LFE Enabled) - Specifications**

| Description       | Directivity | Source Match | Load Match | Transmission Tracking | Reflection Tracking | Crosstalk |
|-------------------|-------------|--------------|------------|-----------------------|---------------------|-----------|
| 1 kHz to 10 kHz   | 1           | 7            | 7          | --                    | --                  | --        |
| 10 kHz to 1 MHz   | 16          | 15           | 19         | --                    | --                  | --        |
| 1 MHz to 5 MHz    | 16          | 9            | 11         | --                    | --                  | --        |
| 5 MHz to 50 MHz   | 5           | 7            | 8          | --                    | --                  | --        |
| 50 MHz to 100 MHz | 5           | 8            | 9          | --                    | --                  | --        |

**Table 21. Error Terms (dB), All Ports, All Options - Typical**

| Description                    | Directivity | Source Match | Load Match | Transmission Tracking | Reflection Tracking | Crosstalk |
|--------------------------------|-------------|--------------|------------|-----------------------|---------------------|-----------|
| 10 MHz to 50 MHz <sup>1</sup>  | 23 (23)     | 17 (10)      | 16 (10)    | ±1.5                  | ±1.5                | -84       |
| 50 MHz to 100 MHz <sup>1</sup> | 29 (29)     | 29 (11)      | 28 (11)    | ±1.5                  | ±1.5                | -90       |
| 100 MHz to 500 MHz             | 29 (29)     | 29 (8)       | 28 (8)     | ±1.5                  | ±1.5                | -110      |
| 500 MHz to 3.2 GHz             | 31 (31)     | 24 (8)       | 22 (8)     | ±1.5                  | ±1.5                | -120      |
| 3.2 GHz to 10 GHz              | 25 (25)     | 19 (14)      | 17 (14)    | ±1.5                  | ±1.5                | -122      |
| 10 GHz to 13.5 GHz             | 21 (21)     | 17 (13)      | 15 (13)    | ±1.5                  | ±1.5                | -122      |
| 13.5 GHz to 16 GHz             | 20 (20)     | 16 (16)      | 15 (14)    | ±1.5                  | ±1.5                | -122      |
| 16 GHz to 20 GHz               | 20 (20)     | 15 (12)      | 15 (12)    | ±1.5                  | ±1.5                | -122      |
| 20 GHz to 24 GHz               | 19 (19)     | 13 (11)      | 13 (11)    | ±1.5                  | ±1.5                | -117      |
| 24 GHz to 26.5 GHz             | 20 (20)     | 13 (10)      | 13 (11)    | ±1.5                  | ±1.5                | -114      |

( ) With an LFE option installed.

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 22.

**Table 22. Error Terms (dB), All Ports, All LFE Options (LFE Enabled)- Typical**

| Description       | Directivity | Source Match | Load Match | Transmission Tracking | Reflection Tracking | Crosstalk |
|-------------------|-------------|--------------|------------|-----------------------|---------------------|-----------|
| 500 Hz to 900 Hz  | --          | --           | --         | --                    | --                  | -102      |
| 900 Hz to 1 kHz   | 4           | 8            | 9          | ±1.5                  | ±1.5                | -106      |
| 1 kHz to 10 kHz   | 5           | 9            | 8          | ±1.5                  | ±1.5                | -100      |
| 10 kHz to 100 kHz | 23          | 19           | 23         | ±1.5                  | ±1.5                | -106      |
| 100 kHz to 1 MHz  | 23          | 19           | 23         | ±1.5                  | ±1.5                | -126      |
| 1 MHz to 5 MHz    | 26          | 13           | 14         | ±1.5                  | ±1.5                | -121      |
| 5 MHz to 10 MHz   | 11          | 9            | 10         | ±1.5                  | ±1.5                | -121      |
| 10 MHz to 50 MHz  | 11          | 9            | 10         | ±1.5                  | ±1.5                | -117      |
| 50 MHz to 100 MHz | 11          | 11           | 11         | ±1.5                  | ±1.5                | -117      |

## Test Port Output

See the block diagrams at the end of this document for all models and options.

**Table 23. Frequency Information, All Options**

| Description                             | Specification      | Typical                                                                                             |
|-----------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------|
| N5221B Frequency Range                  | 10 MHz to 13.5 GHz | --                                                                                                  |
| N5222B Frequency Range                  | 10 MHz to 26.5 GHz | --                                                                                                  |
| N5221B Frequency Range (LFE Options)    | 900 Hz to 13.5 GHz | 500 Hz to 900 Hz                                                                                    |
| N5222B Frequency Range (LFE Options)    | 900 Hz to 26.5 GHz | 500 Hz to 900 Hz                                                                                    |
| Frequency Resolution                    | 1 Hz               | --                                                                                                  |
| Frequency Accuracy                      | $\pm 0.7$ ppm      | --                                                                                                  |
| Initial Frequency Accuracy <sup>1</sup> | $\pm 0.2$ ppm      | $\pm 0.1$ ppm                                                                                       |
| Frequency Stability                     | --                 | $\pm 0.05$ ppm, $-10^{\circ}$ to $70^{\circ}$ C <sup>2</sup><br>$\pm 0.5$ (first year) <sup>3</sup> |

<sup>1</sup> Verified after Factory Frequency Reference adjustment, or after adjustment at a Keysight Service Center.

<sup>2</sup> Assumes no variation in time.

<sup>3</sup> Assumes no variation in temperature.

**Table 24. Maximum Leveled Power (dBm) - Specification**

| Description        | Option 200, 400, 201, 401 |            | Option 217, 417, 219, 419 |            |
|--------------------|---------------------------|------------|---------------------------|------------|
|                    | Ports 1, 3                | Ports 2, 4 | Ports 1, 3                | Ports 2, 4 |
| 10 MHz to 50 MHz   | 12                        | 12         | 12                        | 12         |
| 50 MHz to 16 GHz   | 13                        | 13         | 13                        | 13         |
| 16 GHz to 20 GHz   | 13                        | 12         | 10                        | 10         |
| 20 GHz to 24 GHz   | 13                        | 10         | 10                        | 7          |
| 24 GHz to 26.5 GHz | 7                         | 5          | 4                         | 2          |

**Table 25. Maximum Leveled Power (dBm) - Typical**

| Description        | Option 200, 400, 201, 401 |            | Option 217, 417, 219, 419 |            |
|--------------------|---------------------------|------------|---------------------------|------------|
|                    | Ports 1, 3                | Ports 2, 4 | Ports 1, 3                | Ports 2, 4 |
| 10 MHz to 50 MHz   | 20                        | 17         | 20                        | 17         |
| 50 MHz to 500 MHz  | 20                        | 18         | 20                        | 18         |
| 500 MHz to 1 GHz   | 20                        | 20         | 19                        | 20         |
| 1 GHz to 3.2 GHz   | 19                        | 20         | 19                        | 20         |
| 3.2 GHz to 10 GHz  | 22                        | 21         | 22                        | 21         |
| 10 GHz to 13.5 GHz | 22                        | 19         | 21                        | 18         |
| 13.5 GHz to 16 GHz | 20                        | 18         | 19                        | 17         |
| 16 GHz to 20 GHz   | 20                        | 16         | 18                        | 14         |
| 20 GHz to 24 GHz   | 18                        | 14         | 16                        | 12         |
| 24 GHz to 26.5 GHz | 14                        | 11         | 12                        | 9          |

**Table 26. Maximum Leveled Power (dBm) - Option 205, 405**

| Description                    | Specification |            | Typical    |            |
|--------------------------------|---------------|------------|------------|------------|
|                                | Ports 1, 3    | Ports 2, 4 | Ports 1, 3 | Ports 2, 4 |
| 10 MHz to 50 MHz <sup>1</sup>  | 5             | 5          | 13         | 10         |
| 50 MHz to 500 MHz <sup>1</sup> | 8             | 8          | 15         | 13         |
| 500 MHz to 3.2 GHz             | 9             | 9          | 15         | 16         |
| 3.2 GHz to 10 GHz              | 11            | 11         | 20         | 19         |
| 10 GHz to 13.5 GHz             | 11            | 11         | 20         | 17         |
| 13.5 GHz to 16 GHz             | 10            | 10         | 17         | 15         |
| 16 GHz to 20 GHz               | 10            | 9          | 17         | 13         |
| 20 GHz to 24 GHz               | 10            | 7          | 15         | 11         |
| 24 GHz to 26.5 GHz             | 5             | 2          | 12         | 8          |

<sup>1</sup> With option 205, 405 installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 28.

**Table 27. Maximum Leveled Power (dBm) - Option 220, 420**

| Description                    | Specification |            | Typical    |            |
|--------------------------------|---------------|------------|------------|------------|
|                                | Ports 1, 3    | Ports 2, 4 | Ports 1, 3 | Ports 2, 4 |
| 10 MHz to 50 MHz <sup>1</sup>  | 5             | 5          | 13         | 10         |
| 50 MHz to 500 MHz <sup>1</sup> | 9             | 9          | 16         | 14         |
| 500 MHz to 3.2 GHz             | 10            | 10         | 16         | 17         |
| 3.2 GHz to 10 GHz              | 11            | 11         | 20         | 19         |
| 10 GHz to 13.5 GHz             | 11            | 11         | 19         | 16         |
| 13.5 GHz to 16 GHz             | 11            | 11         | 17         | 15         |
| 16 GHz to 20 GHz               | 8             | 8          | 16         | 12         |
| 20 GHz to 24 GHz               | 8             | 5          | 14         | 10         |
| 24 GHz to 26.5 GHz             | 2             | 0          | 10         | 7          |

<sup>1</sup> With option 220, 420 installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 28.

**Table 28. Maximum Power (dBm), All Ports – All LFE Options (LFE Enabled)**

| Description       | Specification | Typical <sup>1</sup> |
|-------------------|---------------|----------------------|
| 500 Hz to 900 Hz  | --            | 12                   |
| 900 Hz to 1 kHz   | 10            | 13                   |
| 1 kHz to 10 kHz   | 12            | 13                   |
| 10 kHz to 100 kHz | 12            | 14                   |
| 100 kHz to 1 MHz  | 12            | 14                   |
| 1 MHz to 5 MHz    | 10            | 13                   |
| 5 MHz to 10 MHz   | 9             | 11                   |
| 10 MHz to 50 MHz  | 8             | 10                   |
| 50 MHz to 100 MHz | 8             | 10                   |

<sup>1</sup> Values apply to all ports. Ports 2 and 4 typically 1 dB higher.

**Table 29. Power Level Accuracy (dB) at Nominal Power<sup>1</sup>, All Options**

| Description                    | Specification | Typical <sup>1</sup> |
|--------------------------------|---------------|----------------------|
| 10 MHz to 50 MHz <sup>2</sup>  | ±1.5          | ±0.5                 |
| 50 MHz to 500 MHz <sup>2</sup> | ±1.0          | ±0.2                 |
| 500 MHz to 3.2 GHz             | ±1.0          | ±0.1                 |
| 3.2 GHz to 10 GHz              | ±1.0          | ±0.2                 |
| 10 GHz to 13.5 GHz             | ±1.2          | ±0.2                 |
| 13.5 GHz to 18 GHz             | ±2.0          | ±0.3                 |
| 18 GHz to 26.5 GHz             | ±2.5          | ±0.4                 |

<sup>1</sup> Level accuracy at power other than nominal power, Power Level Accuracy (dB) at Nominal Power + Power Level Linearity (dB)

<sup>2</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 30.

**Table 30. Power Level Accuracy (dB), All Ports, All LFE Options (LFE Enabled)**

| Description       | Specification | Typical <sup>1</sup> |
|-------------------|---------------|----------------------|
| 500 Hz to 900 Hz  | --            | ± 0.1                |
| 900 Hz to 1 kHz   | ± 1.0         | ± 0.1                |
| 1 kHz to 10 kHz   | ± 1.0         | ± 0.1                |
| 10 kHz to 100 kHz | ± 1.0         | ± 0.1                |
| 100 kHz to 1 MHz  | ± 1.0         | ± 0.15               |
| 1 MHz to 5 MHz    | ± 1.0         | ± 0.15               |
| 5 MHz to 10 MHz   | ± 1.0         | ± 0.2                |
| 10 MHz to 50 MHz  | ± 1.0         | ± 0.2                |
| 50 MHz to 100 MHz | ± 1.0         | ± 0.2                |

**Table 31. Power Level Linearity<sup>1</sup> (dB), All Options - Specification**

| Description                     | Ports 1, 3 <sup>2</sup><br>-25 dBm ≤ P <-20 dBm | Ports 1, 3 <sup>2</sup><br>-20 dBm ≤ P <-15 dBm | Ports 1, 3 <sup>2</sup><br>P ≥ -15 dBm |
|---------------------------------|-------------------------------------------------|-------------------------------------------------|----------------------------------------|
| 10 MHz to 50 MHz <sup>3</sup>   | ±2.0                                            | ±1.5                                            | ±1.5                                   |
| 50 MHz to 26.5 GHz <sup>3</sup> | ±1.5                                            | ±1.5                                            | ±1.5                                   |

<sup>1</sup> Referenced to nominal power.

<sup>2</sup> Either port can be used as the source port.

<sup>3</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 33.

**Table 32. Power Level Linearity<sup>1</sup> (dB), All Options - Specification**

| Description                    | Ports 2, 4 <sup>2</sup><br>-25 dBm ≤ P < -20 dBm | Ports 2, 4 <sup>2</sup><br>-20 dBm ≤ P < -15 dBm | Ports 2, 4 <sup>2</sup><br>P ≥ -15 dBm |
|--------------------------------|--------------------------------------------------|--------------------------------------------------|----------------------------------------|
| 10 MHz to 50 MHz <sup>3</sup>  | ±2.5                                             | ±1.5                                             | ±1.5                                   |
| 50 MHz to 500 MHz <sup>3</sup> | ±2.0                                             | ±1.5                                             | ±1.5                                   |
| 500 MHz to 26.5 GHz            | ±1.5                                             | ±1.5                                             | ±1.5                                   |

<sup>1</sup> Referenced to nominal power.

<sup>2</sup> Either port can be used as the source port.

<sup>3</sup> With an LFE option installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 33.

**Table 33. Power Level Linearity<sup>1</sup> (dB), All Ports, All LFE Options (LFE Enabled)**

| Description       | Specification |
|-------------------|---------------|
| 500 Hz to 900 Hz  | --            |
| 900 Hz to 100 MHz | ±1.0          |

<sup>1</sup> Referenced to nominal power, from -25 dBm to max power.

**Table 34. Power Sweep Range (dB) - Specification**

| Description        | Option 200, 400, 201, 401 |            | Option 217, 417, 219, 419 |            |
|--------------------|---------------------------|------------|---------------------------|------------|
|                    | Ports 1, 3                | Ports 2, 4 | Ports 1, 3                | Ports 2, 4 |
| 10 MHz to 50 MHz   | 37                        | 37         | 37                        | 37         |
| 50 MHz to 16 GHz   | 38                        | 38         | 38                        | 38         |
| 16 GHz to 20 GHz   | 38                        | 37         | 35                        | 35         |
| 20 GHz to 24 GHz   | 38                        | 35         | 35                        | 32         |
| 24 GHz to 26.5 GHz | 32                        | 30         | 29                        | 27         |

**Table 35. Power Sweep Range (dB), All Options - Typical**

| Description        | Option 200, 400, 201, 401 |            | Option 217, 417, 219, 419 |            |
|--------------------|---------------------------|------------|---------------------------|------------|
|                    | Ports 1, 3                | Ports 2, 4 | Ports 1, 3                | Ports 2, 4 |
| 10 MHz to 50 MHz   | 47                        | 44         | 47                        | 44         |
| 50 MHz to 500 MHz  | 47                        | 45         | 47                        | 45         |
| 500 MHz to 1 GHz   | 47                        | 47         | 46                        | 47         |
| 1 GHz to 3.2 GHz   | 46                        | 47         | 46                        | 47         |
| 3.2 GHz to 10 GHz  | 49                        | 48         | 49                        | 48         |
| 10 GHz to 13.5 GHz | 49                        | 46         | 48                        | 45         |
| 13.5 GHz to 16 GHz | 47                        | 45         | 46                        | 44         |
| 16 GHz to 20 GHz   | 47                        | 43         | 45                        | 41         |
| 20 GHz to 24 GHz   | 45                        | 41         | 43                        | 39         |
| 24 GHz to 26.5 GHz | 41                        | 38         | 39                        | 36         |

**Table 36. Power Sweep Range (dB), Option 205, 405**

| Description                    | Specification |            | Typical    |            |
|--------------------------------|---------------|------------|------------|------------|
|                                | Ports 1, 3    | Ports 2, 4 | Ports 1, 3 | Ports 2, 4 |
| 10 MHz to 50 MHz <sup>1</sup>  | 30            | 30         | 40         | 37         |
| 50 MHz to 500 MHz <sup>1</sup> | 33            | 33         | 42         | 40         |
| 500 MHz to 3.2 GHz             | 34            | 34         | 42         | 43         |
| 3.2 GHz to 10 GHz              | 36            | 36         | 47         | 46         |
| 10 GHz to 13.5 GHz             | 36            | 36         | 47         | 44         |
| 13.5 GHz to 16 GHz             | 35            | 35         | 44         | 42         |
| 16 GHz to 20 GHz               | 35            | 34         | 44         | 40         |
| 20 GHz to 24 GHz               | 35            | 32         | 42         | 38         |
| 24 GHz to 26.5 GHz             | 30            | 27         | 39         | 35         |

<sup>1</sup> With Option 205, 405 installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 38.



**Table 37. Power Sweep Range (dB), Option 220, 420**

| Description                    | Specification |            | Typical    |            |
|--------------------------------|---------------|------------|------------|------------|
|                                | Ports 1, 3    | Ports 2, 4 | Ports 1, 3 | Ports 2, 4 |
| 10 MHz to 50 MHz <sup>1</sup>  | 30            | 30         | 38         | 35         |
| 50 MHz to 500 MHz <sup>1</sup> | 34            | 34         | 41         | 39         |
| 500 MHz to 3.2 GHz             | 35            | 35         | 41         | 42         |
| 3.2 GHz to 10 GHz              | 36            | 36         | 45         | 44         |
| 10 GHz to 13.5 GHz             | 36            | 36         | 44         | 41         |
| 13.5 GHz to 16 GHz             | 36            | 36         | 42         | 40         |
| 16 GHz to 20 GHz               | 33            | 33         | 41         | 37         |
| 20 GHz to 24 GHz               | 33            | 30         | 39         | 35         |
| 24 GHz to 26.5 GHz             | 27            | 25         | 35         | 42         |

<sup>1</sup> With Option 220, 420 installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 38.

**Table 38. Power Sweep Range (dB) –All LFE Options (LFE Enabled)**

| Description       | Specification | Typical <sup>1</sup> |
|-------------------|---------------|----------------------|
| 500 Hz to 900 Hz  | --            | 39                   |
| 900 Hz to 1 kHz   | 35            | 40                   |
| 1 kHz to 10 kHz   | 37            | 40                   |
| 10 kHz to 100 kHz | 37            | 41                   |
| 100 kHz to 1 MHz  | 37            | 41                   |
| 1 MHz to 5 MHz    | 35            | 40                   |
| 5 MHz to 10 MHz   | 34            | 38                   |
| 10 MHz to 50 MHz  | 33            | 37                   |
| 50 MHz to 100 MHz | 33            | 37                   |

**Table 39. Nominal Power (Preset Power, dBm)**

| Description  | Option 200, 201, 205, 400, 401, 405 | Option 217, 219, 220, 417, 419, 420 |
|--------------|-------------------------------------|-------------------------------------|
| Preset Power | 0                                   | -5                                  |

**Table 40. Power Resolution and Maximum/Minimum Settable Power, All Ports<sup>1</sup>**

| Description                         | Specification (dB) | Typical (dBm) |
|-------------------------------------|--------------------|---------------|
| Power Resolution                    | 0.01               | --            |
| Maximum Settable Power              | --                 | 30            |
| Minimum Settable Power              |                    |               |
| Option 200, 201, 205, 400, 401, 405 | --                 | -30           |
| Option 217, 219, 220, 417, 419, 420 | --                 | -95           |

**Table 41. 2<sup>nd</sup> and 3<sup>rd</sup> Harmonics at Max Specified Power (dBc), All Options - Typical**

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

| Description                   | 2nd Harmonic | 3rd Harmonic |
|-------------------------------|--------------|--------------|
| 10 MHz to 50 MHz <sup>1</sup> | -16          | -15          |
| 50 MHz to 2 GHz               | -23          | -17          |
| 2 GHz to 8.85 GHz             | -17          | -19          |
| 8.85 GHz to 13.25 GHz         | -17          | --           |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 42.

**Table 42. 2<sup>nd</sup> and 3<sup>rd</sup> Harmonics at Max Specified Power (dBc), All Ports, All LFE Options (LFE Enabled) - Typical**

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

| Description       | 2nd Harmonic | 3rd Harmonic |
|-------------------|--------------|--------------|
| 500 Hz to 900 Hz  | -32          | -31          |
| 900 Hz to 1 kHz   | -22          | -23          |
| 1 kHz to 10 kHz   | -22          | -23          |
| 10 kHz to 100 kHz | -22          | -23          |
| 100 kHz to 1 MHz  | -25          | -22          |
| 1 MHz to 5 MHz    | -28          | -24          |
| 5 MHz to 10 MHz   | -27          | -22          |
| 10 MHz to 33 MHz  | -28          | -21          |
| 33 MHz to 50 MHz  | -28          | --           |

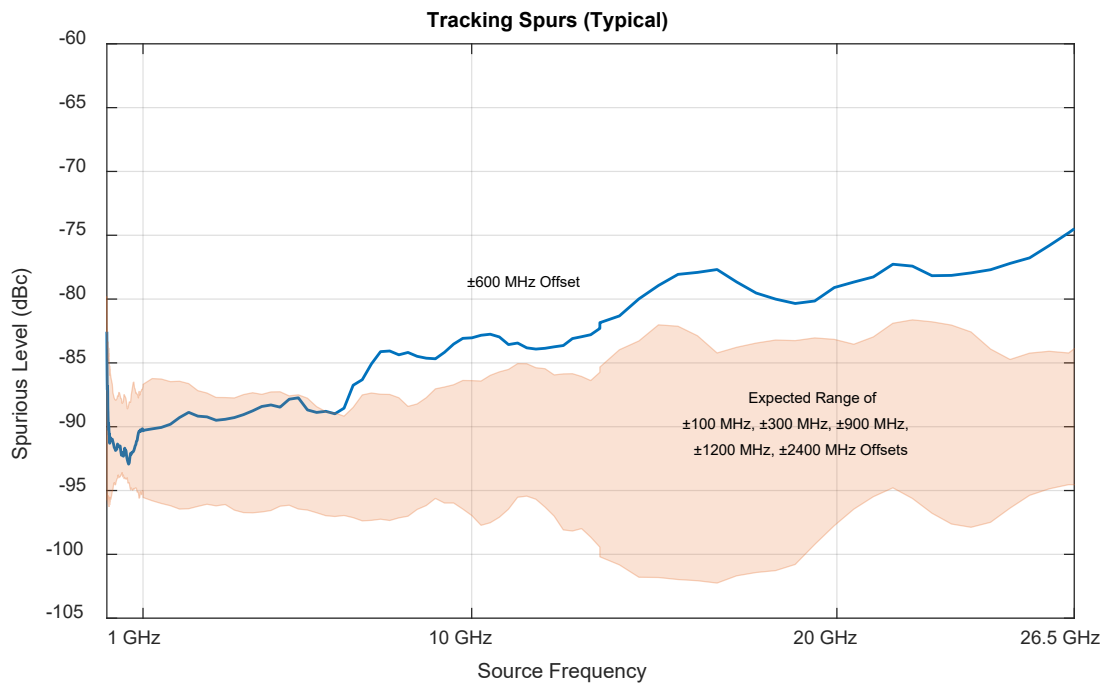
**Table 43. Non-Harmonic Spurs<sup>1</sup> at Nominal Power (dBc), All Options – Typical**

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

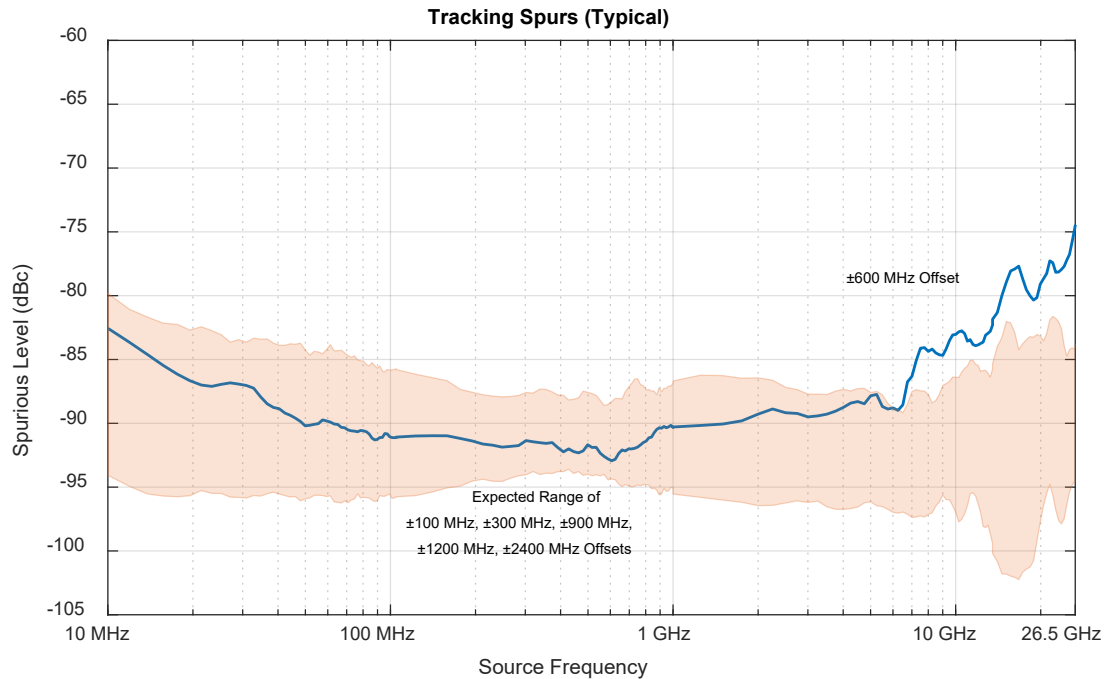
| Description        | Non-Harmonic | ±600 MHz Tracking Spur |
|--------------------|--------------|------------------------|
| 10 MHz to 1 GHz    | -80          | -80                    |
| 1 GHz to 10 GHz    | -85          | -81                    |
| 10 GHz to 20 GHz   | -82          | -75                    |
| 20 GHz to 26.5 GHz | -80          | -70                    |

<sup>1</sup> Non-harmonic spurs are negligible with Option 425 installed and LFE enabled.

### Tracking Spurs (Linear Frequency Scale)



## Tracking Spurs (Logarithmic Frequency Scale)



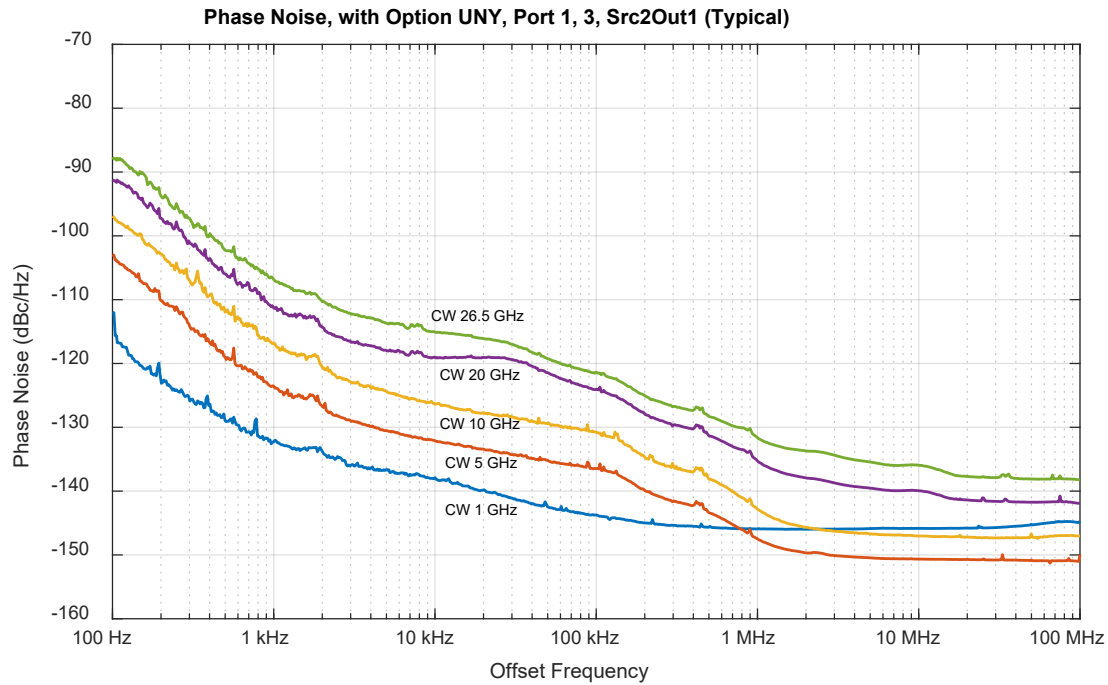
**Table 44. Phase Noise (dBc/Hz), All Options, with UNY, Port 1, 3 - Typical**

| 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 45. Phase Noise (dBc/Hz), All Options, 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          |

## Phase Noise with Option UNY



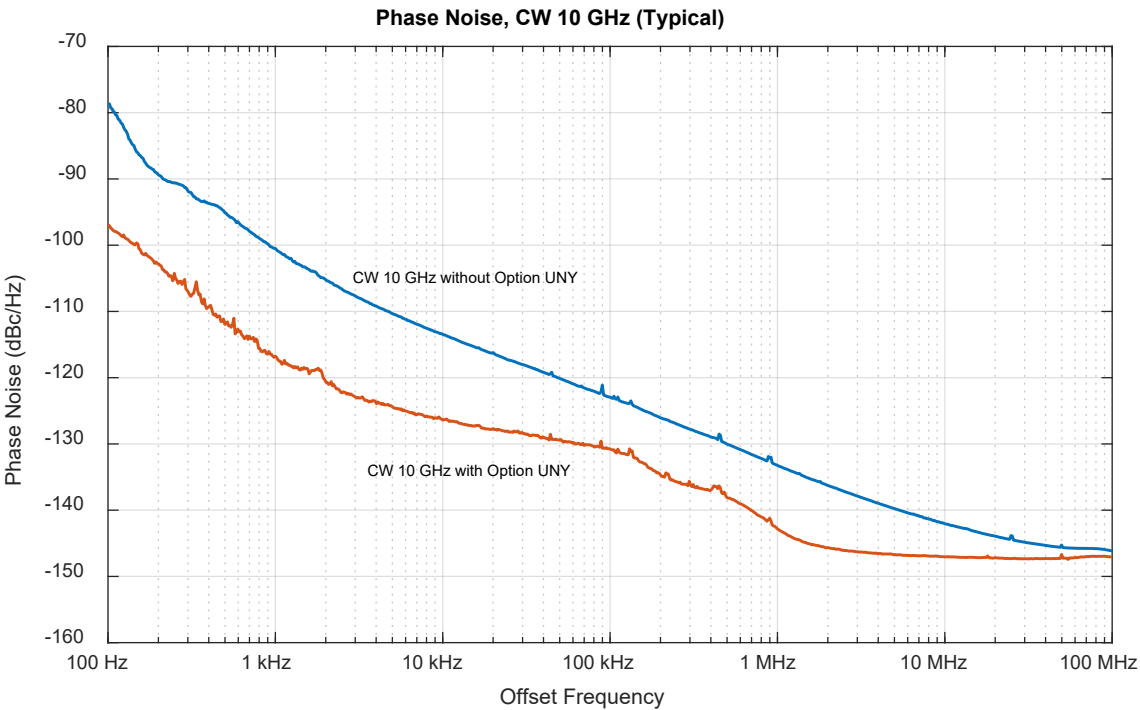
**Table 46. Phase Noise (dBc/Hz), All LFE Options (LFE Enabled), with UNY, All Ports - Typical**

| Description       | 1 kHz Offset | 10 kHz Offset | 100 kHz Offset | 1 MHz Offset |
|-------------------|--------------|---------------|----------------|--------------|
| 500 Hz to 100 MHz | -120         | -130          | -125           | -135         |

**Table 47. Phase Noise (dBc/Hz), All Options, 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          |

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



## Test Port Input

**Table 48. Test Port Noise Floor (dBm) @ 10 Hz IFBW, All Options**

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 |        |
|--------------------------------|---------------|--------|---------|--------|
|                                | N5221B        | N5222B | N5221B  | N5222B |
| 10 MHz to 50 MHz <sup>1</sup>  | -82           | -82    | -88     | -88    |
| 50 MHz to 100 MHz <sup>1</sup> | -95           | -95    | -103    | -103   |
| 100 MHz to 500 MHz             | -105          | -105   | -110    | -110   |
| 500 MHz to 2 GHz               | -114          | -114   | -118    | -118   |
| 2 GHz to 13.5 GHz              | -114          | -114   | -119    | -119   |
| 13.5 GHz to 20 GHz             | --            | -114   | --      | -120   |
| 20 GHz to 24 GHz               | --            | -111   | --      | -118   |
| 24 GHz to 26.5 GHz             | --            | -107   | --      | -116   |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 49.

**Table 49. Noise Floor (dBm) @ 10 Hz IFBW, All LFE Options (LFE Enabled)**

| Description                    | Specification | Typical |
|--------------------------------|---------------|---------|
| 500 Hz to 900 Hz               | --            | -93     |
| 900 Hz to 1 kHz                | -90           | -96     |
| 1 kHz to 10 kHz                | -91           | -96     |
| 10 kHz to 100 kHz              | -101          | -105    |
| 100 kHz to 1 MHz               | -107          | -110    |
| 1 MHz to 5 MHz                 | -108          | -112    |
| 5 MHz to 10 MHz                | -102          | -106    |
| 10 MHz to 50 MHz               | -102          | -106    |
| 50 MHz to 100 MHz <sup>1</sup> | -102          | -106    |

<sup>1</sup> May be degraded at 100 MHz due to spurious receiver residuals.

**Table 50. Direct Receiver Access Input Noise Floor (dBm), Options 201, 205, 217, 219, 220, 401, 405, 417, 419, 420**

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 |        |
|--------------------|---------------|--------|---------|--------|
|                    | N5221B        | N5222B | N5221B  | N5222B |
| 10 MHz to 50 MHz   | -118          | -118   | -133    | -133   |
| 50 MHz to 100 MHz  | -107          | -107   | -129    | -129   |
| 100 MHz to 250 MHz | -117          | -117   | -136    | -136   |
| 250 MHz to 500 MHz | -117          | -117   | -130    | -130   |
| 500 MHz to 2 GHz   | -126          | -126   | -133    | -133   |
| 2 GHz to 13.5 GHz  | -126          | -126   | -134    | -134   |
| 13.5 GHz to 20 GHz | --            | -126   | --      | -135   |
| 20 GHz to 24 GHz   | --            | -123   | --      | -133   |
| 24 GHz to 26.5 GHz | --            | -119   | --      | -131   |

**Table 51. 0.1 dB Compression, Option 201, 217, 219, 220, 401, 417, 419, and All LFE Options - Typical**

| Description                    | N5221B                | N5222B                |
|--------------------------------|-----------------------|-----------------------|
|                                | Test Port Power (dBm) | Test Port Power (dBm) |
| 10 MHz to 100 MHz <sup>1</sup> | 15                    | 15                    |
| 100 MHz to 13.5 GHz            | 12                    | 12                    |
| 13.5 GHz to 20 GHz             | --                    | 12                    |
| 20 GHz to 26.5 GHz             | --                    | 10                    |

<sup>1</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table Table 52.



**Table 52. 0.1 dB Compression, All Ports, All LFE Options (LFE Enabled) - Typical**

| Description       | Test Port Power (dBm) |
|-------------------|-----------------------|
| 500 Hz to 900 Hz  | 13                    |
| 900 Hz to 1 kHz   | 13                    |
| 1 kHz to 10 kHz   | 13                    |
| 10 kHz to 100 kHz | 13                    |
| 100 kHz to 1 MHz  | 13                    |
| 1 MHz to 5 MHz    | 11                    |
| 5 MHz to 10 MHz   | 13                    |
| 10 MHz to 50 MHz  | 14                    |
| 50 MHz to 100 MHz | 14                    |

**Table 53. Compression - Specification**

| Description                    | Test Port Power (dBm) | Receiver Compression |                 |
|--------------------------------|-----------------------|----------------------|-----------------|
|                                | Option 200, 400       | Magnitude (dB)       | Phase (degrees) |
| 10 MHz to 500 MHz <sup>1</sup> | --                    | --                   | --              |
| 500 MHz to 16 GHz              | 8                     | 0.21                 | 1.60            |
| 16 GHz to 24 GHz               | 8                     | 0.24                 | 1.73            |
| 24 GHz to 26.5 GHz             | 8                     | 0.42                 | 2.51            |

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

**Table 54. Compression - Specification**

| Description                    | Test Port Power (dBm) |                 |                 | Receiver Compression |                 |
|--------------------------------|-----------------------|-----------------|-----------------|----------------------|-----------------|
|                                | Option 201, 205, 401  | Option 217, 417 | Option 219, 419 | Magnitude (dB)       | Phase (degrees) |
| 10 MHz to 500 MHz <sup>1</sup> | --                    | --              | --              | --                   | --              |
| 500 MHz to 16 GHz              | 8                     | 8               | 8               | 0.17                 | 0.97            |
| 16 GHz to 24 GHz               | 8                     | 8               | 8               | 0.23                 | 1.20            |
| 24 GHz to 26.5 GHz             | 8                     | 8               | 8               | 0.29                 | 1.74            |

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

**Table 55. Compression, All Ports, All LFE Options (LFE Enabled) - Specification**

| Description       | Test Port Power (dBm) | Receiver Compression |                 |
|-------------------|-----------------------|----------------------|-----------------|
|                   | All Options           | Magnitude (dB)       | Phase (degrees) |
| 500 Hz to 900 Hz  | --                    | --                   | --              |
| 900 Hz to 1 kHz   | 10                    | 0.2                  | 1               |
| 1 kHz to 10 kHz   | 12                    | 0.2                  | 1               |
| 10 kHz to 100 kHz | 12                    | 0.2                  | 1               |
| 100 kHz to 1 MHz  | 12                    | 0.2                  | 1               |
| 1 MHz to 5 MHz    | 10                    | 0.2                  | 1               |
| 5 MHz to 10 MHz   | 9                     | 0.2                  | 1               |
| 10 MHz to 50 MHz  | 8                     | 0.2                  | 1               |
| 50 MHz to 100 MHz | 8                     | 0.2                  | 1               |

**Table 56. Trace Noise<sup>1</sup> Magnitude (dB rms), All Options**

| Description                      | Specification | Typical    |              |              |
|----------------------------------|---------------|------------|--------------|--------------|
|                                  | 1 kHz IFBW    | 1 kHz IFBW | 100 kHz IFBW | 600 kHz IFBW |
| 10 MHz to 100 MHz <sup>2</sup>   | 0.007         | 0.0036     | 0.053        | 0.103        |
| 100 MHz to 13.5 GHz <sup>2</sup> | 0.002         | 0.0005     | 0.004        | 0.010        |
| 13.5 GHz to 16 GHz               | 0.002         | 0.0003     | 0.003        | 0.007        |
| 16 GHz to 22.5 GHz               | 0.002         | 0.0005     | 0.003        | 0.007        |
| 22.5 GHz to 24 GHz               | 0.003         | 0.0008     | 0.004        | 0.011        |
| 24 GHz to 26.5 GHz               | 0.005         | 0.0012     | 0.007        | 0.017        |

<sup>1</sup> Ratioed measurement, nominal power at test port.

<sup>2</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 57.

**Table 57. Trace Noise<sup>1</sup> Magnitude (dB rms), All Ports, All LFE Options (LFE Enabled)**

| Description      | Specification |            | Typical     |            |              |              |
|------------------|---------------|------------|-------------|------------|--------------|--------------|
|                  | 100 Hz IFBW   | 1 kHz IFBW | 100 Hz IFBW | 1 kHz IFBW | 100 kHz IFBW | 600 kHz IFBW |
| 500 Hz to 900 Hz | --            | --         | 0.002       | --         | --           | --           |
| 900 Hz to 4 kHz  | 0.004         | --         | 0.001       | --         | --           | --           |
| 4 kHz to 300 kHz | --            | 0.004      | --          | 0.002      | --           | --           |
| 300 kHz to 2 MHz | --            | 0.004      | --          | 0.001      | 0.01         | --           |
| 2 MHz to 100 MHz | --            | 0.004      | --          | 0.001      | 0.01         | 0.025        |

<sup>1</sup> Ratioed measurement, nominal power at test port.

**Table 58. Trace Noise<sup>1</sup> Phase (deg rms), All Options**

| Description                      | Specification | Typical    |              |              |
|----------------------------------|---------------|------------|--------------|--------------|
|                                  |               | 1 kHz IFBW | 100 kHz IFBW | 600 kHz IFBW |
| 10 MHz to 100 MHz <sup>2</sup>   | 0.051         | 0.0237     | 0.341        | 0.663        |
| 100 MHz to 13.5 GHz <sup>2</sup> | 0.015         | 0.0045     | 0.027        | 0.067        |
| 13.5 GHz to 16 GHz               | 0.042         | 0.0045     | 0.019        | 0.042        |
| 16 GHz to 22.5 GHz               | 0.042         | 0.0075     | 0.024        | 0.050        |
| 22.5 GHz to 24 GHz               | 0.054         | 0.0080     | 0.031        | 0.073        |
| 24 GHz to 26.5 GHz               | 0.054         | 0.0128     | 0.049        | 0.118        |

<sup>1</sup> Ratioed measurement, nominal power at test port.

<sup>2</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 59.

**Table 59. Trace Noise<sup>1</sup> Phase (deg rms), All Ports, All LFE Options (LFE Enabled)**

| Description      | Specification |            | Typical     |            |              |              |
|------------------|---------------|------------|-------------|------------|--------------|--------------|
|                  | 100 Hz IFBW   | 1 kHz IFBW | 100 Hz IFBW | 1 kHz IFBW | 100 kHz IFBW | 600 kHz IFBW |
| 500 Hz to 900 Hz | --            | --         | 0.012       | --         | --           | --           |
| 900 Hz to 4 kHz  | 0.03          | --         | 0.008       | --         | --           | --           |
| 4 kHz to 300 kHz | --            | 0.03       | --          | 0.014      | --           | --           |
| 300 kHz to 2 MHz | --            | 0.03       | --          | 0.007      | 0.064        | --           |
| 2 MHz to 100 MHz | --            | 0.03       | --          | 0.007      | 0.068        | 0.166        |

<sup>1</sup> Ratioed measurement, nominal power at test port.

**Table 60. Reference Level Magnitude, All Options - Specification**

| Description | Magnitude (dB) | Phase (°) |
|-------------|----------------|-----------|
| Range       | $\pm 500$      | $\pm 500$ |
| Resolution  | 0.001          | 0.01      |

**Table 61. Stability<sup>1</sup>, All Options - Typical**

| Description                    | Magnitude (dB/°C) | Phase (°/°C) |
|--------------------------------|-------------------|--------------|
| 10 MHz to 50 MHz <sup>2</sup>  | 0.010             | 0.180        |
| 50 MHz to 500 MHz <sup>2</sup> | 0.010             | 0.060        |
| 500 MHz to 3.2 GHz             | 0.010             | 0.080        |
| 3.2 GHz to 10 GHz              | 0.020             | 0.130        |
| 10 GHz to 13.5 GHz             | 0.020             | 0.160        |
| 13.5 GHz to 16 GHz             | 0.020             | 0.300        |
| 16 GHz to 20 GHz               | 0.020             | 0.400        |
| 20 GHz to 24 GHz               | 0.030             | 0.500        |
| 24 GHz to 26.5 GHz             | 0.030             | 0.560        |

<sup>1</sup> Stability is defined as a ratio measurement made at the test port.

<sup>2</sup> With an LFE option installed and LFE disabled, applied to frequencies  $\leq 100$  MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance  $\leq 100$  MHz, see Table 62.

**Table 62. Stability<sup>1</sup>, All LFE Options (LFE Enabled) - Typical**

| Description       | Magnitude (dB/°C) | Phase (°/°C) |
|-------------------|-------------------|--------------|
| 500 Hz to 900 Hz  | 0.010             | 0.2          |
| 900 Hz to 1 kHz   | 0.010             | 0.2          |
| 1 kHz to 10 kHz   | 0.010             | 0.2          |
| 10 kHz to 100 kHz | 0.010             | 0.2          |
| 100 kHz to 1 MHz  | 0.010             | 0.1          |
| 1 MHz to 5 MHz    | 0.010             | 0.1          |
| 5 MHz to 10 MHz   | 0.010             | 0.1          |
| 10 MHz to 50 MHz  | 0.010             | 0.1          |
| 50 MHz to 100 MHz | 0.020             | 0.1          |

<sup>1</sup> Stability is defined as a ratio measurement made at the test port.

**Table 63. Damage Input Level, All Options - Specification**

| Description | Option 200, 201, 219, 400, 401, 419 | Option 217, 417 | All LFE Options |
|-------------|-------------------------------------|-----------------|-----------------|
| RF, DC      | 30 dBm, 40 V                        | 30 dBm, 7 V     | 20 dBm, 50 V    |

## Phase Noise Measurement Performance (with S930317B phase noise measurement application)<sup>1</sup>

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

**Table 64. Absolute Phase Noise Sensitivity (dBc/Hz), in Best mode - Supplemental Performance Data <sup>2</sup>**

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 65. Absolute AM Noise Sensitivity (dBc/Hz), in Best mode - Supplemental Performance Data**

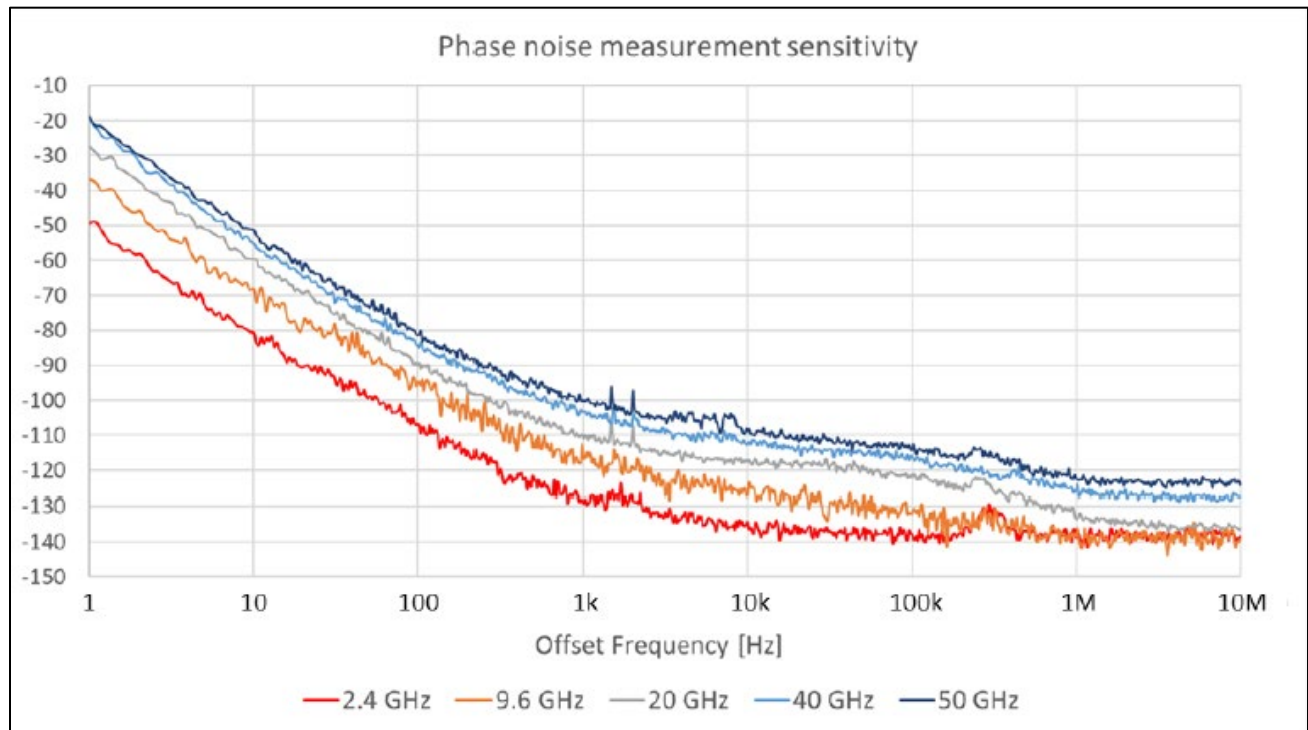
Input Power level: +5 dBm (-5 dBm at 50 GHz)

| 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   |

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

<sup>2</sup> For embedded-LO frequency converters, the frequency used for the table should be that of the embedded-LO.

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



## Single-Channel Residual Noise Measurement <sup>3</sup>

**Table 66. 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 | 10 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   |

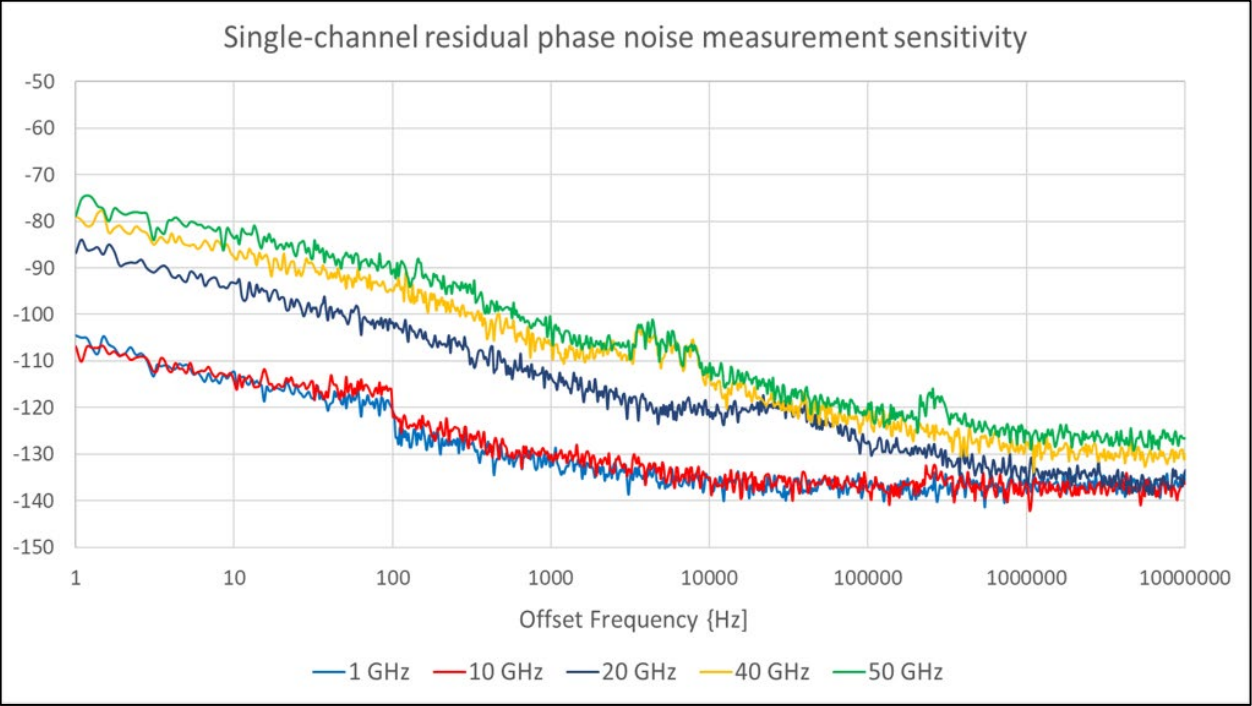
**Table 67. Single-Channel Residual AM Noise Sensitivity (dBc/Hz), with Option UNY in Best mode - Supplemental Performance Data**

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 | 10 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   |

<sup>3</sup> The data is when a THRU device is connected, in other words, when the input and output frequencies are the same. The single-channel residual noise measurement is used for the phase noise measurements for frequency converting devices, and the sensitivity is determined as the absolute phase noise sensitivity at the embedded-LO frequency (Table 64). In the single-channel residual noise measurement mode, the phase or AM noise of the DUT input 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





**Table 68. Single-Channel Residual Phase Noise Sensitivity (dBc/Hz), without Option UNY in Best mode - Supplemental Performance Data <sup>4</sup>**

Input Power level: +10 dBm (+6 dBm at 40 GHz, 0 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 | 10 MHz |
| 1 GHz                | -94              | -95   | -100   | -120  | -133   | -136    | -138    | -137  | -136   |
| 10 GHz               | -77              | -78   | -83    | -102  | -114   | -124    | -129    | -135  | -138   |
| 20 GHz               | -70              | -74   | -75    | -95   | -109   | -118    | -127    | -128  | -133   |
| 40 GHz               | -64              | -67   | -70    | -92   | -102   | -112    | -116    | -121  | -128   |
| 50 GHz               | -61              | -63   | -66    | -87   | -101   | -109    | -113    | -119  | -125   |

**Table 69. Single-Channel Residual AM Noise Sensitivity (dBc/Hz), without Option UNY in Best mode - Supplemental Performance Data**

Input Power level: +10 dBm (+6 dBm at 40 GHz, 0 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 | 10 MHz |
| 1 GHz             | -105             | -110  | -123   | -125  | -134   | -138    | -139    | -143  | -138   |
| 10 GHz            | -104             | -110  | -116   | -125  | -133   | -134    | -133    | -141  | -141   |
| 20 GHz            | -104             | -109  | -116   | -127  | -127   | -126    | -128    | -133  | -137   |
| 40 GHz            | -103             | -110  | -115   | -125  | -120   | -130    | -126    | -130  | -132   |
| 50 GHz            | -98              | -106  | -111   | -121  | -124   | -125    | -122    | -129  | -129   |

<sup>4</sup> The data is when a THRU device is connected, in other words, when the input and output frequencies are the same. The single-channel residual noise measurement is used for the phase noise measurements for frequency converting devices, and the sensitivity is determined as the absolute phase noise sensitivity at the embedded-LO frequency (Table 64). In the single-channel residual noise measurement mode, the phase or AM noise of the DUT input 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.

## 2-Channel Residual Noise Measurement for Non-Frequency Converting Devices<sup>5</sup>

**Table 70. 2-Channel Residual Phase Noise Sensitivity (dBc/Hz) 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 | 10 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   |

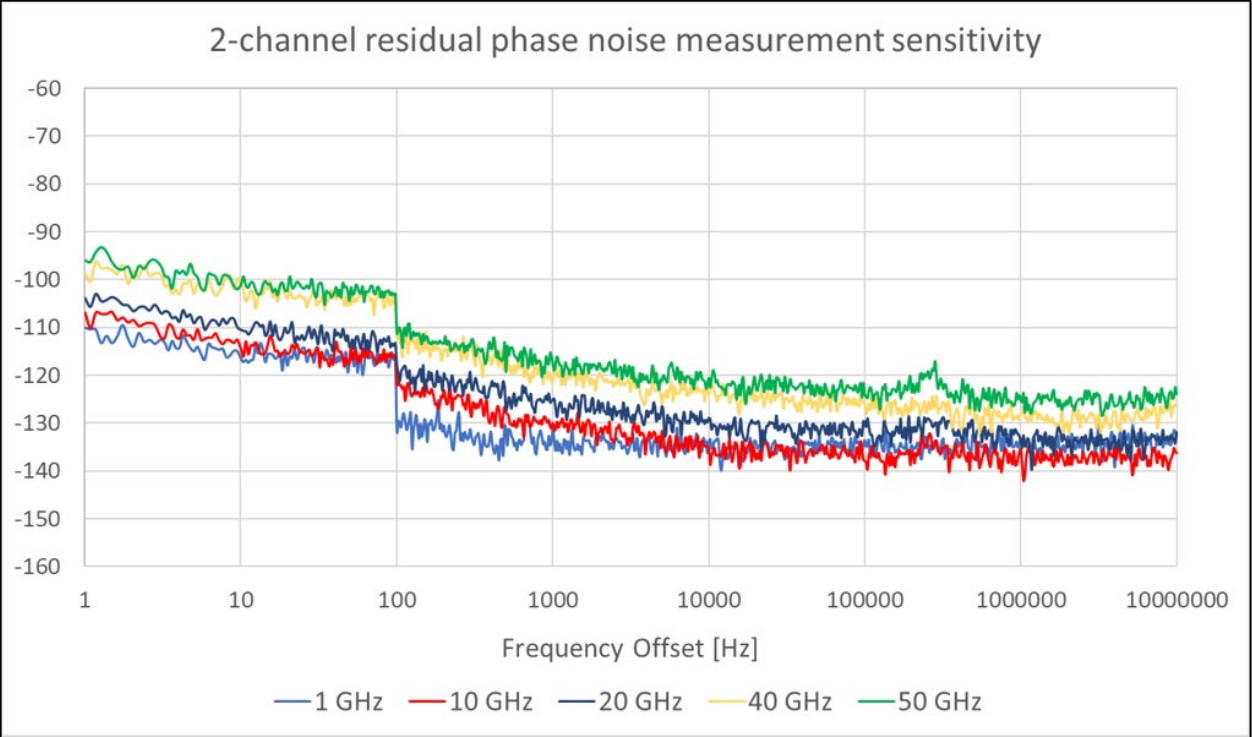
**Table 71. 2-Channel Residual AM Noise Sensitivity (dBc/Hz) in Best mode - Supplemental Performance Data**

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 | 10 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   |

<sup>5</sup> 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

Standard receiver accuracy of the test port input power reading relative to the reference input power level. It is verified with the following measurements:

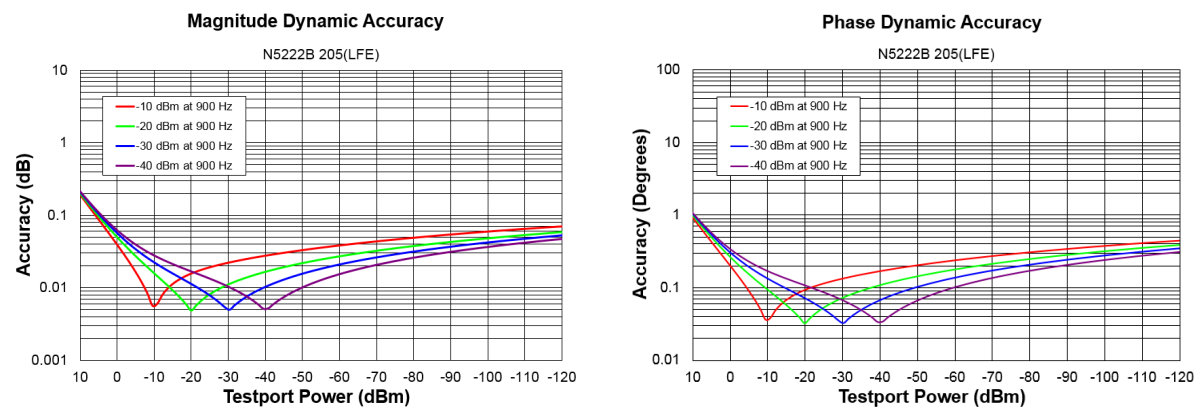
- Compression over frequency

IF linearity at a single frequency of either 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 value below -60 dBm, refer to [VNA Receiver Dynamic Accuracy Specifications and Uncertainties](#).

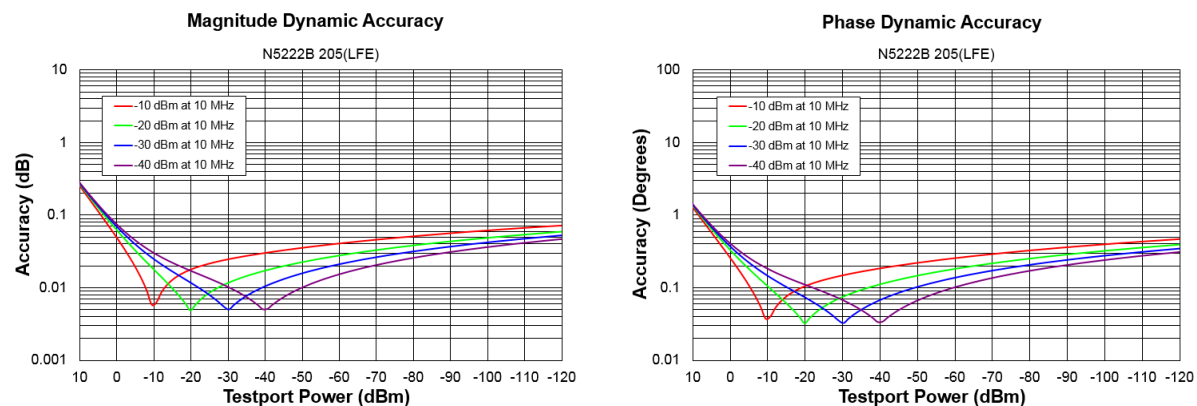
Please download our free Uncertainty Calculator from [http://www.keysight.com/find/na\\_calculator](http://www.keysight.com/find/na_calculator) to generate the curves for your PNA.

Table 72. N5221B and N5222B Dynamic Accuracy - Specification

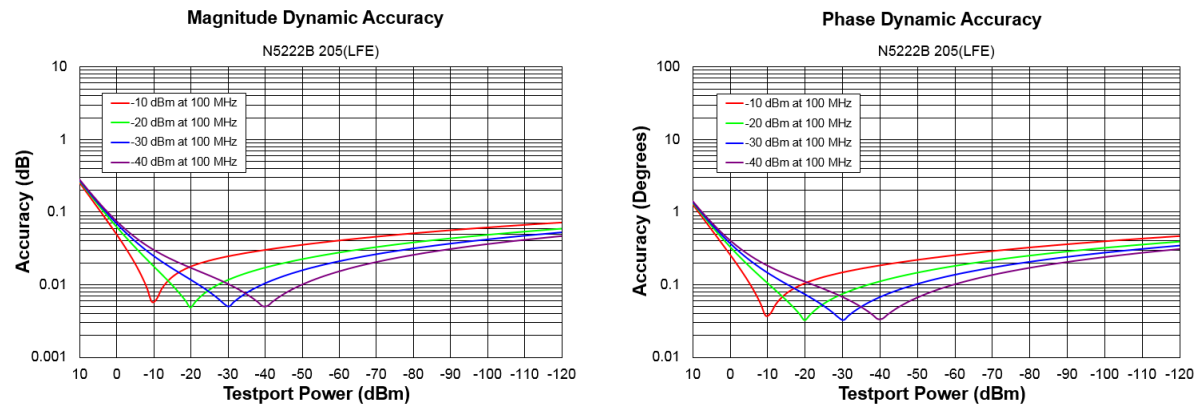
### N5221B/22B Dynamic Accuracy, 900 Hz, All LFE Options (LFE Enabled) - Specification



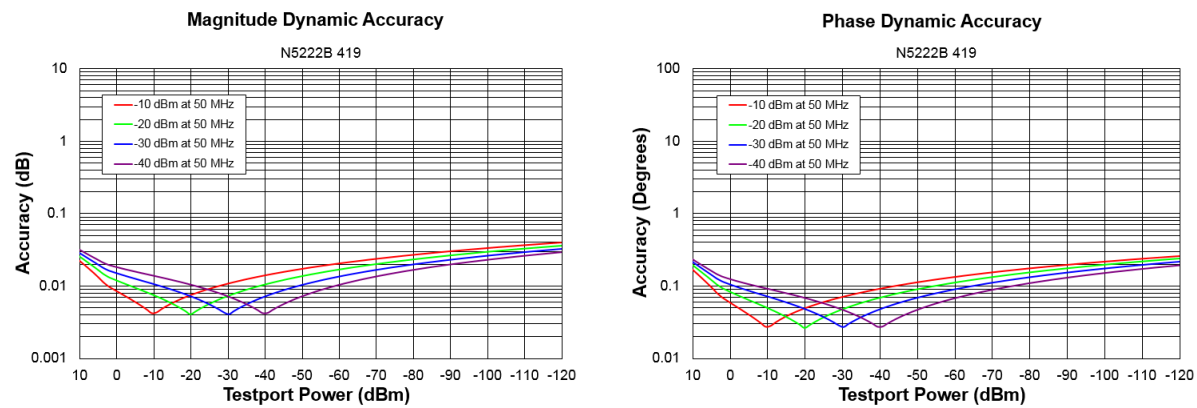
### N5221B/22B Dynamic Accuracy, 10 MHz, All LFE Options (LFE Enabled) - Specification



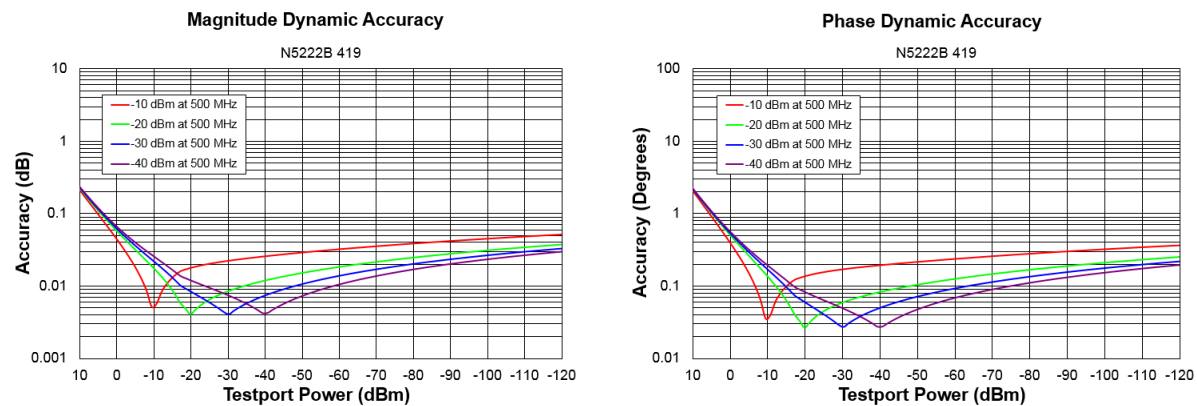
## N5221B/22B Dynamic Accuracy, 100 MHz, All LFE Options (LFE Enabled) - Specification



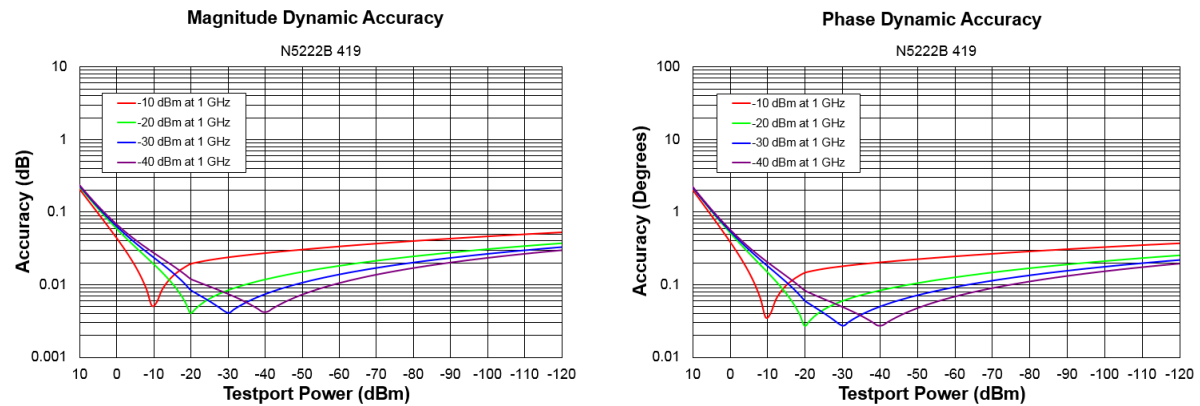
## N5221B/22B Dynamic Accuracy, 10 MHz to 50 MHz - Specification



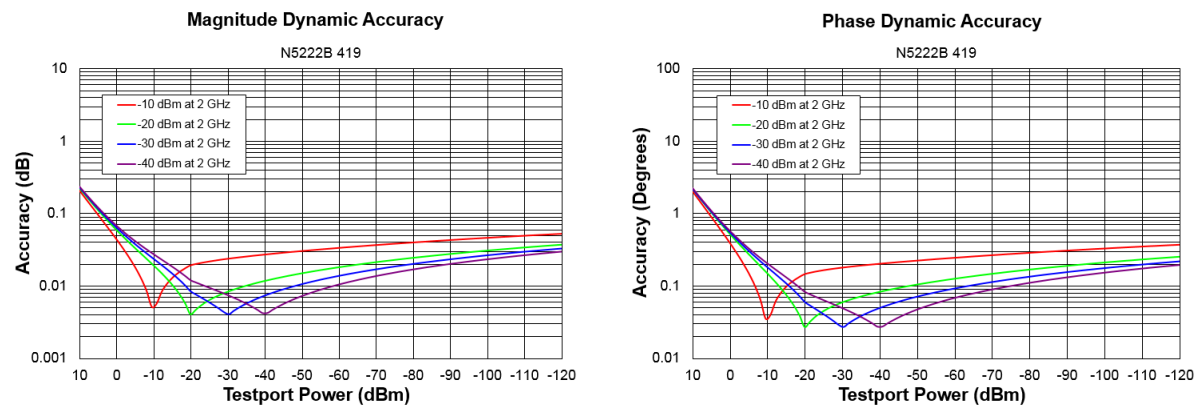
## N5221B/22B Dynamic Accuracy, 50 MHz to 500 MHz - Specification



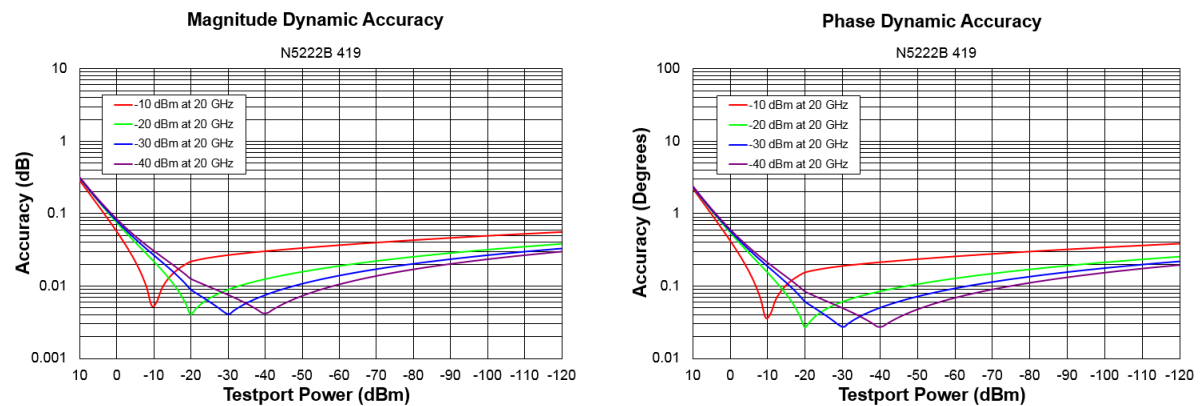
## N5221B/22B Dynamic Accuracy, 500 MHz to 1 GHz - Specification



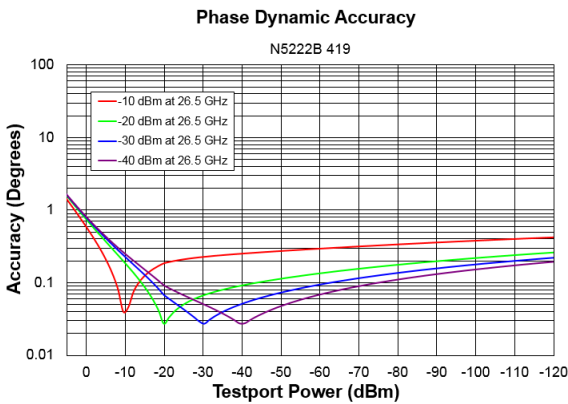
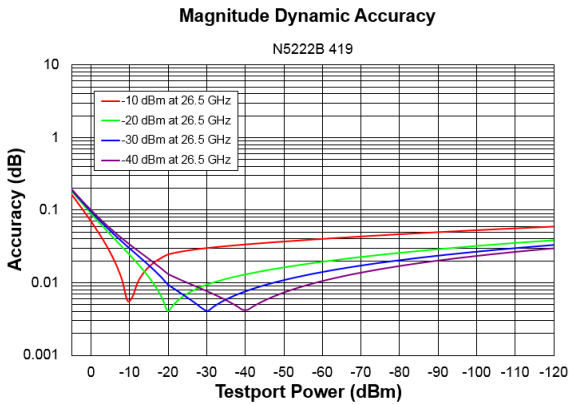
## N5221B/22B Dynamic Accuracy, 1 GHz to 2 GHz - Specification



## N5221B/22B Dynamic Accuracy, 2 GHz to 20 GHz - Specification



N5221B/22B Dynamic Accuracy, 20 GHz to 26.5 GHz - Specification



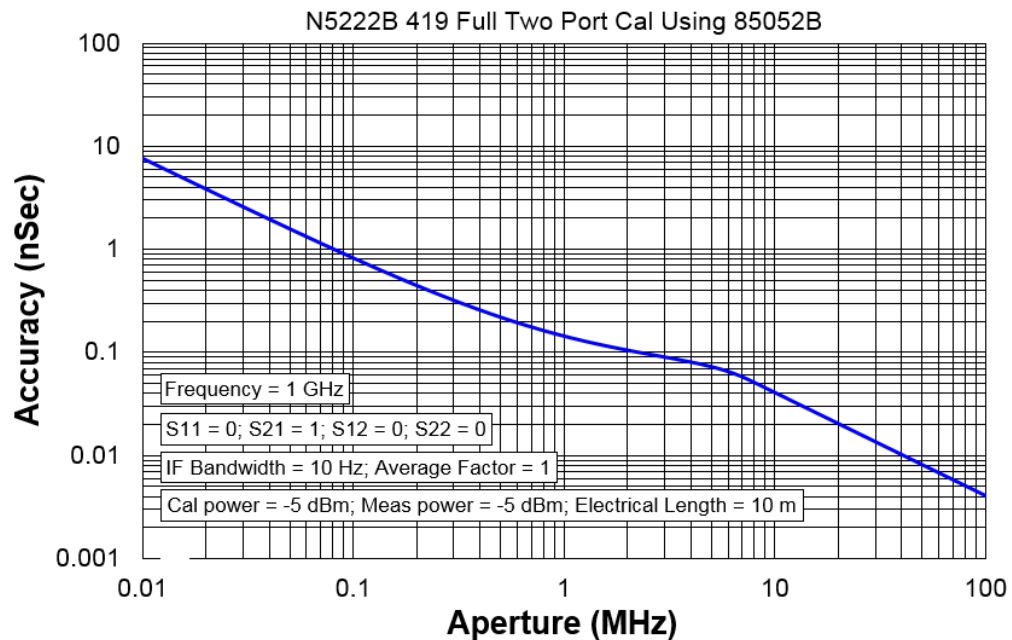
**Table 73. Group Delay<sup>1</sup> - Typical**

| 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.) |
| Accuracy              | See graph below. Char.                                                               |

The following graph shows 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 Accuracy (Typical)



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.

<sup>1</sup> 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).



## General Information

**Table 74. 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: <a href="http://PNA.Hard Drives and CPUs (keysight.com)"><u>PNA Hard Drives and CPUs (keysight.com)</u></a> |                                                                               |
| LXI                       | CPU version 7.0, 8.0                                                                                                                                                              | CPU version 9.0                                                               |
|                           | Class C                                                                                                                                                                           | LXI 1.5<br>Extended Functions:<br>HiSLIP; VSI-11 Discovery and Identification |
| Maximum Number of Points  | 100003                                                                                                                                                                            |                                                                               |

**Table 75. Front Panel Information, All Options**

| Description                              | Typical Performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RF Connectors</b>                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Type                                     | 3.5 mm (male), 50 ohm (nominal)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Center Pin Recession                     | 0.002 in. (characteristic)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>USB 2.0 Ports - Primary (4 ports)</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Standard                                 | Compatible with USB 2.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Connector                                | USB Type-A female                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Display</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 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"> <li>• A complete row or column consists of "stuck" or "dark" pixels.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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).</li> <li>• "Stuck on" pixels or more than two "dark" pixels less than 6.5 mm apart (excluding consecutive pixels).</li> </ul> |

| Description               | Typical Performance                        |
|---------------------------|--------------------------------------------|
| <b>Display Range</b>      |                                            |
| Magnitude                 | $\pm 2500$ dB (at 500 dB/div), max         |
| Phase                     | $\pm 2500^\circ$ (at 500 degrees/div), max |
| Polar                     | 10 pUnits, min<br>10,000 Units, max        |
| <b>Display Resolution</b> |                                            |
| Magnitude                 | 0.001 dB/div, min                          |
| Phase                     | 0.01°/div, min                             |
| <b>Marker Resolution</b>  |                                            |
| Magnitude                 | 0.001 dB, min                              |
| Phase                     | 0.01°, min                                 |
| Polar                     | 10 pUnit, min                              |

**Table 76. Rear Panel Information, All Options**

| Description                 | Typical Performance                                                                        |
|-----------------------------|--------------------------------------------------------------------------------------------|
| <b>10 MHz Reference In</b>  |                                                                                            |
| Connector                   | BNC, female                                                                                |
| Input Frequency             | 10 MHz $\pm 1$ ppm, 100 MHz $\pm 1$ ppm<br>20 MHz $\pm 1$ ppm, 80 MHz $\pm 1$ ppm          |
| Input Level                 | 10 MHz: -15 dBm to +20 dBm<br>100 MHz: -10 dBm to +20 dBm                                  |
| Input Impedance             | 50 $\Omega$ , nom.                                                                         |
| <b>10 MHz Reference Out</b> |                                                                                            |
| 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 $\Omega$                                                        |
| Output Impedance            | 50 $\Omega$ , nominal                                                                      |
| Harmonics                   | <-40 dBc, typical                                                                          |
| <b>External IF Inputs</b>   |                                                                                            |
| 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)                                |

| Description                                                      | Typical Performance                                                                               |
|------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Input Frequency<br>Normal IF path                                | RF < 53 MHz: IF = 826.446 KHz<br>RF >= 53 MHz: IF = 7.438 MHz                                     |
| Narrowband IF path                                               | IF = 10.70 MHz                                                                                    |
| Input Impedance                                                  | 50 $\Omega$                                                                                       |
| RF Damage Level                                                  | +23 dBm                                                                                           |
| DC Damage Level                                                  | 5.5 VDC                                                                                           |
| 0.1 dB Compression Point<br>Normal IF path<br>Narrowband IF path | -9.0 dBm at 7.438 MHz<br>-17 dBm at 10.70 MHz                                                     |
| <b>Pulse I/O Connector</b>                                       | 15-pin mini D-sub (for pin assignment information, refer to the <a href="#">PNA online help</a> ) |
| <b>Pulse Inputs (IF Gates)</b>                                   |                                                                                                   |
| Function                                                         | Internal receiver gates used for point-in-pulse and pulse-profile measurements                    |
| Input Impedance                                                  | 1 K Ohm                                                                                           |
| Minimum Pulse Width, Source Modulators                           | 20 ns                                                                                             |
| Minimum Pulse Width, Receiver Gates                              | 20 ns                                                                                             |
| DC Damage Level                                                  | 5.5 VDC                                                                                           |
| Drive Voltage                                                    | 0 V (off), +3.3 V (on), nominal                                                                   |
| <b>RF Pulse Modulator Input (Source Modulator)</b>               |                                                                                                   |
| <b>On/Off Ratio</b>                                              |                                                                                                   |
| 10 MHz to 3.2 GHz                                                | -64 dB                                                                                            |
| 3.2 GHz to 26.5 GHz                                              | -80 dB                                                                                            |
| <b>Pulse Period</b>                                              |                                                                                                   |
| Minimum                                                          | 20 ns                                                                                             |
| Maximum                                                          | 70 s                                                                                              |
| <b>Pulse Outputs</b>                                             |                                                                                                   |
| Voltage (TTL)                                                    | High: 3.3V to 3.5V<br>Low: <1V                                                                    |
| Impedance                                                        | 50 Ohm                                                                                            |
| <b>External Test Set Driver</b>                                  |                                                                                                   |
| Function                                                         | Used for driving remote mixers                                                                    |
| Connections                                                      | 3.5 (female)                                                                                      |
| RF Output Frequency Range                                        | 3.2 GHz to 19 GHz                                                                                 |
| LO Output Frequency Range                                        | 0.01 to 26.5 GHz                                                                                  |

| Description                | Typical Performance                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                     |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rear Panel LO Power        | Upper Limit, Typical (dBm)                                                                                                                                                                                                                                                                            | Lower Limit, Typical (dBm)                                                                                                                                                                                                                                          |
| 10 MHz to 1.7 GHz          | --                                                                                                                                                                                                                                                                                                    | --                                                                                                                                                                                                                                                                  |
| 1.7 GHz to 16 GHz          | 0                                                                                                                                                                                                                                                                                                     | -10                                                                                                                                                                                                                                                                 |
| 16 GHz to 21 GHz           | 4                                                                                                                                                                                                                                                                                                     | -6                                                                                                                                                                                                                                                                  |
| 21 GHz to 26.5 GHz         | 6                                                                                                                                                                                                                                                                                                     | -4                                                                                                                                                                                                                                                                  |
| Rear Panel RF Power        | Upper Limit, Typical (dBm)                                                                                                                                                                                                                                                                            | Lower Limit, Typical (dBm)                                                                                                                                                                                                                                          |
| 3.2 GHz to 19 GHz          | -3                                                                                                                                                                                                                                                                                                    | -8                                                                                                                                                                                                                                                                  |
| Bias Tee Inputs            |                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                     |
| Connectors                 | BNC(f) for ports 1, 2, 3 and 4                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                     |
| Fuse                       | 500 mA, bi-pin style                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                     |
| Maximum Bias Current       | ±200 mA with no degradation of RF specifications                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                     |
| Maximum Bias Voltage       | ±40 VDC                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                     |
| Other Rear Panel Interface |                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                     |
| 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                                                                                                                                                                 |                                                                                                                                                                                                                                                                     |
| 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. |

| Description        | Typical Performance                                                                              |                                                                                                                                                                         |
|--------------------|--------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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) <sup>1</sup> , and Display Port (port TB1 only) |
| LAN                | 1G port;<br>10/100/1000 BaseT Ethernet, 8-pin configuration; auto selects between the data rates | 1G and 10G ports;<br>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                                                                                                      |
| <b>Line Power</b>  |                                                                                                  |                                                                                                                                                                         |
| Frequency, Voltage | 50/60/400 Hz for 100-120 VAC<br>50/60 Hz for 220-240 VAC                                         |                                                                                                                                                                         |
|                    | Power supply is auto switching                                                                   |                                                                                                                                                                         |
| Max                | 575 watts                                                                                        |                                                                                                                                                                         |

<sup>1</sup> High power devices require external power supply

**Table 77. Analyzer Dimensions and Weight**

All models are shipped with bottom feet, handles, and front and rear hardware.

| Cabinet Dimensions                          | Metric (mm)     | Imperial (inches) |
|---------------------------------------------|-----------------|-------------------|
| <b>Height</b>                               |                 |                   |
| Without bottom feet:EIA RU <sup>1</sup> = 6 | 266.1           | 10.5              |
| With bottom feet                            | 279.1           | 11.0              |
| <b>Width</b>                                |                 |                   |
| 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              |
| <b>Depth</b>                                |                 |                   |
| Without front and rear panel hardware       | 533.0           | 21.0              |
| With front and rear panel hardware, handles | 578.0           | 22.7              |
| <b>Weight (nominal)</b>                     | <b>Net</b>      | <b>Shipping</b>   |
| 2-port models                               | 27 kg (60 lb)   | 43 kg (95 lb)     |
| 4-port models                               | 36.7 kg (81 lb) | 51 kg (112 lb)    |

<sup>1</sup> Electronics Industry Association rack units. 1 RU = 1.75 in.

## 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

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. LF Auto BW off.

**Table 78. Cycle Time (ms) for Measurement Completion, All Models, All Options - Typical**

| Sweep Range              | IF Bandwidth |             | Number of Points |       |       |        |        |
|--------------------------|--------------|-------------|------------------|-------|-------|--------|--------|
|                          |              |             | 201              | 401   | 1601  | 16001  | 32001  |
| <b>50 kHz to 100 MHz</b> | 10 kHz       | Uncorrected | 66.8             | 129.3 | 529   | 4870   | 9988   |
|                          |              | 2-Port cal  | 133              | 255.3 | 984   | 9919   | 19707  |
|                          | 1 kHz        | Uncorrected | 289.7            | 574   | 2282  | 22831  | 45609  |
|                          |              | 2-Port cal  | 580              | 1148  | 4564  | 45746  | 91737  |
|                          | 100 Hz       | Uncorrected | 2562             | 5044  | 20143 | 201207 | 402348 |
|                          |              | 2-Port cal  | 5056             | 10087 | 40291 | 402482 | 805000 |
| <b>9 GHz to 10 GHz</b>   | 600 kHz      | Uncorrected | 3.7              | 4.2   | 8.1   | 54     | 109.7  |
|                          |              | 2-Port cal  | 7.6              | 8.7   | 16.6  | 109    | 216.8  |
|                          | 10 kHz       | Uncorrected | 29.8             | 53.2  | 201.8 | 1990   | 3998   |
|                          |              | 2-Port cal  | 61.2             | 107.4 | 404   | 3978   | 7981   |
|                          | 1 kHz        | Uncorrected | 201.8            | 399   | 1585  | 15812  | 31643  |
|                          |              | 2-Port cal  | 403              | 798   | 3169  | 31664  | 63412  |
| <b>10 GHz to 20 GHz</b>  | 600 kHz      | Uncorrected | 14.6             | 13.6  | 14.7  | 59.3   | 110.2  |
|                          |              | 2-Port cal  | 26.6             | 27    | 29.2  | 120.1  | 256.5  |
|                          | 10 kHz       | Uncorrected | 43.8             | 82.3  | 223   | 1995   | 3983   |
|                          |              | 2-Port cal  | 104              | 163.2 | 412   | 4002   | 7962   |
|                          | 1 kHz        | Uncorrected | 212              | 402   | 1588  | 15816  | 31625  |
|                          |              | 2-Port cal  | 409              | 804   | 3198  | 31636  | 63376  |

**Table 79. N5221B Cycle Time (ms) for Full-Span Measurement Completion - Typical**

| 10 MHz to 13.5 GHz |             | Number of Points |       |      |       |       |
|--------------------|-------------|------------------|-------|------|-------|-------|
| IF Bandwidth       |             | 201              | 401   | 1601 | 16001 | 32001 |
| 600 kHz            | Uncorrected | 23.6             | 32.7  | 44.4 | 89.3  | 141.9 |
|                    | 2-Port cal  | 47.6             | 65.2  | 82   | 177.4 | 301.3 |
| 10 kHz             | Uncorrected | 51.4             | 94.3  | 306  | 2155  | 4030  |
|                    | 2-Port cal  | 104.8            | 188.4 | 611  | 4321  | 8098  |
| 1 kHz              | Uncorrected | 212.3            | 416   | 1641 | 16200 | 32388 |
|                    | 2-Port cal  | 424              | 829   | 3296 | 32397 | 64922 |

**Table 80. N5222B Cycle Time (ms) for Full-Span Measurement Completion - Typical**

| 10 MHz to 26.5 GHz |             | Number of Points |       |      |       |       |
|--------------------|-------------|------------------|-------|------|-------|-------|
| IF Bandwidth       |             | 201              | 401   | 1601 | 16001 | 32001 |
| 600 kHz            | Uncorrected | 27.5             | 39    | 57   | 98.2  | 145.2 |
|                    | 2-Port cal  | 55.2             | 80.6  | 115  | 184.4 | 289.7 |
| 10 kHz             | Uncorrected | 53.6             | 95.1  | 337  | 2295  | 4103  |
|                    | 2-Port cal  | 107.1            | 189.4 | 697  | 4560  | 8203  |
| 1 kHz              | Uncorrected | 214.5            | 415   | 1645 | 16018 | 32021 |
|                    | 2-Port cal  | 431              | 854   | 3232 | 32035 | 64221 |



**Table 81. 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       | N5221B/22B      |                                |
|-------------------|-----------------|--------------------------------|
| IF Bandwidth (Hz) | Cycle Time (ms) | Trace Noise Magnitude (dB rms) |
| 600,000           | 2.4             | 0.0045                         |
| 100,000           | 3.5             | 0.0018                         |
| 30,000            | 6.9             | 0.0011                         |
| 10,000            | 26.8            | 0.0006                         |
| 3,000             | 71.7            | 0.0004                         |
| 1,000             | 206.5           | 0.0003                         |
| 300               | 616             | 0.0002                         |
| 100               | 1798            | 0.0002                         |
| 30                | 5954            | 0.0002                         |
| 10                | 17803           | 0.0002                         |
| 3                 | 59247           | 0.0002                         |

**Table 82. Cycle Time (ms) 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) |        |        |         |
|------------------|-------------------|--------|--------|---------|
| Number of Points | 1,000             | 10,000 | 30,000 | 600,000 |
| 3                | 4.7               | 2.2    | 2      | 1.9     |
| 11               | 12.7              | 3.9    | 2.7    | 2.1     |
| 51               | 53.2              | 8.1    | 3.1    | 1.9     |
| 101              | 101.7             | 14.4   | 4.8    | 2.8     |
| 201              | 205               | 26.9   | 6.9    | 2.4     |
| 401              | 398               | 51.7   | 12     | 3.3     |
| 801              | 813               | 104.7  | 22     | 4.4     |
| 1,601            | 1584              | 200.8  | 42.5   | 7.4     |
| 6,401            | 6326              | 824    | 162.8  | 22.3    |
| 16,001           | 15811             | 1989   | 401    | 59.3    |
| 32,001           | 31642             | 3975   | 803    | 106.9   |

**Table 83. Data Transfer Time<sup>1</sup> (ms) - Typical**

**NOTE**

The following was measured on a unit with Synthesizer 6.

| Description                                                            | Number of Points |      |      |        |        |
|------------------------------------------------------------------------|------------------|------|------|--------|--------|
|                                                                        | 201              | 401  | 1601 | 16,001 | 32,001 |
| SCPI over GPIB (Program executed on external PC <sup>2</sup> )         |                  |      |      |        |        |
| 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 SICT/LAN or TCP/IP Socket (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    |
| COM <sup>3</sup> (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 LAN <sup>3</sup> (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  |

<sup>1</sup> Measured with the analyzer display off. Values will increase slightly if the analyzer display is on.

<sup>2</sup> Measured when using the SCPI command DISPlay: VISible OFF.

<sup>3</sup> Values are for real and imaginary pairs, with the analyzer display off.

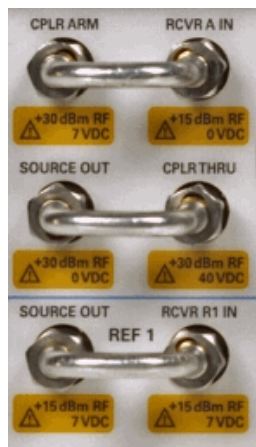
**NOTE**

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

## Front-Panel Jumpers

**NOTE**

The following options have front-panel jumpers for each port:  
201, 205, 217, 219, 220, 401, 405, 417, 419, 420



**Table 84. Measurement Receiver Inputs (dBm) - Typical**

(RCVR A, B, C, D IN) @ 0.1dB Typical Compression

| Description          | All Options |
|----------------------|-------------|
| 10 MHz to 500 MHz    | -4          |
| 500 MHz to 3.2 GHz   | -2          |
| 3.2 GHz to 10 GHz    | -3          |
| 10 GHz to 13.5 GHz   | -4          |
| 13.5 GHz to 26.5 GHz | -5          |

**Table 85. Reference Receiver Inputs and Reference Source Outputs (dBm) - Typical**

(RCVR R1 IN, REF 1 SOURCE OUT) @ Max Specified Output Power

| Description        | Option 201, 401 | Option 217, 219, 417, 419 |
|--------------------|-----------------|---------------------------|
| 10 MHz to 50 MHz   | -4              | -4                        |
| 50 MHz to 10 GHz   | -3              | -2                        |
| 10 GHz to 16 GHz   | -4              | -2                        |
| 16 GHz to 20 GHz   | -5              | -6                        |
| 20 GHz to 24 GHz   | -6              | -7                        |
| 24 GHz to 26.5 GHz | -14             | -14                       |

**Table 86. Reference Receiver Inputs and Reference Source Outputs (dBm) - Typical**

(RCVR R2 IN, RCVR R3 IN, RCVR R4 IN, REF 2 SOURCE OUT, REF 3 SOURCE OUT, REF 4 SOURCE OUT) @ Max Specified Output Power

| Description        | Option 201, 401                                                     | Option 401                      | Option 217, 219, 417, 419                                           |                                 |
|--------------------|---------------------------------------------------------------------|---------------------------------|---------------------------------------------------------------------|---------------------------------|
|                    | RCVR R2 IN,<br>RCVR R4 IN,<br>REF 2 SOURCE OUT,<br>REF 4 SOURCE OUT | RCVR R3 IN,<br>REF 3 SOURCE OUT | RCVR R2 IN,<br>RCVR R4 IN,<br>REF 2 SOURCE OUT,<br>REF 4 SOURCE OUT | RCVR R3 IN,<br>REF 3 SOURCE OUT |
| 10 MHz to 50 MHz   | -2                                                                  | -2                              | -2                                                                  | -2                              |
| 50 MHz to 500 MHz  | -1                                                                  | -1                              | -1                                                                  | -1                              |
| 500 MHz to 3.2 GHz | -1                                                                  | -1                              | 0                                                                   | 0                               |
| 3.2 GHz to 10 GHz  | 0                                                                   | 0                               | +1                                                                  | +1                              |
| 10 GHz to 16 GHz   | 0                                                                   | 0                               | +2                                                                  | +2                              |
| 16 GHz to 20 GHz   | 0                                                                   | +1                              | -1                                                                  | -1                              |
| 20 GHz to 24 GHz   | -2                                                                  | +1                              | -3                                                                  | 0                               |
| 24 GHz to 26.5 GHz | -8                                                                  | -6                              | -9                                                                  | -7                              |

**Table 87. Source Outputs (dBm) - Typical**

(PORT 1 SOURCE OUT, PORT 2 SOURCE OUT, PORT 3 SOURCE OUT, PORT 4 SOURCE OUT)  
@ Max Specified Output Power

| Description        | Option 201, 401                         | Option 201, 401                         | Option 217, 219, 417, 419               |                                         |
|--------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
|                    | PORT 1 SOURCE OUT,<br>PORT 3 SOURCE OUT | PORT 2 SOURCE OUT,<br>PORT 4 SOURCE OUT | PORT 1 SOURCE OUT,<br>PORT 3 SOURCE OUT | PORT 2 SOURCE OUT,<br>PORT 4 SOURCE OUT |
| 10 MHz to 50 MHz   | +12                                     | +12                                     | +12                                     | +12                                     |
| 50 MHz to 500 MHz  | +13                                     | +13                                     | +13                                     | +13                                     |
| 500 MHz to 3.2 GHz | +13                                     | +13                                     | +14                                     | +14                                     |
| 3.2 GHz to 10 GHz  | +14                                     | +14                                     | +14                                     | +14                                     |
| 10 GHz to 16 GHz   | +14                                     | +14                                     | +15                                     | +15                                     |
| 16 GHz to 20 GHz   | +14                                     | +13                                     | +12                                     | +12                                     |
| 20 GHz to 24 GHz   | +14                                     | +11                                     | +12                                     | +9                                      |
| 24 GHz to 26.5 GHz | +8                                      | +6                                      | +6                                      | +4                                      |

**Table 88. Coupler Inputs (dB) - Typical**

(PORT 1 CPLR THRU, PORT 2 CPLR THRU, PORT 3 CPLR THRU, PORT 4 CPLR THRU) Insertion Loss of Coupler Thru

| Description        | Options 201, 401 | Option 217, 219, 417, 419 |
|--------------------|------------------|---------------------------|
| 10 MHz to 50 MHz   | 0                | -0.50                     |
| 50 MHz to 100 MHz  | -0.25            | -0.50                     |
| 100 MHz to 500 MHz | -0.25            | -1.00                     |
| 500 MHz to 3.2 GHz | -0.50            | -1.00                     |
| 3.2 GHz to 10 GHz  | -0.75            | -1.25                     |
| 10 GHz to 13.5 GHz | -1.00            | -1.75                     |
| 13.5 GHz to 16 GHz | -1.00            | -2.00                     |
| 16 GHz to 20 GHz   | -1.20            | -2.00                     |
| 20 GHz to 24 GHz   | -1.30            | -2.50                     |
| 24 GHz to 26.5 GHz | -1.50            | -2.50                     |

**Table 89. Damage Level - Typical**

| Description                | RF (dBm)              | DC (v)                                  |
|----------------------------|-----------------------|-----------------------------------------|
| RCVR A, B, C, D IN         | 15                    | 7                                       |
| RCVR R1, R2, R3, R4 IN     | 15                    | 7                                       |
| REF 1 SOURCE OUT           | 15                    | 7                                       |
| REF 2, 3, 4 SOURCE OUT     | 30                    | 7                                       |
| PORT 1, 2, 3, 4 SOURCE OUT | 30                    | 7                                       |
| PORT 1, 2, 3, 4 CPLR THRU  | 30 (20 <sup>1</sup> ) | 40 (50 <sup>1</sup> ) (7 <sup>2</sup> ) |
| PORT 1, 2, 3, 4 CPLR ARM   | 30                    | 7                                       |

<sup>1</sup> With an LFE option installed.

<sup>2</sup> With a thru connection between test ports of option 217, 222, 417 or 422 configuration, 7 VDC input to CPLR THRU ports damages the source attenuator on the connected port.

## Test Set Block Diagrams

### NOTE

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

### Legend

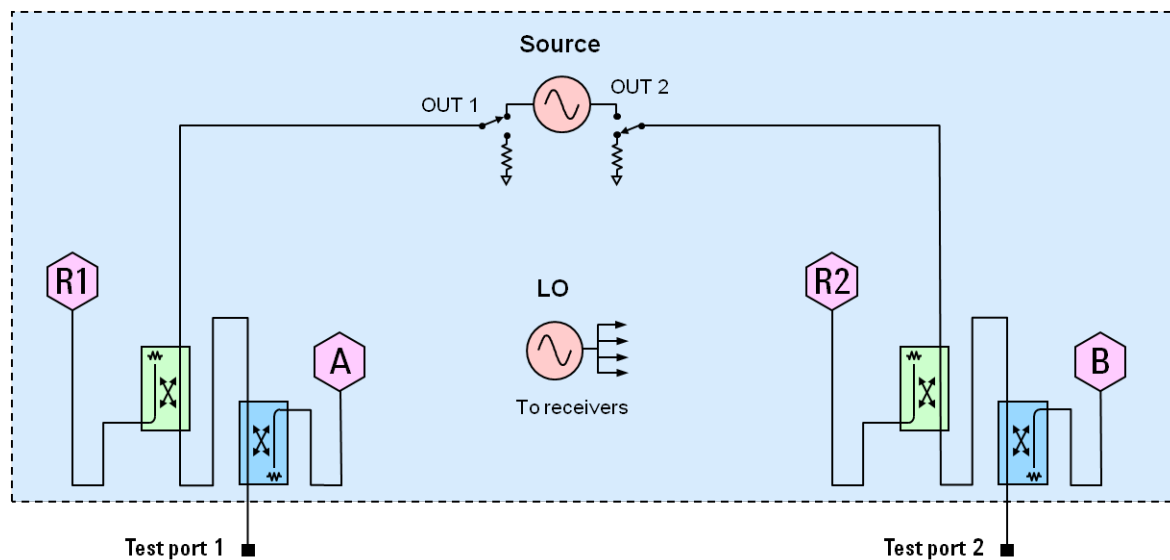
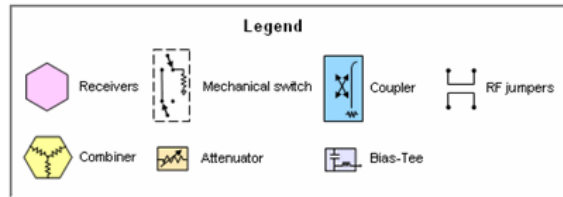


Figure 1. N5221B and N5222B Option 200 (2-port base model)

The diagram illustrates the internal architecture of the rear panel, which is divided into two main sections for **Test port 1** and **Test port 2**. At the top, a **Source** block provides two output channels, **OUT 1** and **OUT 2**, each equipped with a **Pulse modulator**. These outputs are connected to the test ports via a series of components: a switch, a green box containing a switch and a variable capacitor (indicated by a double-headed arrow), and a blue box containing a switch and a variable capacitor (also with a double-headed arrow). The test ports are labeled **R1** and **A** for Test port 1, and **R2** and **B** for Test port 2. In the center, a **LO** (Local Oscillator) block is shown, which is connected to **To receivers**. Above the LO, there are **Pulse generators** represented by four orange boxes, each containing a pulse waveform. At the top right, a group of **IF Inputs** (Intermediate Frequency Inputs) is shown, labeled **R**, **A**, **B**, **C**, and **D**.

The following LFE block diagram shows how the low-frequency hardware is configured for a single test port. The other ports are configured similarly.

The attenuators do not apply to Options 205 and 405.





To base model, adds front-panel jumpers, R1 receiver switch, and source and receiver attenuators (extended power range).

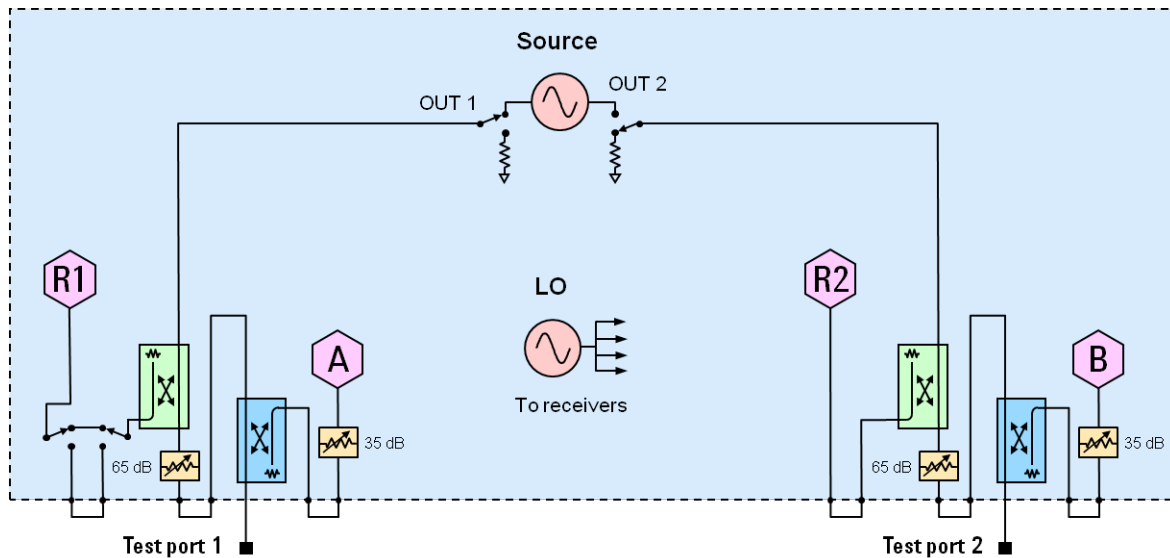


Figure 4. N5221B and N5222B Option 217

To base model, adds front-panel jumpers, R1 receiver switch, source and receiver attenuators (extended power range), and bias-tees.

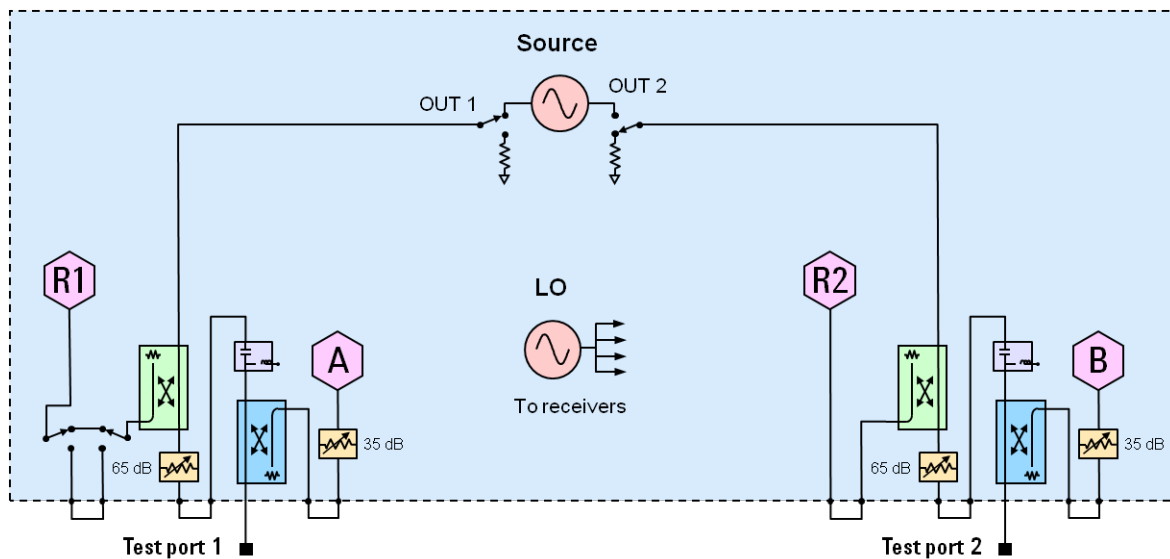


Figure 5. N5221B and N5222B Option 219

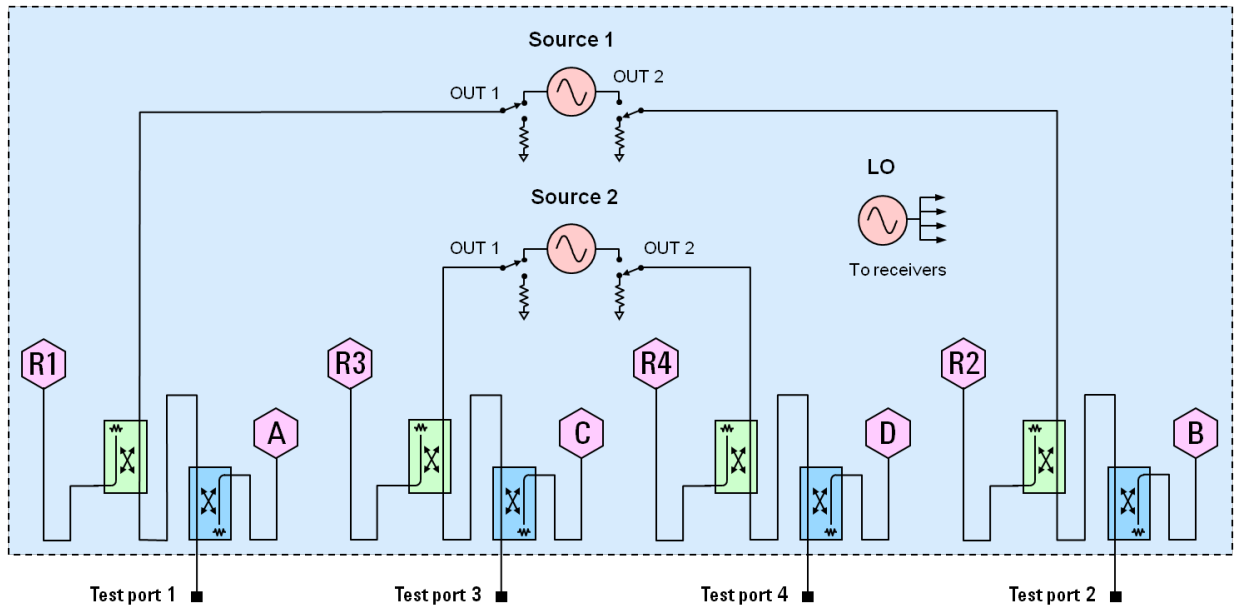


Figure 6. N5221B and N5222B Option 400 (4-port base model)

To base model, adds front-panel jumpers and R1 receiver switch

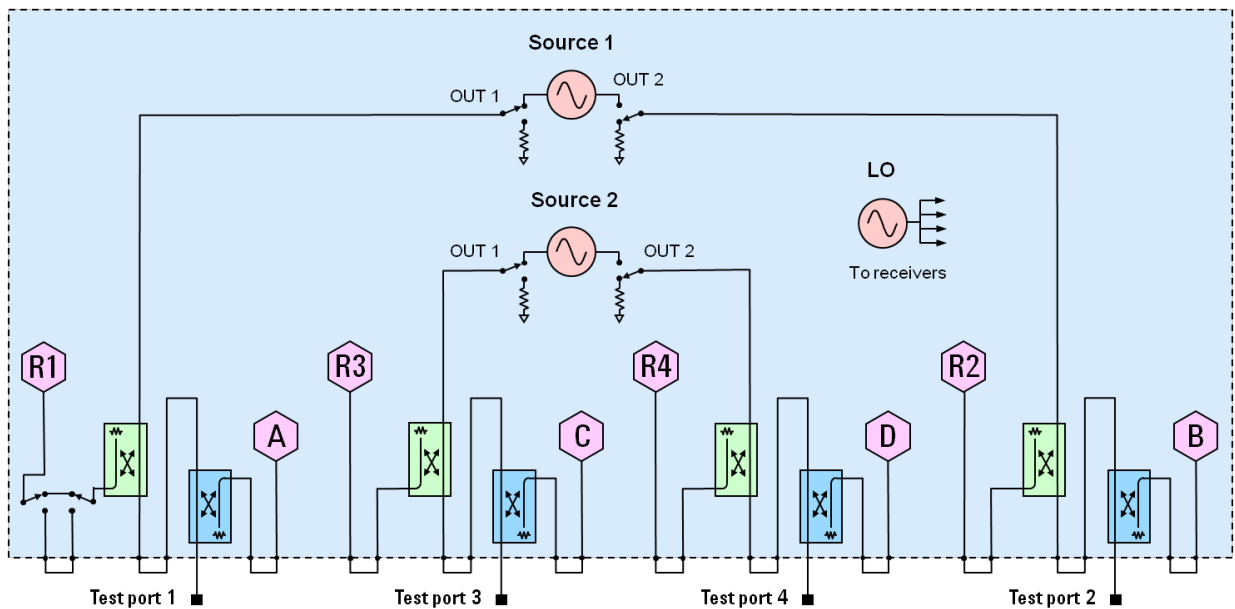


Figure 7. N5221B and N5222B Option 401

To base model, adds front-panel jumpers, R1 receiver switch, and source and receiver attenuators (extended power range).

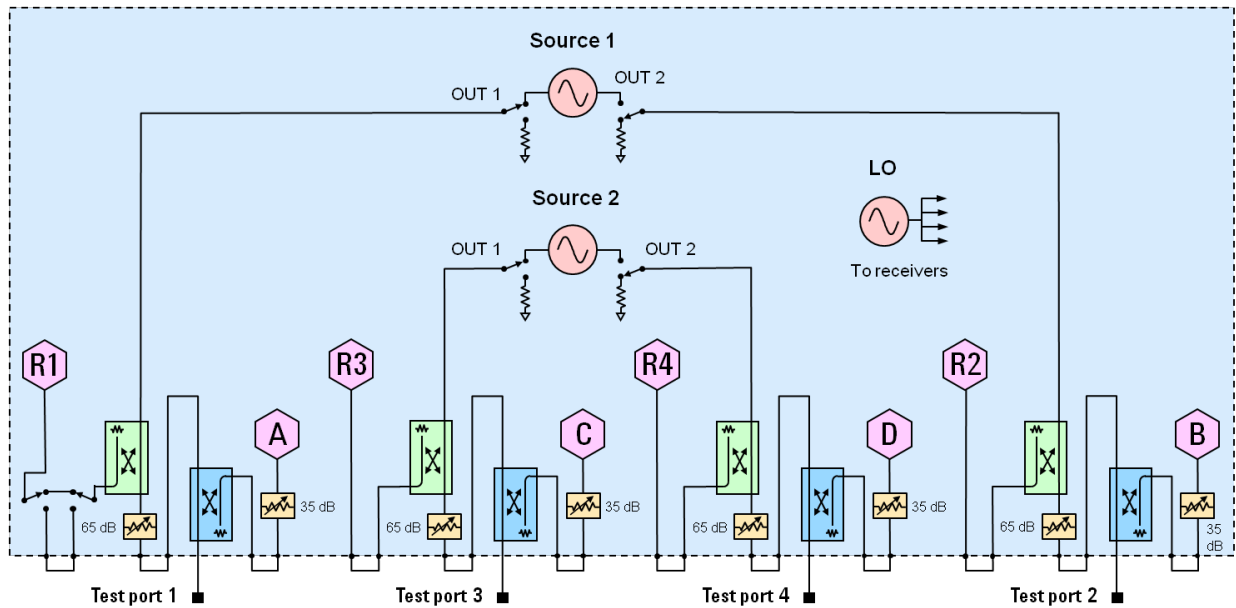


Figure 8. N5221B and N5222B Option 417

To base model, adds front-panel jumpers, R1 receiver switch, source and receiver attenuators (extended power range), and bias-tees.

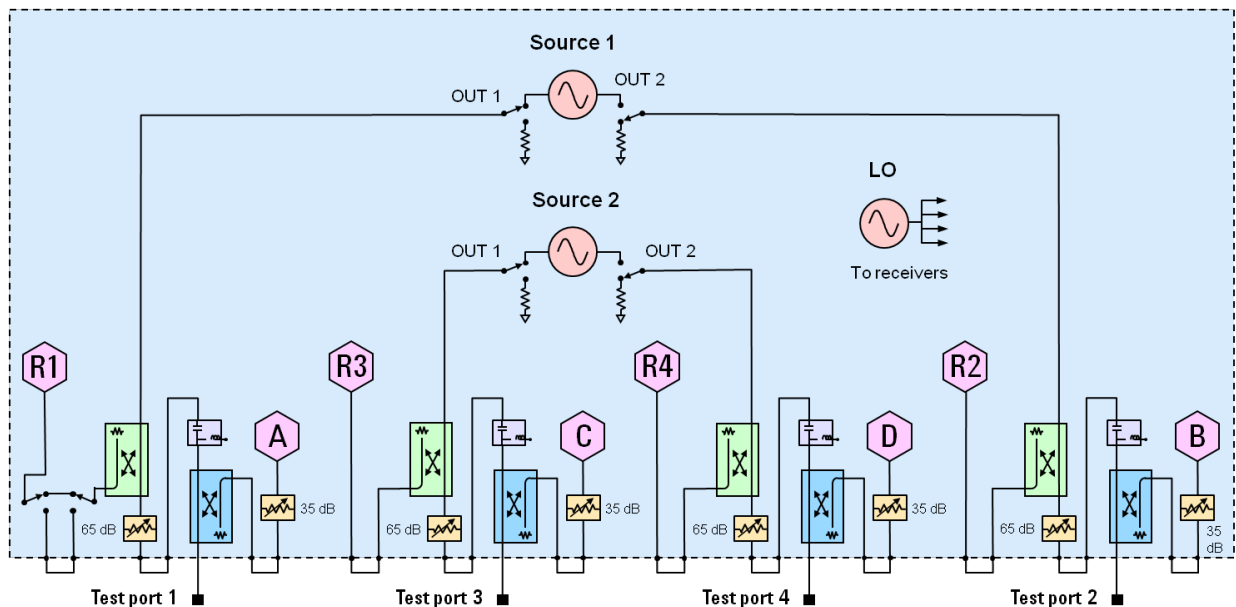


Figure 9. N5221B and N5222B Option 419

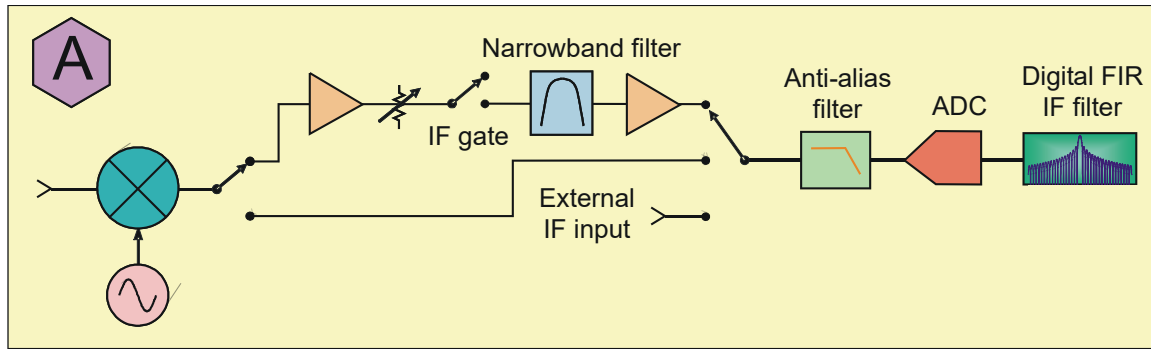


Figure 10. Receiver Block Diagram

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