Keysight 2-Port and 4-Port PNA Network Analyzer

N5221B 900 Hz to 13.5 GHz
N5222B 900 Hz to 26.5 GHz

Data Sheet and Technical Specifications

KEYSIGHT TECHNOLOGIES

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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 for all models and options beginning on page 69.

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.

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 to generate the curves for your calibration kit and PNA setup.

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

Definitions

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

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

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

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

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

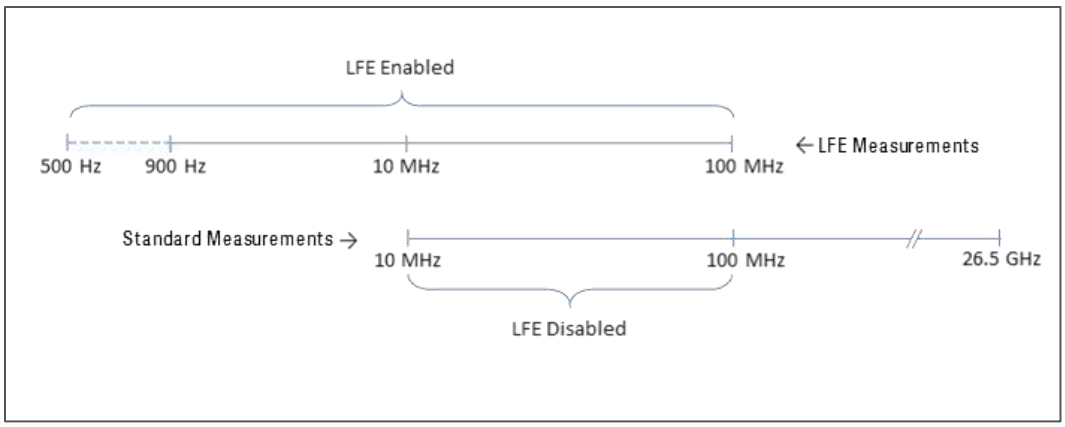
Calibration: The process of measuring known standards to characterize a network analyzer's systematic (repeatable) errors.

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.

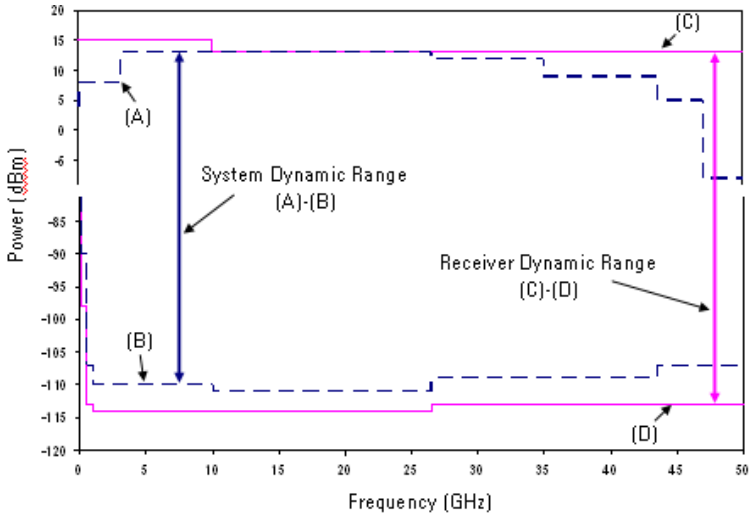


Dynamic Range

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 1a. System Dynamic Range at Test Port (dB), Options 200 or 400

Description	Specification		Typical	
	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4
10 MHz to 50 MHz	104	102	111	109
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

[1] Either port can be used as the source port. Any other port can be used as the receiver port.

Table 1b. System Dynamic Range at Test Port (dB), Options 201 or 401

Description	Specification		Typical	
	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4
10 MHz to 50 MHz	104	101	111	109
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

[1] Either port can be used as the source port. Any other port can be used as the receiver port.

Table 1c. System Dynamic Range at Test Port (dB), Options 217 or 417

Description	Specification		Typical	
	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4
10 MHz to 50 MHz	105	102	111	109
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

[1] Either port can be used as the source port. Any other port can be used as the receiver port.

Table 1d. System Dynamic Range at Test Port (dB), Options 219 or 419

Description	Specification		Typical	
	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4
10 MHz to 50 MHz	103	101	110	108
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

[1] Either port can be used as the source port. Any other port can be used as the receiver port.

Table 1e. System Dynamic Range at Test Port (dB), Option 205, 405

Description	Specification		Typical	
	Ports[2] 1, 3	Ports[2] 2, 4	Ports[2] 1, 3	Ports[2] 2, 4
10 MHz to 50 MHz[1]	98	95	105	102
50 MHz to 100 MHz[1]	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

[1] With Option 205, 405 installed and LFE disabled, applied to frequencies <= 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

[2] Either port can be used as the source port. Any other port can be used as the receiver port.

Table 1f. System Dynamic Range at Test Port (dB), Option 220, 420

Description	Specification		Typical	
	Ports[2] 1, 3	Ports[2] 2, 4	Ports[2] 1, 3	Ports[2] 2, 4
10 MHz to 50 MHz[1]	96	94	104	102
50 MHz to 100 MHz[1]	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

[1] With Option 220, 420 installed and LFE disabled, applied to frequencies <= 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

Table 1g. System Dynamic Range at Test Port (dB), All LFE Options (LFE Enabled)

Description	Specification		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

Extended Dynamic Range

Table 2a. Extended Dynamic Range at Direct Receiver Access Input (dB) – Typical

Description	Option 201, 401		Option 217, 417	
	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4
10 MHz to 50 MHz	155	153	155	153
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

[1] Either port can be used as the source port. Any other port can be used as the receiver port.

Table 2b. Extended Dynamic Range at Direct Receiver Access Input (dB) – Typical

Description	Option 219, 419		Option 220, 420		Option 205, 405	
	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4	Ports[1] 1, 3	Ports[1] 2, 4
10 MHz to 50 MHz	154	152	147	145	149	146
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

[1] Either port can be used as the source port. Any other port can be used as the receiver port.

Receiver Dynamic Range

Table 3a. Receiver Dynamic Range (dB), All Options

Description	Typical
10 MHz to 50 MHz[1]	103
50 MHz to 100 MHz[1]	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

[1] 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.

Table 3b. 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

For any Sii reflection measurement:

- Sjj = 0.

For any Sij transmission measurement:

- Sji = Sij when Sij ≤ 1
- Sji = 1/Sij when Sij >1
- Skk = 0 for all k

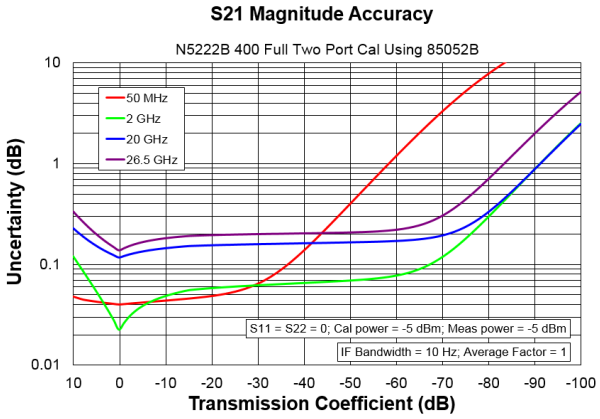
Applies to the N5221B/2B Option 200, 201, 205, 217, 219, 220, 400, 401, 405, 417, 419, or 420 analyzers, 85131F flexible test port cable set, and a full 2-port calibration. Also applies to the following condition: Environmental temperature 23° ±3 °C, with < 1 °C deviation from calibration temperature

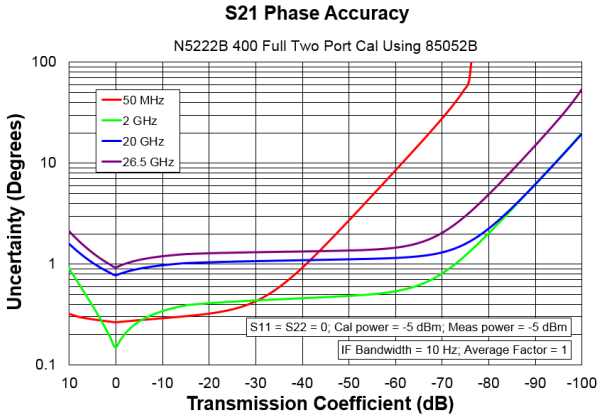
Table 4a. N5221B and N5222B with 85052B Calibration Kit

Description	Specification (dB)					
	10 MHz to 50 MHz[1]	50 MHz to 500 MHz[1]	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
Reflection Tracking						
Mag	±0.003	±0.003	±0.003	±0.006	±0.006	±0.006
Phase (°)	±0.020	±0.020	±0.020	±0.040	±0.040	±0.040
Transmission Tracking						
Mag	±0.034	±0.017	±0.017	±0.091	±0.104	±0.119
Phase (°)	±0.225	±0.110	±0.110	±0.602	±0.688	±0.788

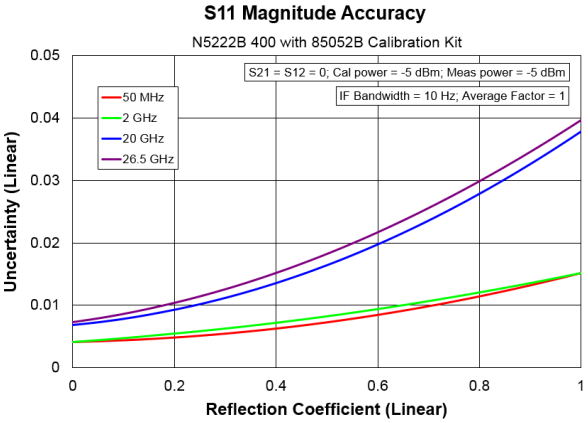
[1] With an LFE option installed and LFE disabled, applied to frequencies <= 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

Transmission Uncertainty, All Options





Reflection Uncertainty, All Options



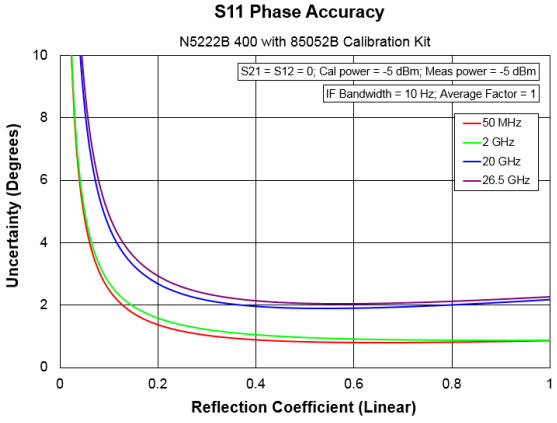
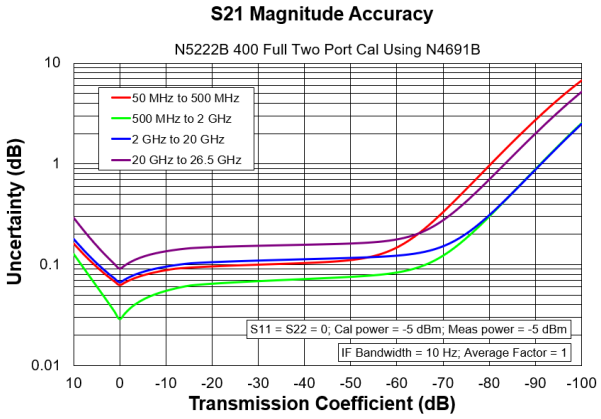


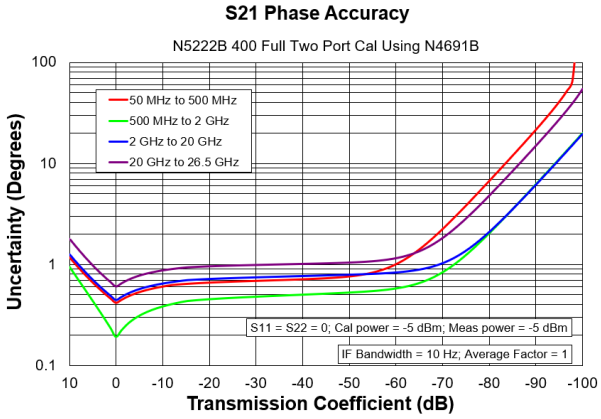
Table 4b. N5221B and N5222B with N4691B 2-Port Electronic Calibration Module

Description	Specification (dB)					
	10 MHz to 50 MHz[1]	50 MHz to 500 MHz[1]	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
Reflection Tracking 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
Transmission Tracking 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

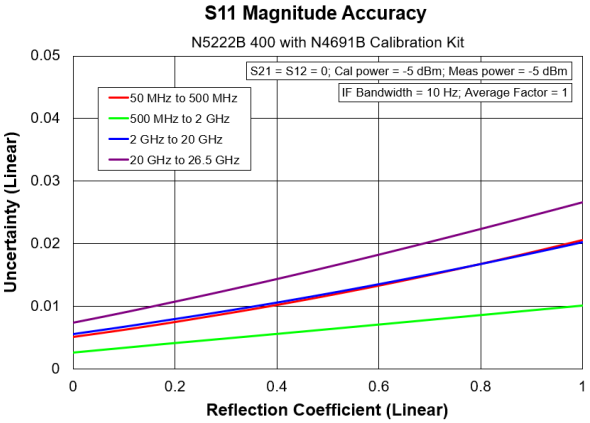
[1] With an LFE option installed and LFE disabled, applied to frequencies <= 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

Transmission Uncertainty, All Options





Reflection Uncertainty, All Options



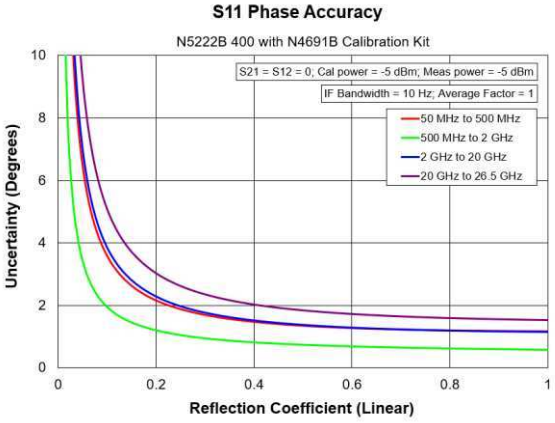
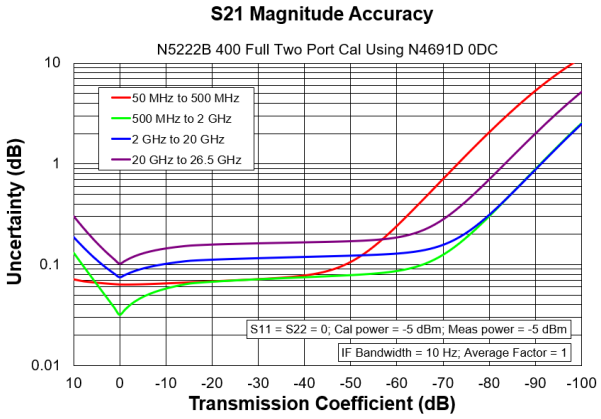


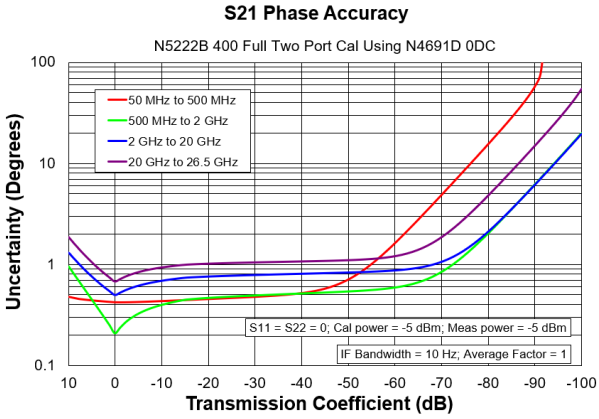
Table 4c. N5221B and N5222B with N4691D 2-Port Electronic Calibration Module

Description	Specification (dB)					
	10 MHz to 50 MHz[1]	50 MHz to 500 MHz[1]	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
Reflection Tracking 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
Transmission Tracking 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

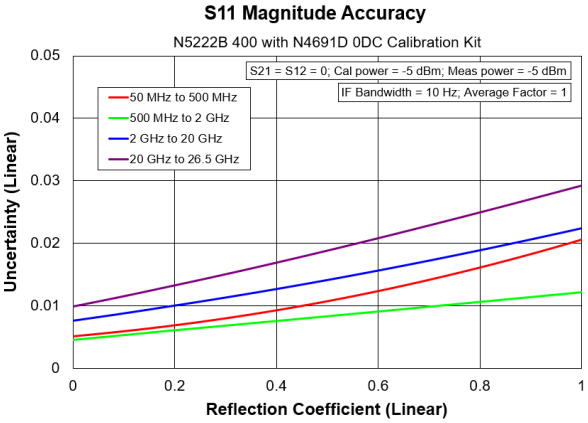
[1] With an LFE option installed and LFE disabled, applied to frequencies <= 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled.

Transmission Uncertainty, All Options





Reflection Uncertainty, All Options



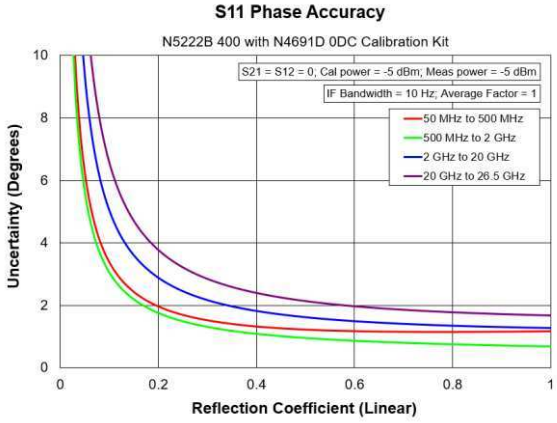


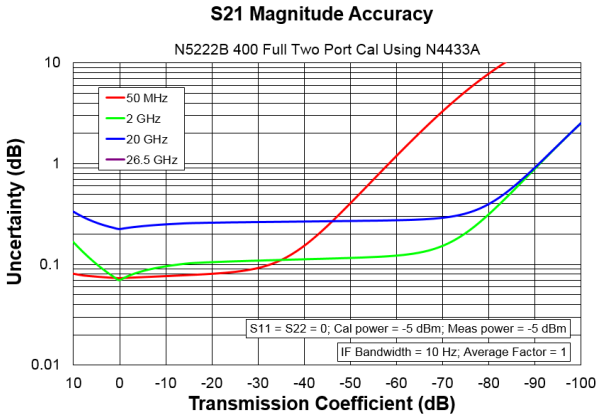
Table 4d. N5221B and N5222B with N4433A 4-Port Electronic Calibration Module

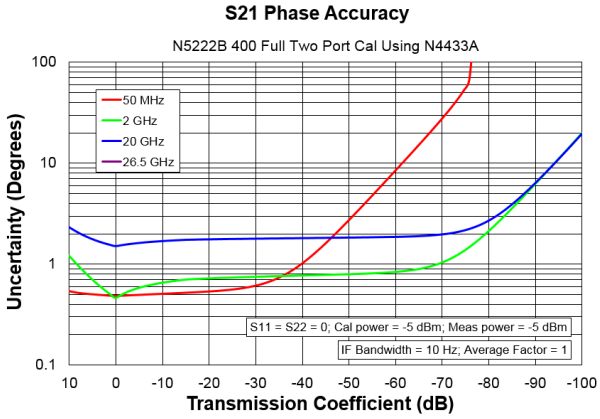
NOTE Uncertainty curves for the N4433A are created using a 2-port calibration. Multiport uncertainties are not supported at this time.

Description	Specification (dB)				
	10 MHz to 50 MHz[1]	50 MHz to 500 MHz[1]	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
Reflection Tracking					
Mag	±0.060	±0.060	±0.060	±0.100	±0.180
Phase (°)	±0.396	±0.396	±0.396	±0.660	±1.188
Transmission Tracking					
Mag	±0.068	±0.064	±0.064	±0.115	±0.210
Phase (°)	±0.447	±0.421	±0.421	±0.761	±1.387

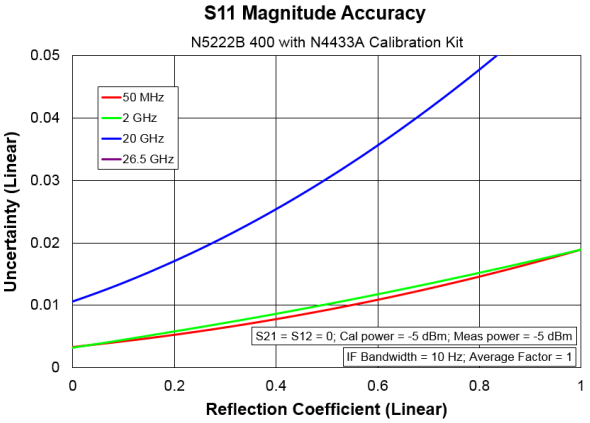
[1] With an LFE option installed and LFE disabled, applied to frequencies <= 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance <= 100 MHz, see Table 4d.

Transmission Uncertainty, All Options





Reflection Uncertainty, All Options



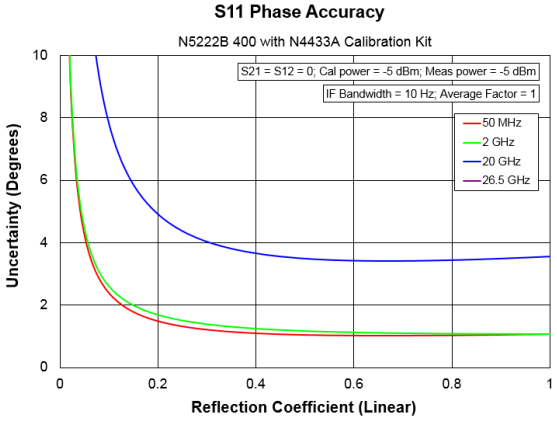
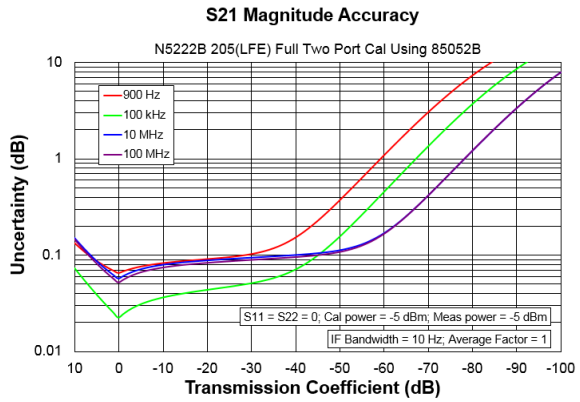


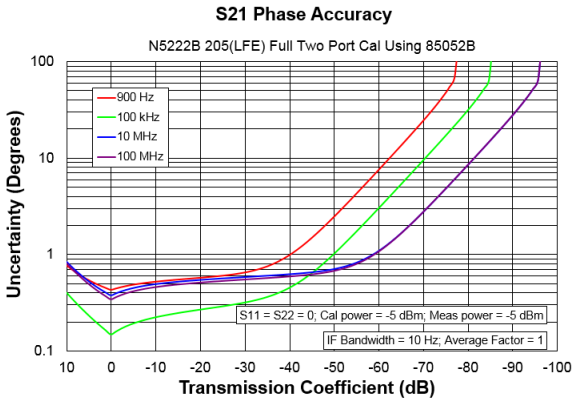
Table 4e. N5221B and N5222B with 85052B Calibration Kit, All LFE Options (LFE Enabled)

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
Reflection Tracking Mag	±0.003	±0.003	±0.003	±0.003	±0.003
Phase (°)	±0.020	±0.020	±0.020	±0.020	±0.020
Transmission Tracking Mag	±0.055	±0.016	±0.050	±0.045	±0.045
Phase (°)	±0.361	±0.105	±0.333	±0.296	±0.296

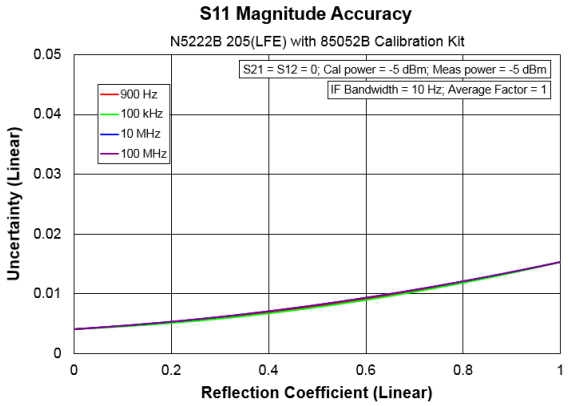
Transmission Uncertainty, All LFE Options

NOTE The plots are valid for all LFE options.





Reflection Uncertainty, All LFE Options



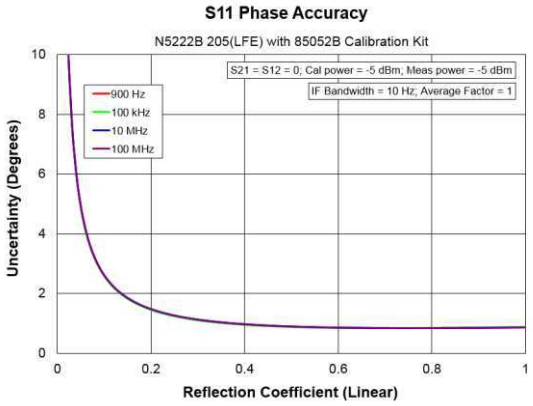
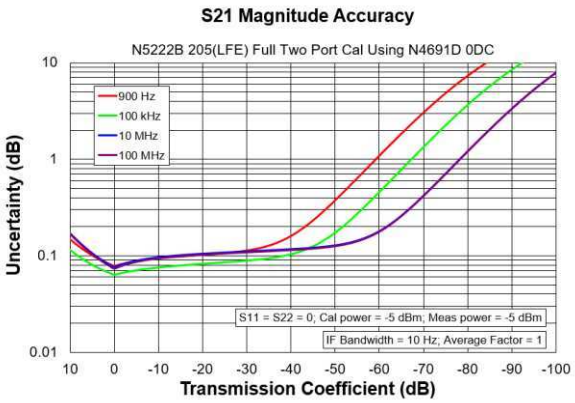


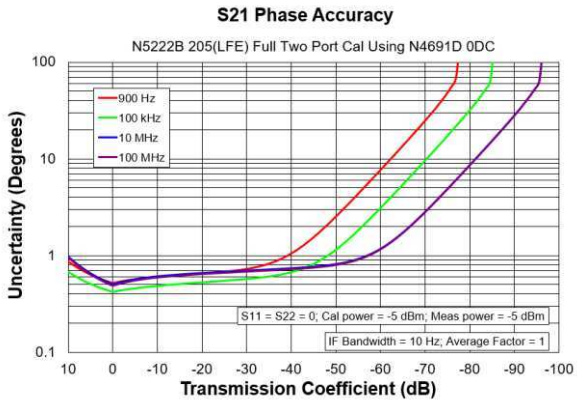
Table 4f. N5221B and N5222B with N4691D Calibration Kit, All LFE Options (LFE Enabled)

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
Reflection Tracking Mag	±0.051	±0.051	±0.051	±0.051	±0.051
Phase (°)	±0.34	±0.34	±0.34	±0.34	±0.34
Transmission Tracking Mag	±0.070	±0.055	±0.063	±0.068	±0.066
Phase (°)	±0.46	±0.37	±0.42	±0.45	±0.44

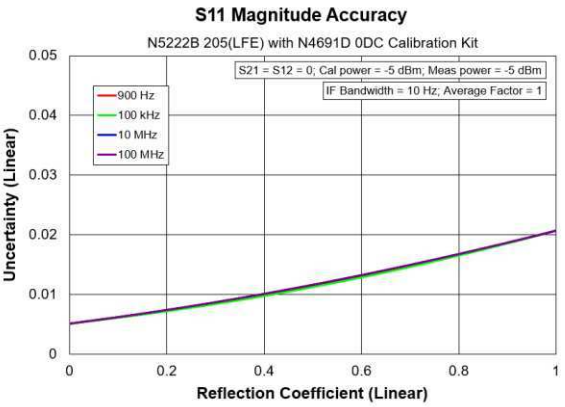
Transmission Uncertainty, All LFE Options

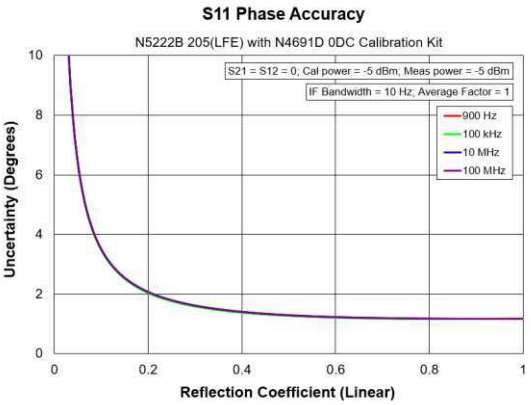
NOTE The plots are valid for all LFE options.





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 5a. Error Terms (dB), All Ports, All Options – Specifications

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

( ) With option 205, 405 installed.
[ ] With option 220, 420 installed.
[1] 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 5b.

Table 5b. 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 5c. Error Terms (dB), All Ports, All Options – Typical

Description	Directivity	Source Match	Load Match	Transmission Tracking	Reflection Tracking	Crosstalk
10 MHz to 50 MHz[1]	23 (23)	17 (10)	16 (10)	±1.5	±1.5	-84
50 MHz to 100 MHz[1]	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.

[1] 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 5d.

Table 5d. 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 Block diagrams for all models and options.

Table 6. 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)[1]	900 Hz to 13.5 GHz	500 Hz to 900 Hz
N5222B Frequency Range (LFE Options)[1]	900 Hz to 26.5 GHz	500 Hz to 900 Hz
Frequency Resolution	1 Hz	--
Frequency Accuracy	±1 ppm	--
Frequency Stability	--	±0.05 ppm, -10° to 70° C[2] ±0.1 ppm/yr maximum[3]

[1] Extended frequency down to 500 Hz.
[2] Assumes no variation in time.
[3] Assumes no variation in temperature.

Table 7a. Maximum Leveled Power (dBm) - Specification

Description	Option 200, 400, 201, 401		Option 217, 417, 219, 419	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 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 7b. Maximum Leveled Power (dBm) – Typical

Description	Option 200, 400, 201, 401		Option 217, 417, 219, 419	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 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 7c. Maximum Leveled Power (dBm) – Option 205, 405

Description	Specification		Typical	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 2	Port 2, Port 4
10 MHz to 50 MHz[1]	5	5	13	10
50 MHz to 500 MHz[1]	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

[1] With Option 205, 405 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 7e.

Table 7d. Maximum Leveled Power (dBm) – Option 220, 420

Description	Specification		Typical	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 4
10 MHz to 50 MHz[1]	5	5	13	10
50 MHz to 500 MHz[1]	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

[1] With Option 220, 420 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 7e.

Table 7e. Maximum Power (dBm), All Ports – All LFE Options (LFE Enabled)

Description	Specification	Typical[1]
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

[1] Values apply to all ports. Ports 2 and 4 typically 1 dB higher.

Table 8a. Power Level Accuracy (dB) at Nominal Power[1], All Options

Description	Specification	Typical
10 MHz to 50 MHz[2]	±1.5	±0.5
50 MHz to 500 MHz[2]	±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

[1] Level accuracy at power other than nominal power, Power Level Accuracy (dB) at Nominal Power + Power Level Linearity (dB).

[2] 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 8b.

Table 8b. Power Level Accuracy (dB), All Ports, All LFE Options (LFE Enabled)

Description	Specification	Typical
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 9a. Power Level Linearity[1] (dB), All Options - Specification

Description	Port 1 or 3[2] -25dBm ≤ P<-20dBm	Port 1 or 3[2] -20dBm ≤ P<-15dBm	Port 1 or 3[2] P ≥-15dBm
10 MHz to 50 MHz[3]	±2.0	±1.5	±1.5
50 MHz to 26.5 GHz[3]	±1.5	±1.5	±1.5

[1] Referenced to nominal power.
[2] Either port can be used as the source port.
[3] 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 9c.

Table 9b. Power Level Linearity[1] (dB), All Options - Specification

Description	Port 2 or 4[2] -25dBm ≤ P<-20dBm	Port 2 or 4[2] -20dBm ≤ P<-15dBm	Port 2 or 4[2] P ≥-15dBm
10 MHz to 50 MHz[3]	±2.5	±1.5	±1.5
50 MHz to 500 MHz[3]	±2.0	±1.5	±1.5
500 MHz to 26.5 GHz	±1.5	±1.5	±1.5

[1] Referenced to nominal power.
[2] Either port can be used as the source port.
[3] 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 9c.

Table 9c. Power Level Linearity[1] (dB), All Ports, All LFE Options (LFE Enabled)

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

[1] Referenced to nominal power, from -25 dBm to max power.

Table 10a. Power Sweep Range (dB) - Specification

Description	Option 200, 400, 201, 401		Option 217, 417, 219, 419	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 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 10b. Power Sweep Range (dB), All Options - Typical

Description	Option 200, 400, 201, 401		Option 217, 417, 219, 419	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 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 10c. Power Sweep Range (dB) – Option 205, 405

Description	Specification		Typical	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 4
10 MHz to 50 MHz[1]	30	30	40	37
50 MHz to 500 MHz[1]	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

[1] With Option 205, 405 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 10e.

Table 10d. Power Sweep Range (dB) – Option 220, 420

Description	Specification		Typical	
	Port 1, Port 3	Port 2, Port 4	Port 1, Port 3	Port 2, Port 4
10 MHz to 50 MHz[1]	30	30	38	35
50 MHz to 500 MHz[1]	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

[1] With Option 220, 420 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 10e.

Table 10e. Power Sweep Range (dB) – All LFE Options (LFE Enabled)

Description	Specification	Typical
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 11. Nominal (Preset) Power (dBm)

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

Table 12. Power Resolution and Maximum/Minimum Settable Power, All Options

Description	Specification (dB)	Typical (dBm)
PowerResolution	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 13a. 2nd and 3rd Harmonics at Max Specified Power (dBc) All Options – Typical

Listed frequency is harmonic frequency; test at max specified power

Description	N5221B	N5222B
20 MHz to 4 GHz[1]	-15	-15
4 GHz to 13.5 GHz	-19	-19
13.5 GHz to 24 GHz	--	-19
24 GHz to 26.5 GHz	--	-21

[1] 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 13b.

Table 13b. 2nd and 3rd 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	N5222B (2nd Harmonic)	N5222B (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 14. Non-Harmonic Spurs at Nominal Power (dBc), All Options - Typical

Description	Based on 100kHz offset Frac-N
10 MHz to 500 MHz[1]	-50
500 MHz to 2 GHz	-42
2 GHz to 4 GHz	-45
4 GHz to 8 GHz	-39
8 GHz to 16 GHz	-33
16 GHz to 26.5 GHz	-27

[1] Non-harmonic spurs are negligible with an LFE option installed and LFE enabled.

Table 15a. Phase Noise (dBc/Hz), All Options - Typical

Description	1 kHz Offset	10 kHz Offset	100 kHz Offset	1 MHz Offset
10 MHz to 500 MHz[1]	-100	-95	-95	-120
500 MHz to 1 GHz	-107	-117	-112	-127
1 GHz to 2 GHz	-101	-111	-106	-121
2 GHz to 4 GHz	-95	-105	-100	-115
4 GHz to 8 GHz	-89	-99	-94	-109
8 GHz to 16 GHz	-83	-93	-88	-103
16 GHz to 26.5 GHz	-77	-87	-82	-97

[1] 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 15b.

Table 15b. Phase Noise (dBc/Hz) All Ports, All LFE Options (LFE Enabled) - Typical

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

Test Port Input

Table 16a. 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[1]	-82	-82	-88	-88
50 MHz to 100 MHz[1]	-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

[1] 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 16b.

Table 16b. Test Port 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	-102	-106

Table 17. 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 18a. 0.1 dB Compression, Option 201, 217, 219, 220, 401, 417, 419, and All LFE Options – Typical

Description	N5221B Test Port Power (dBm)	N5222B Test Port Power (dBm)
10 MHz to 100 MHz[1]	15	15
100 MHz to 13.5 GHz	12	12
13.5 GHz to 20 GHz	--	12
20 GHz to 26.5 GHz	--	10

[1] 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 18b.

Table 18b. 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 18c. Compression - Specification

Description	Test Port Power (dBm)	Receiver Compression	
	Option 200, 400	Magnitude (dB)	Phase (degrees)
10 MHz to 500 MHz[1]	--	--	--
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

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

Table 18d. 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[1]	--	--	--	--	--
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

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

Table 18e. 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 19a. Trace Noise[2] 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[1]	0.007	0.0036	0.053	0.103
100 MHz to 13.5 GHz[1]	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

[1] 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.
[2] Ratioed measurement, nominal power at test port.

Table 19b. Trace Noise[1] 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

[1] Ratioed measurement, nominal power at test port.

Table 20a. Trace Noise[2] Phase (deg rms), All Options

Description	Specification	Typical		
	1 kHz IFBW	1 kHz IFBW	100 kHz IFBW	600 kHz IFBW
10 MHz to 100 MHz[1]	0.051	0.0237	0.341	0.663
100 MHz to 13.5 GHz[1]	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

[1] 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 20b.
[2] Ratioed measurement, nominal power at test port.

Table 20b. Trace Noise[1] 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

[1] Ratioed measurement, nominal power at test port.

Table 21. Reference Level Magnitude, All Options - Specification

Description	Magnitude (dB)	Phase (degrees)
Range	±500	±500
Resolution	0.001	0.01

Table 22a. Stability, All Options – Typical

Description	Magnitude (dB/°C)	Phase (°/°C)
10 MHz to 50 MHz[1]	0.010	0.180
50 MHz to 500 MHz[1]	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

[1] 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 22b.

Table 22b. Stability[1], 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

[1] Stability is defined as a ratio measurement made at the test port.

Table 23. Damage Input Level

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

Dynamic Accuracy

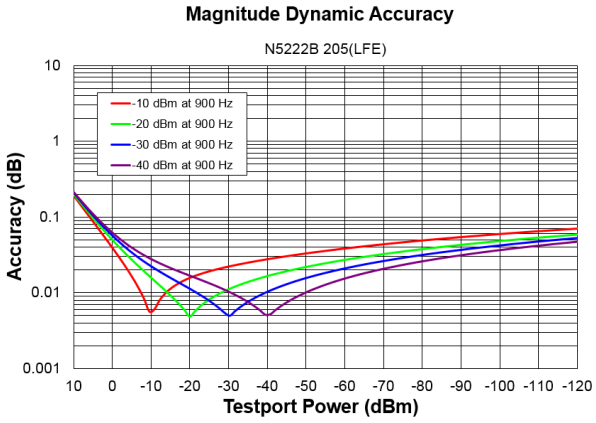
Dynamic accuracy is verified with the following measurements:

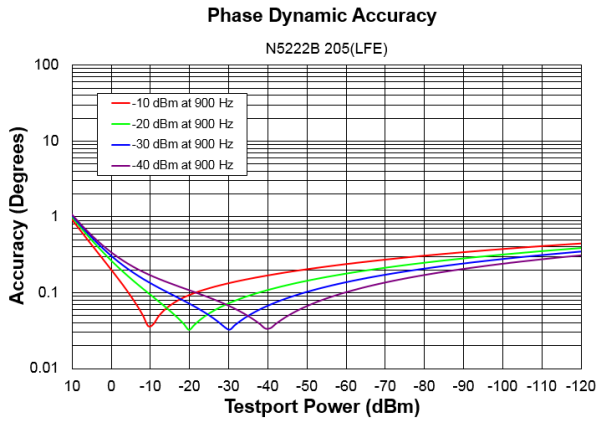
Compression over frequency

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

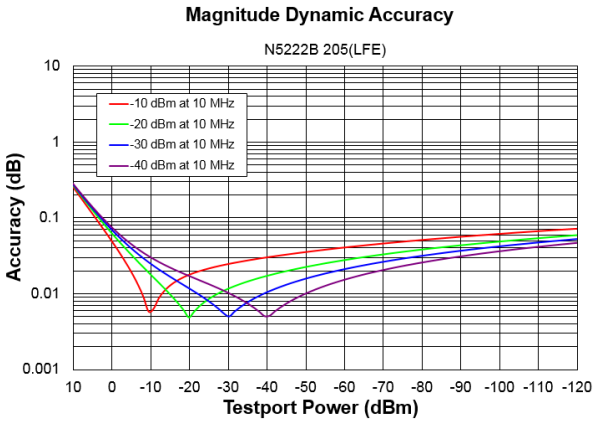
Table 24. N5221B and N5222B Dynamic Accuracy

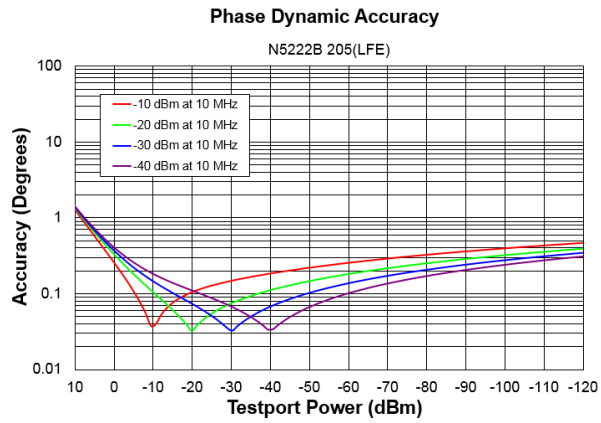
N5221B/22B Dynamic Accuracy, 900 Hz, All LFE Options (LFE Enabled) - Specification



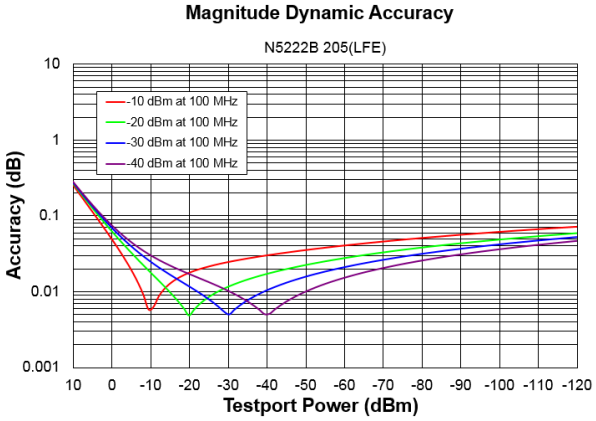


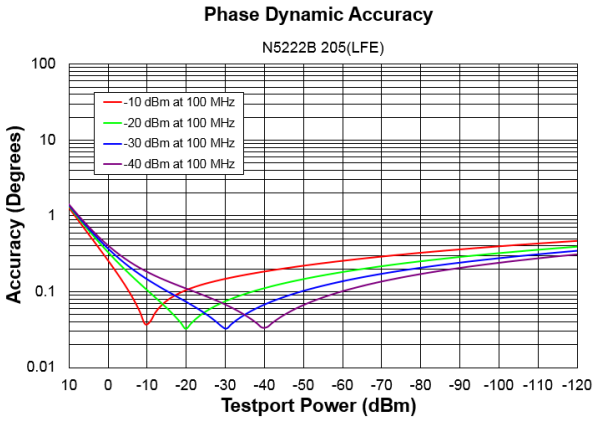
N5221B/22B Dynamic Accuracy, 10 MHz, All LFE Options (LFE Enabled) - Specification



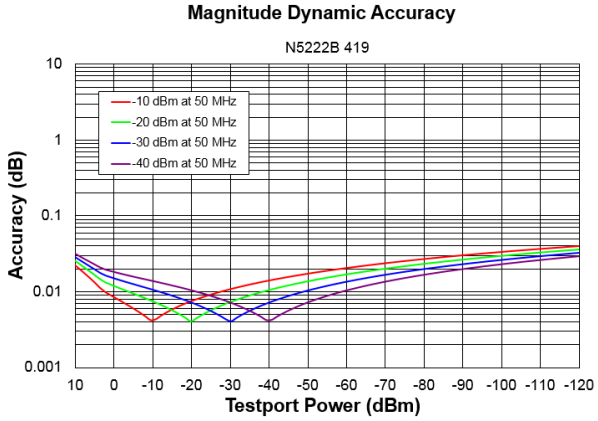


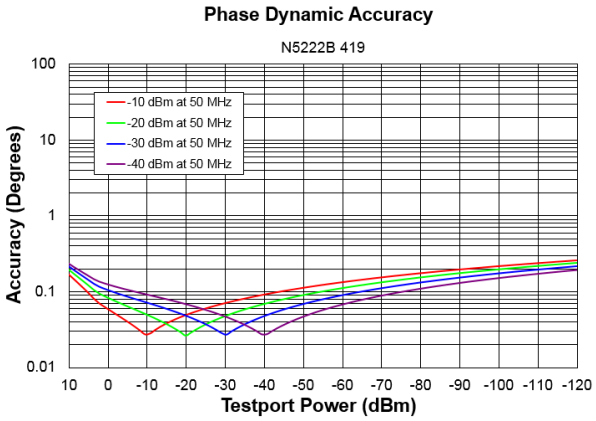
N5221B/22B Dynamic Accuracy, 100 MHz, All LFE Options (LFE Enabled) - Specification



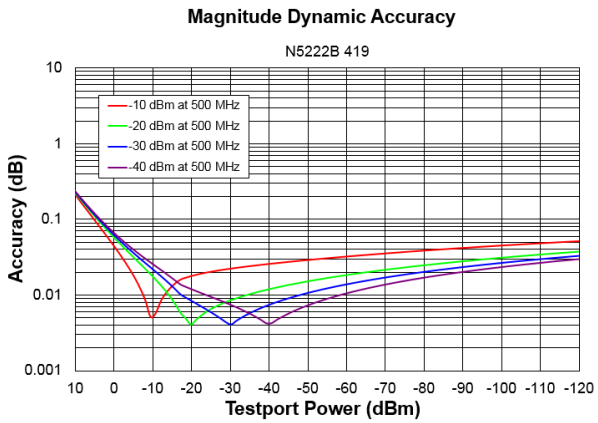


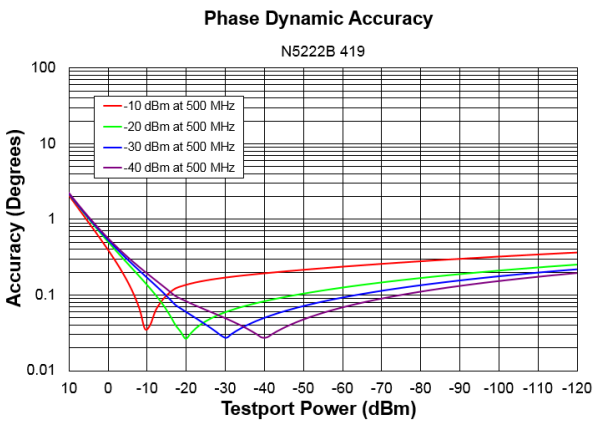
N5221B/22B Dynamic Accuracy, 10 MHz to 50 MHz - Specification



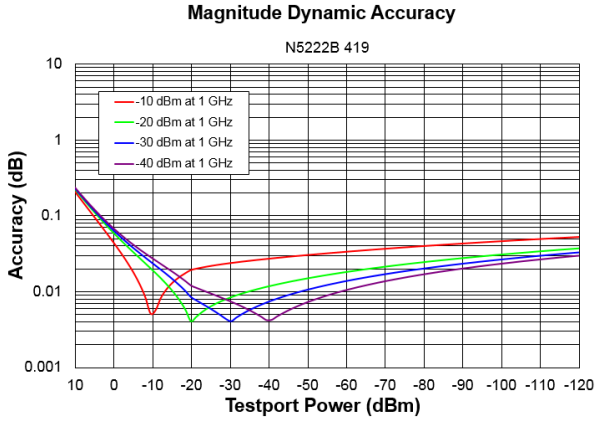


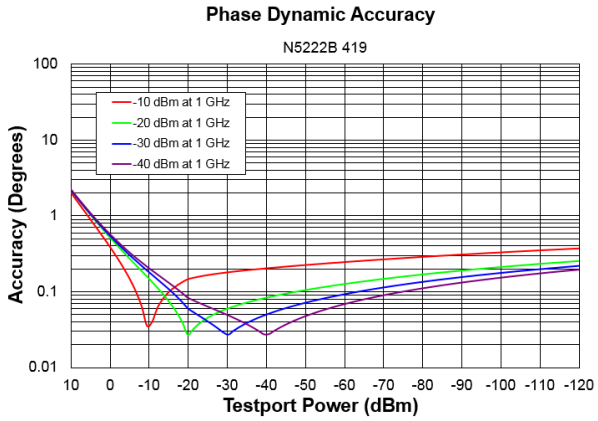
N5221B/22B Dynamic Accuracy, 50 MHz to 500 MHz - Specification



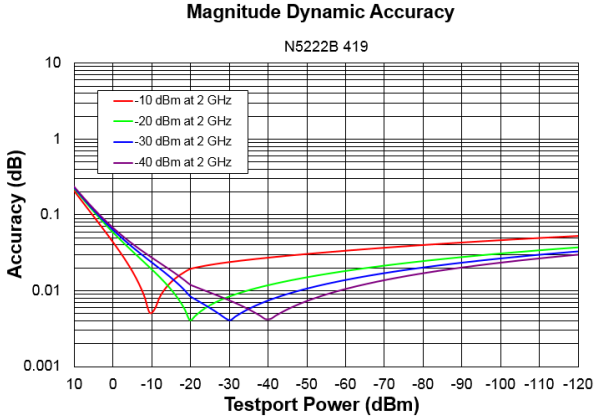


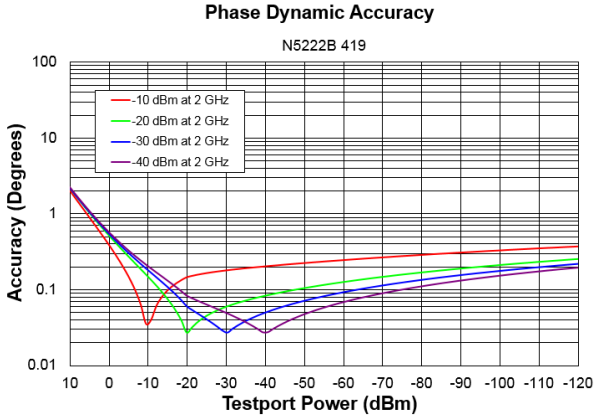
N5221B/22B Dynamic Accuracy, 500 MHz to 1 GHz - Specification



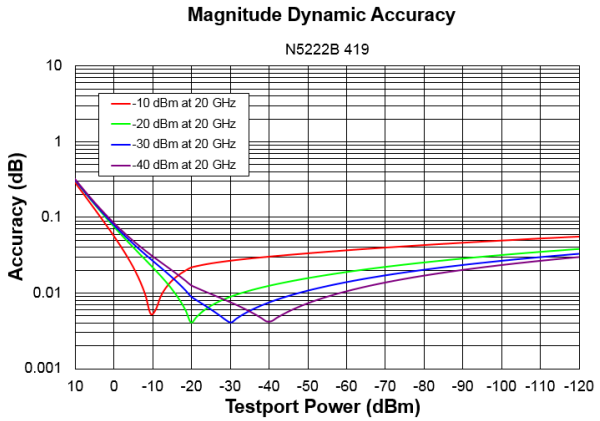


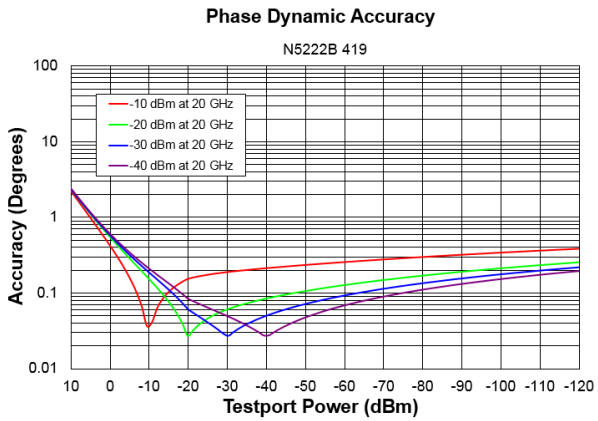
N5221B/22B Dynamic Accuracy, 1 GHz to 2 GHz - Specification



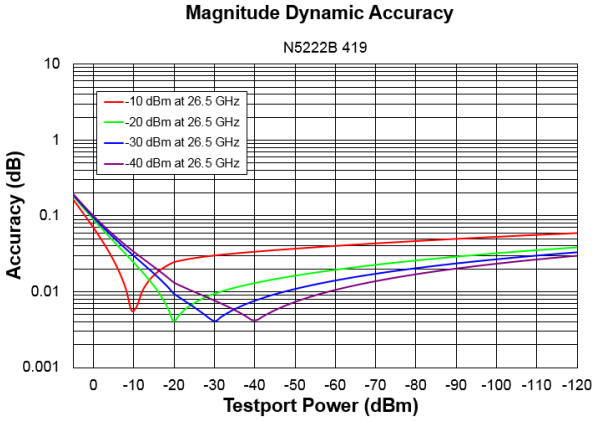


N5221B/22B Dynamic Accuracy, 2 GHz to 20 GHz - Specification





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



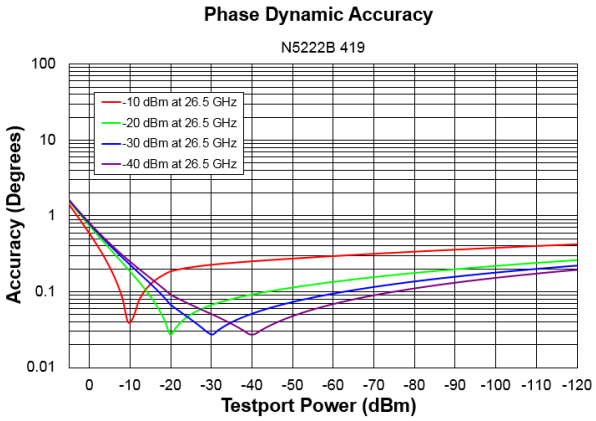


Table 25. Group Delay – Typical

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

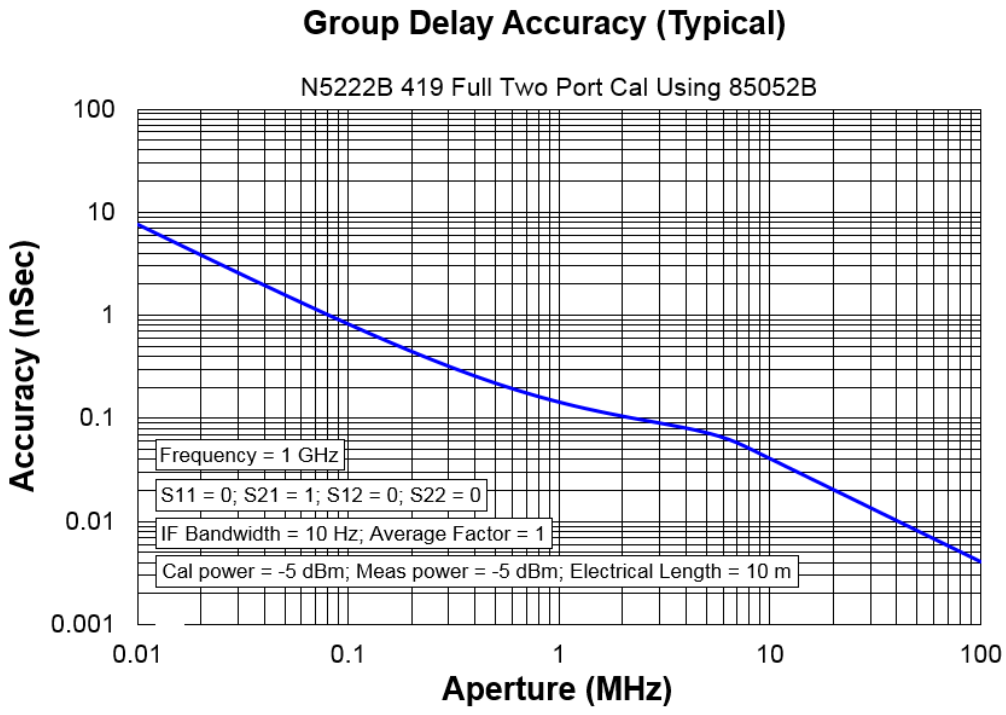
±Phase Accuracy (deg)/[360 × Aperture (Hz)]

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

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

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

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



General Information

- Miscellaneous Information
- Front Panel
- Rear Panel
- Environment and Dimensions

Table 26. 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: http://na.support.keysight.com/pna/hdnumbers.html
LXI	Class C

Table 27. Front Panel Information, All Options

Description	Typical Performance
RF Connectors	
Type	3.5 mm (male), 50 ohm, (nominal)
Center Pin Recession	0.002 in. (characteristic)
USB 2.0 Ports - Master (4 ports)	
Standard	Compatible with USB 2.0
Connector	USB Type-A female
Display	
Size	31 cm (12.1 in) diagonal color active matrix LCD; 1280 (horizontal) X 800 (vertical) resolution
Refresh Rate	Vertical 60 Hz; Horizontal 49.31 kHz
Pixels	Any of the following would cause a display to be considered faulty: • A complete row or column consists of “stuck” or “dark” pixels. • More than six “stuck on” pixels (but not more than three green) or more than 0.002% of the total pixels are within the LCD specifications. • More than twelve “dark” pixels (but no more than seven of the same color) or more than 0.004% of the total pixels are within the LCD specifications. • Two or more consecutive "stuck on" pixels or three or more consecutive "dark" pixel (but no more than one set of two consecutive dark pixels). • “Stuck on” pixels or more than two “dark” pixels less than 6.5 mm apart (excluding consecutive pixels).

Table 27. (Continued) Front Panel Information, All Options

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

Table 28. Rear Panel Information, All Options

Description	Typical Performance
10 MHz Reference In	
Connector	BNC, female
Input Frequency	10 MHz ± 10 ppm
Input Level	-15 dBm to +20 dBm
Input Impedance	200 Ω, nom.
10 MHz Reference Out	
Connector	BNC, female
Output Frequency	10 MHz ± 1 ppm
Signal Type	Sine Wave
Output Level	+10 dBm ± 4 dB into 50 Ω
Output Impedance	50 Ω, nominal
Harmonics	<-40 dBc, typical

Table 28. (Continued) Rear Panel Information, All Options

Description	Typical Performance
External IF Inputs	
Function	Allows use of external IF signals from remote mixers, bypassing the PNA's first converters
Connectors	SMA (female); A, B, C, D, R (4-port); A, B, R1, R2 (2-port)
Input Frequency	
Normal IF path	RF < 53 MHz: IF = 826.446 KHz RF >= 53 MHz: IF = 7.438 MHz
Narrowband IF path	IF = 10.70 MHz
Input Impedance	50 Ω
RF Damage Level	+23 dBm
DC Damage Level	5.5 VDC
0.1 dB Compression Point	
Normal IF path Narrowband IF path	-9.0 dBm at 7.438 MHz -17 dBm at 10.70 MHz
Pulse Inputs (IF Gates)	
Function	Internal receiver gates used for point-in-pulse and pulse-profile measurements
Connectors	15-pin mini D-sub
Input Impedance	1 K Ohm
Minimum Pulse Width, Source Modulators	33 ns
Minimum Pulse Width, Receiver Gates	20 ns
DC Damage Level	5.5 VDC
Drive Voltage	0 V (off), +3.3 V (on), nominal
RF Pulse Modulator Input (Source Modulator)	
On/Off Ratio	
10 MHz to 3.2 GHz	-64
3.2 GHz to 26.5 GHz	-80
Pulse Period	

Minimum	33 ns
Maximum	70 s

Table 28. (Continued) Rear Panel Information, All Options

Description	Typical Performance	
Pulse Outputs		
Voltage (TTL)	High: 3.3V to 3.5V Low: <1V	
Impedance	50 Ohm	
External Test Set Driver		
Function	Used for driving remote mixers	
Connections	3.5 mm (female)	
RF Output Frequency Range	3.2 GHz to 19 GHz	
LO Output Frequency Range	0.01 GHz to 26.5 GHz	
Rear Panel LO Power[1]		
	Upper Limit, Typical (dBm)	**Lower Limit, Typical (dBm)**
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
Devices Supported	**Resolutions**	
Flat Panel (TFT)	1024 X 768, 800 X 600, 640 X 480	
Flat Panel (DSTN)	800 X 600, 640 X 480	
CRT Monitor	1280 X 1024, 1024 X 768, 800 X 600, 640 X 480	
Simultaneous operation of the internal and external displays is allowed, but with 640 X 480 resolution only. If you change resolution, you can only view the external display (internal display will "white out").		

[1] LO output available in full analyzer's frequency range. The power is tested only from 3.2 GHz to 26.5 GHz.

Table 28. (Continued) Rear Panel Information, All Options

Description	Typical Performance
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
Trigger Inputs/Outputs	BNC(f), TTL/CMOS compatible
Test Set IO	25-pin D-Sub connector, available for external test set control
Power IO	9-pin D-Sub, female; analog and digital IO
Handler IO	36-pin parallel I/O port; all input/output signals are default set to negative logic; can be reset to positive logic via GPIB command
Pulse I/O	15-pin D connector provides access to Pulse Modulators and Generators
GPIB	Two ports - dedicated controller and dedicated talker/listener. 24-pin D-sub (Type D-24), female; compatible with IEEE-488
PCIe	Cabled PCIe x4 connector is a 4-lane slot (not currently used)
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.
LAN	10/100/1000 BaseT Ethernet, 8-pin configuration; auto selects between the data rates
VGA Video Output	15-pin mini D-Sub; Drives VGA compatible monitors
Mini DisplayPort	Miniature DisplayPort connector for connection to external displays
Line Power	
Frequency, Voltage	50/60/400 Hz for 100 to 120 VAC 50/60 Hz for 220 to 240 VAC
	Power supply is auto switching
Max	450 watts

Table 29. Analyzer Dimensions and Weight

All models are shipped with handles.

Cabinet Dimensions	Metric (mm)	Imperial (inches)
Height		
Without bottom feet: [1] EIA RU = 6	266.1	10.5
With bottom feet	279.1	11.0
Width		
Without handles or rack-mount flanges	425.6	16.8
With handles, without rack-mount flanges	458.7	18.1
With handles and rack-mount flanges	482.9	19.0
Depth		
Without front and rear panel hardware	533.0	21.0
With front and rear panel hardware, handles	578.0	22.7

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

See detailed PNA dimension drawings at: http://na.support.keysight.com/pna/PNADimensions.pdf

Weight (nominal)	Net	Shipping
All 2-port models	27 kg (60 lb)	43 kg (95 lb)
All 4-port models	36.7 kg (81 lb)	51 kg (112 lb)

Regulatory and Environmental Information

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

Measurement Throughput Summary

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

Cycle time Includes sweep time, retrace time, and band-crossing time. Analyzer display turned off with DISPLAY:ENABLE OFF. Add 21 ms for display on. Data for one trace (S_{11}) measurement. LF Auto BW off.

Table 30a. Typical Cycle Time (ms) for Measurement Completion, All Models / Options

Sweep Range	IF Bandwidth		Number of Points				
			201	401	1601	16001	32001
50 kHz to 100 MHz	10kHz	Uncorrected	75	141	515	4726	9243
		2-Port cal	155	285	1050	9505	18440
	1kHz	Uncorrected	306	599	2339	23000	46003
		2-Port cal	611	1200	4715	46185	91960
	100Hz	Uncorrected	2543	5085	20293	202691	405085
		2-Port cal	5120	10200	40640	405200	809800
9 GHz to 10 GHz	600 kHz	Uncorrected	3.10	3.4	8.2	56.8	111.10
		2-Port cal	6	6.6	16.1	114.2	224.7
	10 kHz	Uncorrected	30	51.6	200.70	1992	3980
		2-Port cal	59.6	103.7	417	4031	8047
	1 kHz	Uncorrected	227	445	1742	17031	33844
		2-Port cal	462	900	3500	34102	67734
10 GHz to 20 GHz	600 kHz	Uncorrected	16.9	17.8	22.2	67.7	116.7
		2-Port cal	33.8	35.3	44	134.5	229
	10 kHz	Uncorrected	64.8	127	322.6	2009	4009
		2-Port cal	129.18	263	645	4030	8055
	1 kHz	Uncorrected	234	458	1781	17383	34531
		2-Port cal	477	922	3578	34789	69109

Table 30b. N5221B Typical Cycle Time (ms) for Full-Span Measurement Completion

10 MHz to 13.5 GHz		Number of Points				
IF Bandwidth		201	401	1601	16001	32001
600 kHz	Uncorrected	33	40.5	61.3	116.1	163.5
	2-Port cal	63.5	78	115.3	266.1	358.8
10 kHz	Uncorrected	72.1	130.7	453.7	2168	4140
	2-Port cal	141.64	258.2	903.6	4334	8252
1 kHz	Uncorrected	237.1	459	1777	17243	34242
	2-Port cal	472	917	3551	34487	68500

Table 30c. N5222B Typical Cycle Time (ms) for Full-Span Measurement Completion

10 MHz to 26.5 GHz		Number of Points				
IF Bandwidth		201	401	1601	16001	32001
600 kHz	Uncorrected	43.7	51.8	72.2	140.4	188.7
	2-Port cal	85.3	101.1	140.2	317.3	411.9
10 kHz	Uncorrected	76.3	137.1	480	2184	4125
	2-Port cal	150.6	271.5	964	4378	8297
1 kHz	Uncorrected	245	472	1809	17508	34773
	2-Port cal	498	950	3622	35047	69609

Table 31. 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	2.2	0.0045
100,000	3.4	0.0018
30,000	7	0.0011
10,000	26.7	0.0006
3,000	69.1	0.0004
1,000	219	0.0003
300	637	0.0002
100	1820	0.0002
30	5975	0.0002
10	17828	0.0002
3	59266	0.0002

Table 32. Cycle Time vs. Number of Points – Typical

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

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

Cycle time includes sweep and retrace time.

Description	IF Bandwidth (Hz)			
Number of Points	1,000	10,000	30,000	600,000
3	4.8	2.2	1.9	1.7
11	13.7	4.5	2.8	1.6
51	57.3	8	2.8	1.8
101	111.3	14.2	4.2	1.9
201	219	26.7	6.9	2.3
401	432	51.6	11.9	3
801	854	101	22	4.4
1,601	1694	201	42.1	7
6,401	6683	797	163	23.4
16,001	16556	1991	403	54.7
32,001	32883	3978	805	109

Table 33. Data Transfer Time (ms) – Typical

Measured with the analyzer display off.

Values will increase slightly if the analyzer display is on.

Description	Number of Points				
	201	401	1601	16,001	32,001
SCPI over GPIB (Program executed on external PC[2])					
32-bit floating point	4.6	9.3	38	352	720
64-bit floating point	9.4	18.8	73.4	730	1455
ASCII	36.7	72.5	288	2882	5762
SCPI over SICL/LAN or TCP/IP Socket[1] (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[1] (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[1] (Program executed on external PC)					
32-bit floating point	<1	<1	<1	2.3	4.4
Variant type	<1	1.6	5.3	52	105.5

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

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

Specifications: Front-Panel Jumpers

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

- Measurement Receiver Inputs
- Reference Receiver Inputs and Reference Source Outputs
- Source Outputs
- Coupler Inputs
- Damage Level

Table 34. 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 35. 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 36. 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, RCVR R4 IN, REF 2 SOURCE OUT, REF 4 SOURCE OUT	RCVR R3 IN, REF 3 SOURCE OUT	RCVR R2 IN, RCVR R4 IN, REF 2 SOURCE OUT, REF 4 SOURCE OUT	RCVR R3 IN, 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 37. 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, PORT 3 SOURCE OUT	PORT 2 SOURCE OUT, PORT 4 SOURCE OUT	PORT 1 SOURCE OUT, PORT 3 SOURCE OUT	PORT 2 SOURCE OUT, 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 38. 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	Option 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 39. 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[1])	40 (50[1]) (7[2])
PORT 1, 2, 3, 4 CPLR ARM	30	7

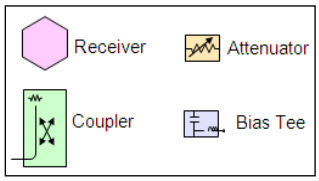
[1] With an LFE option installed.

[2] With a thru connection between test ports of option 217 or 417 configuration, 7 VDC input to CPLR THRU ports damages the source attenuator on the connected port.

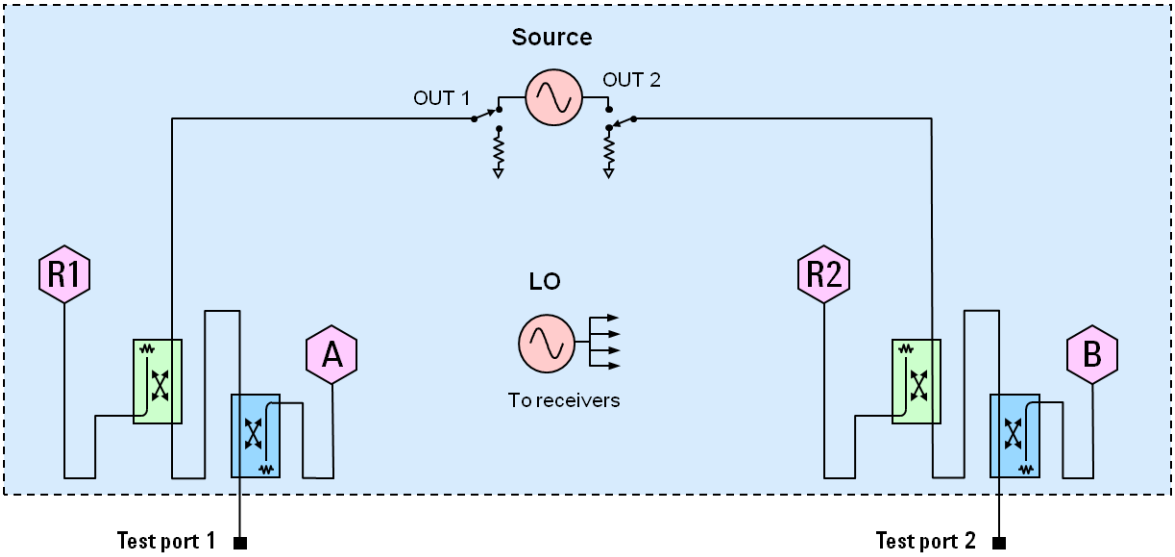
Test Set Block Diagrams

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

Legend

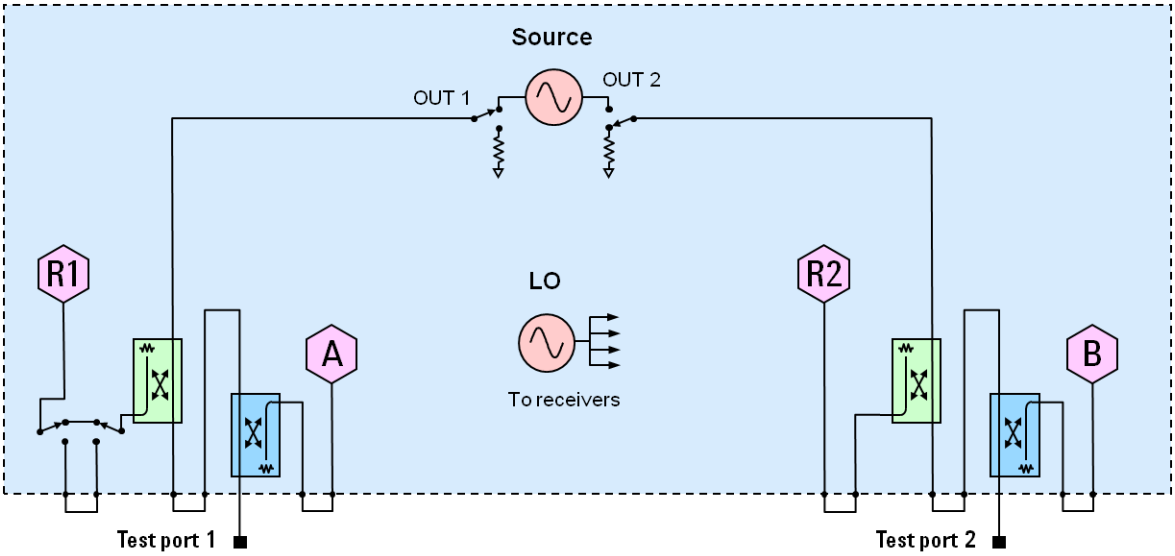


N5221B and N5222B Option 200 (2-port base model)



N5221B and N5222B Option 201

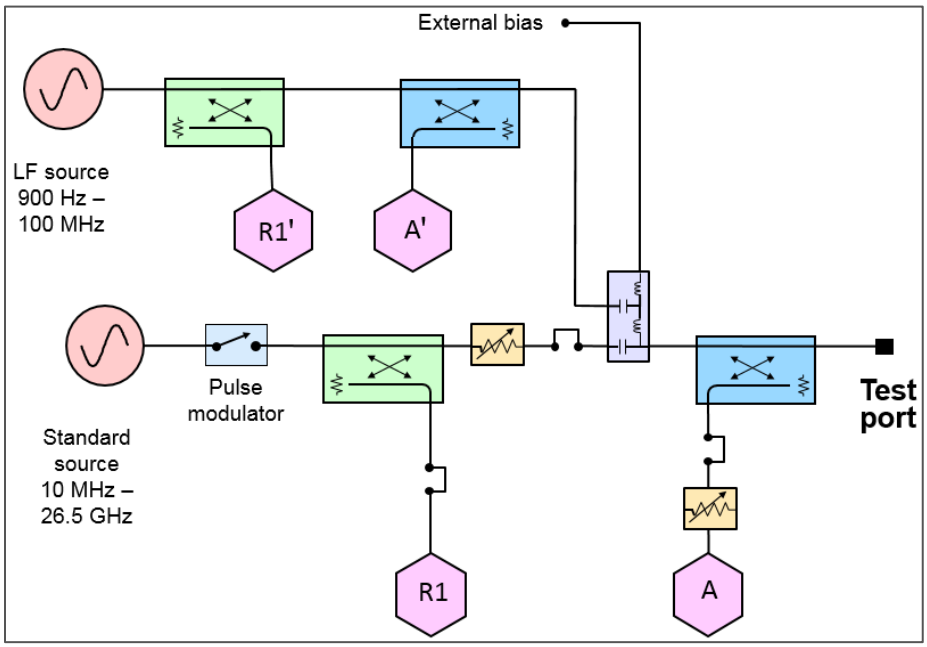
To base model, adds front-panel jumpers and R1 receiver switch



N5221B and N5222B LFE Options

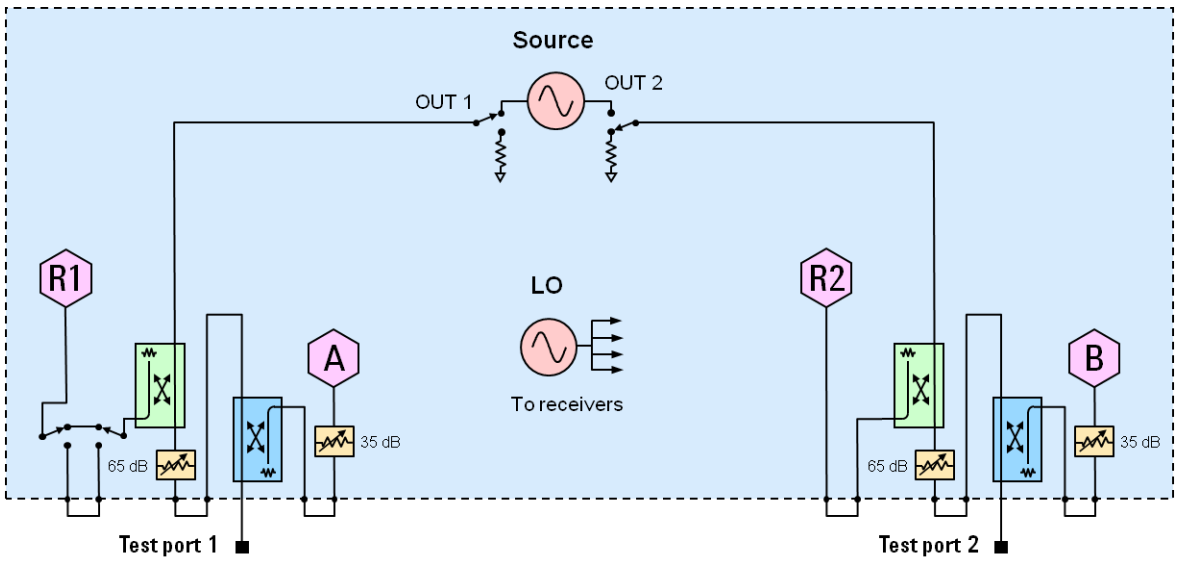
The following LFE block diagram shows how the low-frequency hardware is configured for a single test port. The other ports are configured similarly.

NOTE The attenuators do not apply to Options 205 and 405.



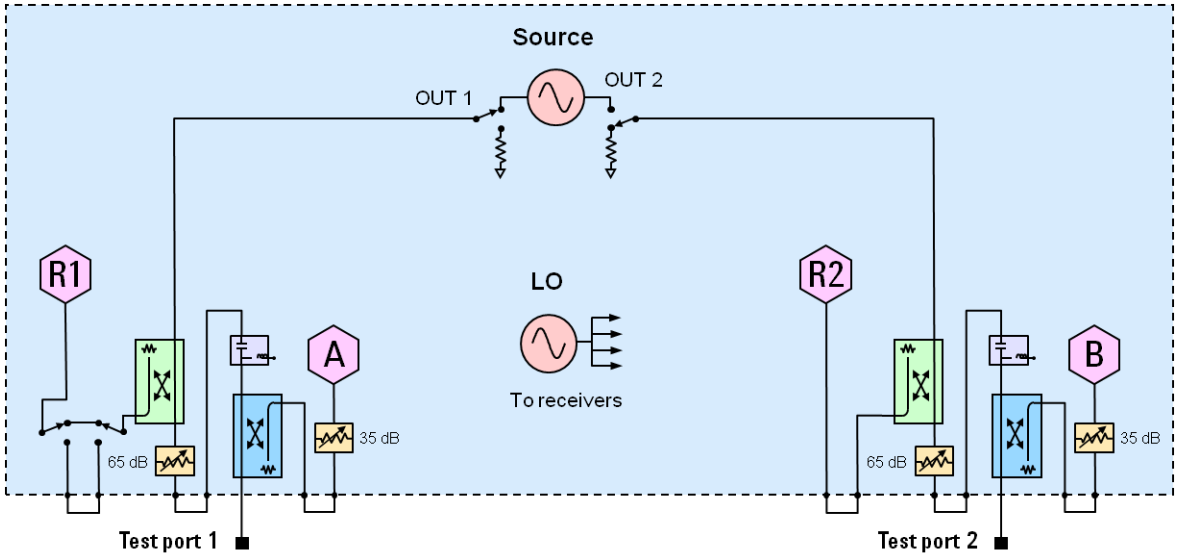
N5221B and N5222B Option 217

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

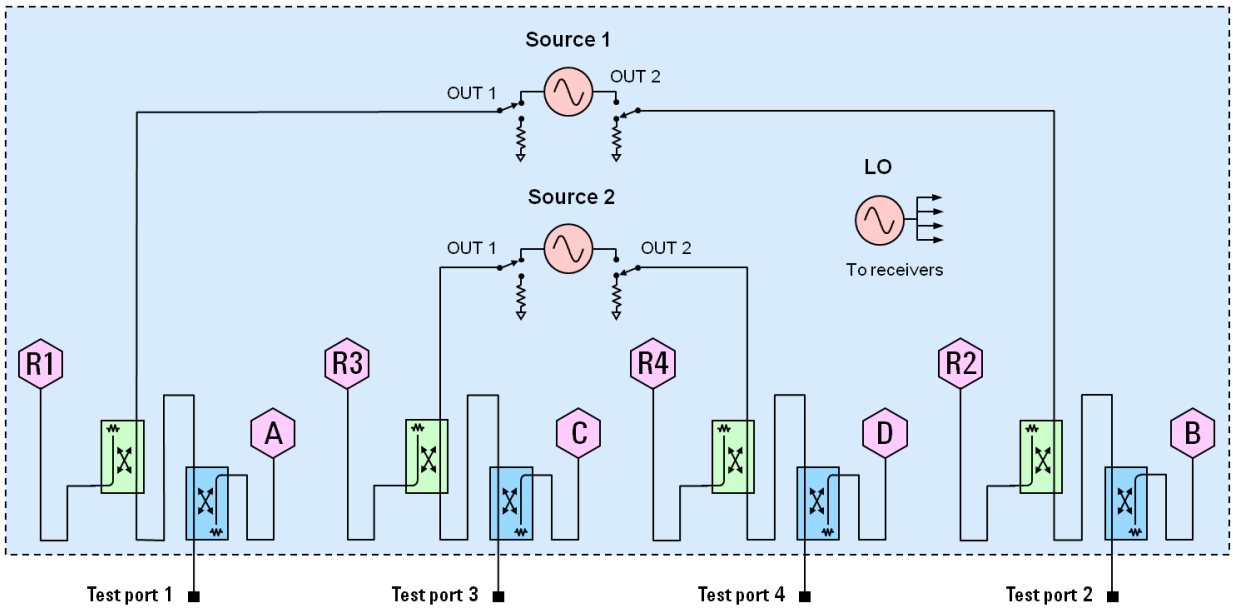


N5221B and N5222B Option 219

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

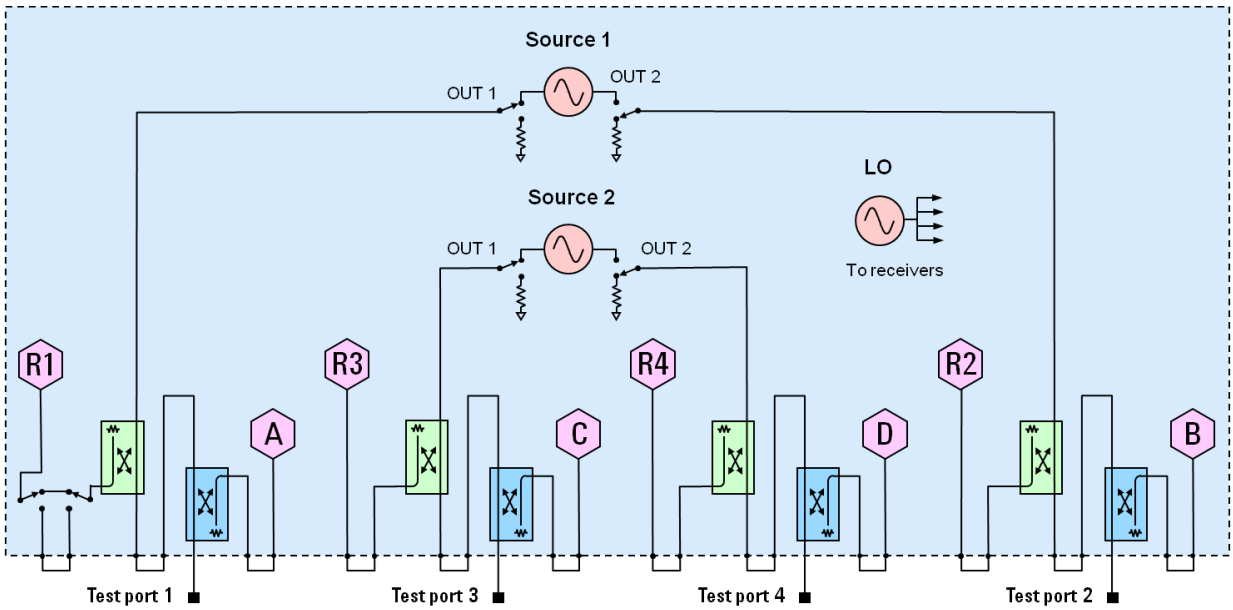


N5221B and N5222B Option 400 (4-port base model)



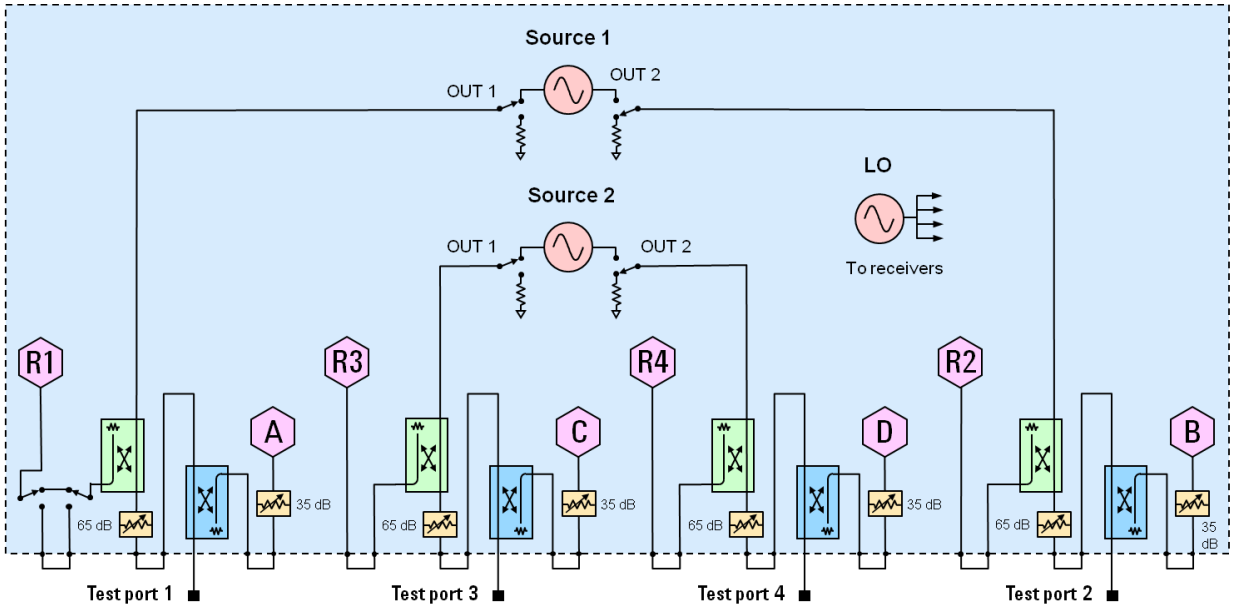
N5221B and N5222B Option 401

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



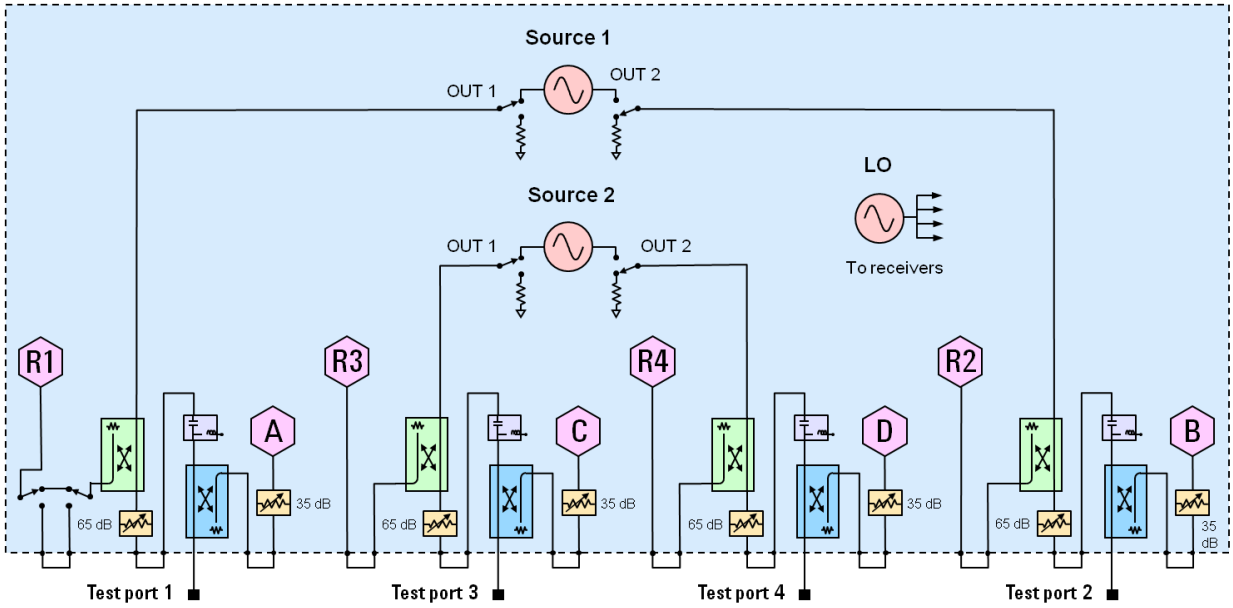
N5221B and N5222B Option 417

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

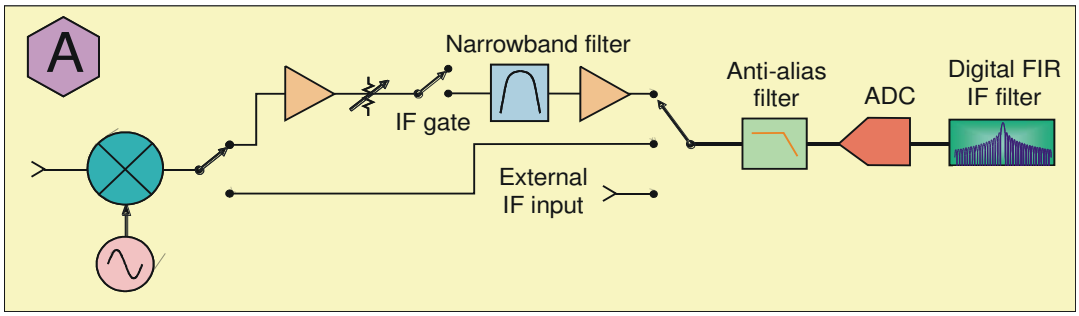


N5221B and N5222B Option 419

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



Receiver Block Diagram



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