Keysight 2-Port and 4-Port Broadband Network Analyzer

N5291A 500 Hz to 125 GHz

(for synthesizer revision 7)

KEYSIGHT

TECHNICAL SPECIFICATIONS

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N5291A System Options

This is a complete list of the technical specifications for the N5291A Broadband millimeter wave Network Analyzer with the following options (see block diagrams at the end of this document):

Option 201

- N5222B 2-port PNA with option 205 and 020
- N5292A Millimeter wave test set controller with options 200 and 222
- 2 N5295AX03 Frequency extenders

Option 202

- N5227B 2-port PNA with option 205 and 020
- N5292A Millimeter wave test set controller with options 200 and 224
- 2 N5295AX03 Frequency extenders

Option 401

- N5242B 4-port PNA-X with option 425 and 020
- N5292A Millimeter wave test set controller with options 400 and 442
- 4 N5295AX03 Frequency extenders

Option 402

- N5242B 4-port PNA-X with options 425, 029, and 020
- N5292A Millimeter wave test set with options 400 and 442
- 4 N5295AX03 Frequency extenders

Option 403

- N5247B 4-port PNA-X with options 425, 029, and 020
- N5292A Millimeter wave test set with options 400 and 444
- 4 N5295AX03 Frequency extenders

Instrument Options

Option 020, adds IF inputs on the rear panel.

Option 029, adds hardware and firmware for high-accuracy noise figure measurements.

Option 205, adds front-panel jumpers, R1 receiver switch, and Low Frequency Extension (LFE) hardware.

Option 425, adds source and receiver attenuators, internal second source, combiner, mechanical switches, low frequency extension (LFE) hardware, and dedicated 26.5 GHz noise receiver.

For Spectrum Analyzer option information, please refer to '*Keysight Spectrum Analyzer Option (090/S93090xA) for PNA/PNA-L/PNA-X/N5290A/N5291A*'.

This document is written for the N5291A with five options (configurations) as given in the previous page. Broadband network analyzers can also be configured with other PNA/-X models with other options and one of the frequency extenders as given in the section, “Configuring Broadband Using Separate System Components” in the N5290A/91A configuration guide, 5992-2179EN. The typical data in this document is valid for the N5291A and these configurations.

A full system calibration and compliance to technical specifications can only be obtained with the five options of the N5291A system. All other configurations will receive individual component functional certifications (typical specifications).

PNA/PNA-X	Description
N5295AX01	Frequency extender, 120 GHz, 1.2m cable, no bias tee
N5295AX02	Frequency extender, 120 GHz, 1.2m cable, pulsed bias tee
N5295AX03	Frequency extender, 120 GHz, 1.2m cable, LFE with bias tee
N5295AX51	Frequency extender, 120 GHz, 1.8m cable, no bias tee
N5295AX52	Frequency extender, 120 GHz, 1.8m cable, pulsed bias tee
N5295AX53	Frequency extender, 120 GHz, 1.8m cable, LFE with bias tee

Definitions

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

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

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

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

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

Supplemental performance data (SPD): 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.

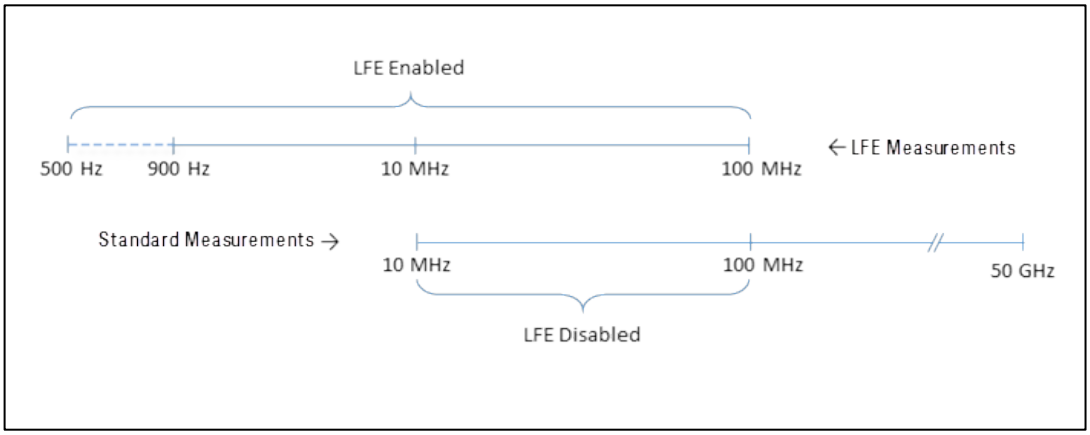
Calibration: The process of measuring known standards to characterize a network analyzer's systematic (repeatable) errors.

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 PNA/PNA-X option 205 or 425, 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.



Traceability: Power measurements are traceable to 110 GHz. Power measurements above 110 GHz are compared against a VDI calorimeter (VDI Model PM5) with partial measurement uncertainty. S-parameters are traceable to 120 GHz.

Notes

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.

Typical performance information between 500 Hz and 125 GHz is shown in this document where available.

All data presented is at the test port of the frequency extenders only.

NOTE LFE refers to the Option 205/425 Low Frequency Extension.

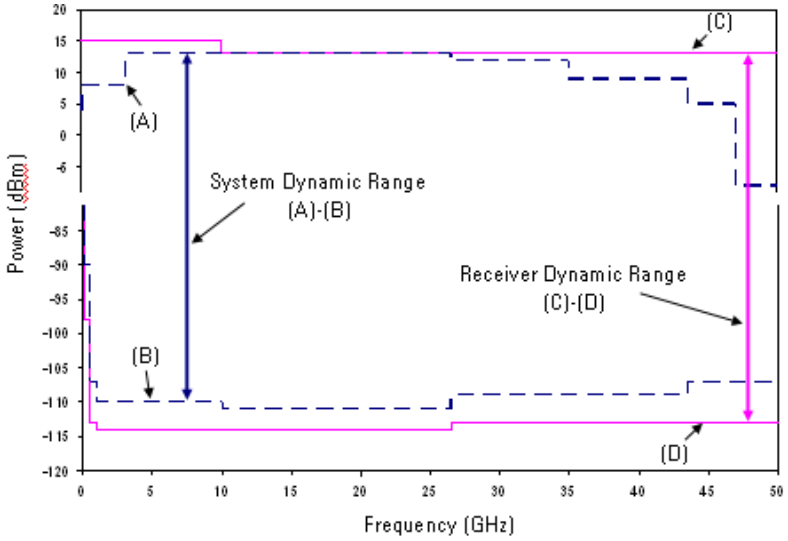
Dynamic Range

The specifications in this section apply for measurements made with the N5244B and N5245B analyzer with the following conditions:

- 10 Hz IF bandwidth
- No averaging applied to data
- Isolation calibration with an averaging factor of 8
- Source in filtered mode where applicable

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

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 1. N5291A System Dynamic Range (dB)

Description	Specification[2]		Typical	
	Ports 1, 3	Ports 2, 4	Ports 1, 3	Ports 2, 4
10 MHz to 50 MHz[1]	67	67	86	85
50 MHz to 100 MHz[1]	90	90	105	105
100 MHz to 500 MHz	99	99	117	117
500 MHz to 1 GHz	113	113	126	126
1 GHz to 2 GHz	121	121	131	131
2 GHz to 2.5 GHz	119	121	129	131
2.5 GHz to 3.2 GHz	119	121	128	131
3.2 GHz to 5 GHz	126	125	132	132
5 GHz to 8 GHz	123	124	131	130
8 GHz to 10 GHz	123	123	131	130
10 GHz to 12 GHz	122	123	130	129
12 GHz to 13.5 GHz	121	121	130	129
13.5 GHz to 15 GHz	121	121	130	129
15 GHz to 16 GHz	122	121	130	129
16 GHz to 18 GHz	119	118	128	128
18 GHz to 20 GHz	119	117	128	126
20 GHz to 24 GHz	118	115	128	125
24 GHz to 26.5 GHz	121	121	129	129
26.5 GHz to 30 GHz	114	114	121	121
30 GHz to 35 GHz	114	114	122	122
35 GHz to 40 GHz	112	112	120	120
40 GHz to 45 GHz	114	114	122	122
45 GHz to 50 GHz	114	114	122	122
50 GHz to 52 GHz[3]	114	113	122	121
52 GHz to 60 GHz	115	115	123	123
60 GHz to 64 GHz	114	114	122	122
64 GHz to 67 GHz	111	111	119	119
67 GHz to 70 GHz	111	111	119	119
70 GHz to 75 GHz	108	108	118	118
75 GHz to 80 GHz	108	108	114	114
80 GHz to 85 GHz	108	108	115	115
85 GHz to 90 GHz	108	108	115	115
90 GHz to 95 GHz	108	108	116	116
95 GHz to 100 GHz	106	106	116	116

Description	Specification[2]		Typical	
100 GHz to 105 GHz	104	104	113	113
105 GHz to 110 GHz	105	105	114	114
110 GHz to 115 GHz	98	98	114	114
115 GHz to 120 GHz	93	93	107	107
120 GHz to 125 GHz	--	--	103	103

[1] With PNA/PNA-X Option 205 or 425 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 2.
[2] Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.
[3] When the N5242B/22B unit is used, specification numbers are reduced by 2 dB and typical numbers are reduced by 4 dB.

Table 2. N5291A System Dynamic Range (dB), All Ports (LFE Enabled)

Description	Specification[1]		Typical	
	Ports 1, 3	Ports 2, 4	Ports 1, 3	Ports 2, 4
500 Hz to 900 Hz	--	--	97	97
900 Hz to 1 kHz	93	93	103	104
1 kHz to 10 kHz	96	96	104	105
10 kHz to 100 kHz	111	112	117	117
100 kHz to 1 MHz	115	117	121	122
1 MHz to 5 MHz	115	116	121	121
5 MHz to 10 MHz	105	106	112	112
10 MHz to 50 MHz	99	100	107	107
50 MHz to 100 MHz	99	100	106	107

[1] Specification applies to new instruments. Test limit during recertification is defined by Maximum Leveled Power - Noise Floor.

Receiver Dynamic Range

Table 3. N5291A Receiver Dynamic Range (dB)

Description	Typical
10 MHz to 50 MHz[1]	92
50 MHz to 100 MHz[1]	105
100 MHz to 500 MHz	117
500 MHz to 1 GHz	125
1 GHz to 2 GHz	128
2 GHz to 5 GHz	127
5 GHz to 20 GHz	128
20 GHz to 24 GHz	127
24 GHz to 26.5 GHz	128
26.5 GHz to 32 GHz	119
32 GHz to 40 GHz	119
40 GHz to 50 GHz	119
50 GHz to 60 GHz	121
60 GHz to 64 GHz	122
64 GHz to 67 GHz	120
67 GHz to 70 GHz	120
70 GHz to 75 GHz	119
75 GHz to 80 GHz	114
80 GHz to 90 GHz	114
90 GHz to 95 GHz	113
95 GHz to 100 GHz	112
100 GHz to 105 GHz	108
105 GHz to 110 GHz	109
110 GHz to 115 GHz	108
115 GHz to 120 GHz	103
120 GHz to 125 GHz	101

[1] With PNA/PNA-X Option 205 or 425 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 4.

Table 4. N5291A Receiver Dynamic Range (dB), All Ports (LFE Enabled)

Description	Typical
500 Hz to 900 Hz	101
900 Hz to 1 kHz	105
1 kHz to 10 kHz	106
10 kHz to 100 kHz	117
100 kHz to 1 MHz	121
1 MHz to 5 MHz	121
5 MHz to 10 MHz	114
10 MHz to 50 MHz	115
50 MHz to 100 MHz	115

Corrected System Performance

Applies to the N5291A Option 201, 202, 401, 402, or 403 systems using the 85059B calibration kit. Also applies to the following condition:

Specification are valid for temperatures of 23°±3°C and < 1° C deviation from the calibration temperature.

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

Please download our free Uncertainty Calculator from http://www.keysight.com/find/na_calculator for specifications for other calibration kits and measurement setups.

N5291A System (10 MHz to 120 GHz) (LFE Disabled)

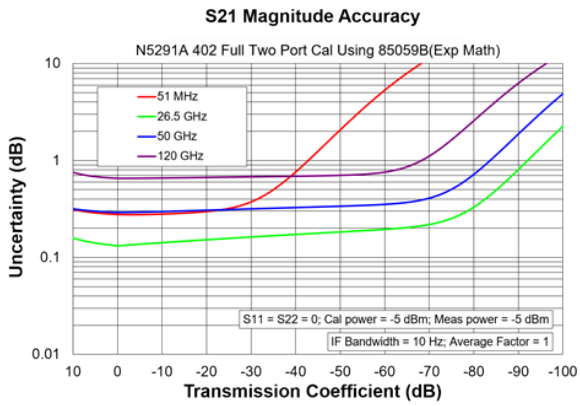
Table 5. Error Terms (dB), All Ports, All Options – Specifications

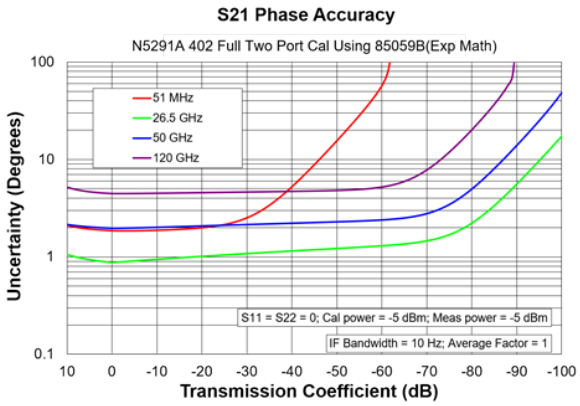
Description	Directivity	Source Match	Load Match	Transmission Tracking		Reflection Tracking	
				Mag	Phase (°)	Mag	Phase (°)
10 MHz to 50 MHz[1]	29	28	29	±0.260	±1.713	±0.020	±0.132
50 MHz to 200 MHz[1]	29	28	29	±0.236	±1.560	±0.020	±0.132
200 MHz to 500 MHz	29	28	29	±0.242	±1.595	±0.020	±0.132
500 MHz to 2 GHz	29	28	29	±0.248	±1.635	±0.020	±0.132
2 GHz to 3.2 GHz	29	28	29	±0.164	±1.081	±0.020	±0.132
3.2 GHz to 10 GHz	30	28	29	±0.182	±1.204	±0.055	±0.363
10 GHz to 13.5 GHz	31	31	30	±0.155	±1.023	±0.090	±0.594
13.5 GHz to 16 GHz	35	31	33	±0.101	±0.667	±0.090	±0.594
16 GHz to 20 GHz	36	35	34	±0.107	±0.708	±0.070	±0.462
20 GH to 24 GHz	37	36	36	±0.090	±0.595	±0.050	±0.330
24 GHz to 26.5 GHz	37	36	36	±0.097	±0.643	±0.050	±0.330
26.5 GHz to 40 GHz	35	33	33	±0.189	±1.245	±0.060	±0.396
40 GHz to 43.5 GHz	33	32	32	±0.222	±1.463	±0.070	±0.462
43.5 GHz to 50 GHz	32	31	31	±0.281	±1.857	±0.075	±0.495
50 GHz to 60 GHz	31	30	29	±0.343	±2.265	±0.115	±0.759
60 GHz to 64 GHz	31	30	29	±0.333	±2.201	±0.150	±0.990
64 GHz to 67 GHz	31	30	28	±0.355	±2.345	±0.150	±0.990
67 GHz to 75 GHz	28	27	26	±0.449	±2.961	±0.150	±0.990
75 GHz to 100 GHz	27	27	26	±0.483	±3.190	±0.120	±0.792

Description	Directivity	Source Match	Load Match	Transmission Tracking		Reflection Tracking	
100 GHz to 110 GHz	27	27	25	±0.560	±3.693	±0.130	±0.858
110 GHz to 120 GHz	27	27	25	±0.633	±4.177	±0.130	±0.858

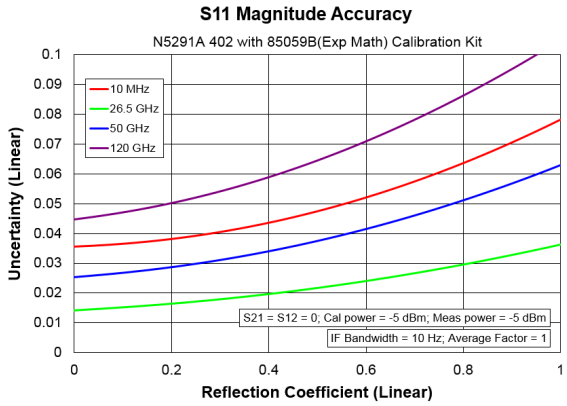
[1] With PNA/PNA-X Option 205 or 425 installed and LFE disabled, applied to frequencies ≤ 100 MHz. Above 100 MHz, performance is the same for both LFE enabled or disabled. For LFE enabled performance ≤ 100 MHz, see Table 6.

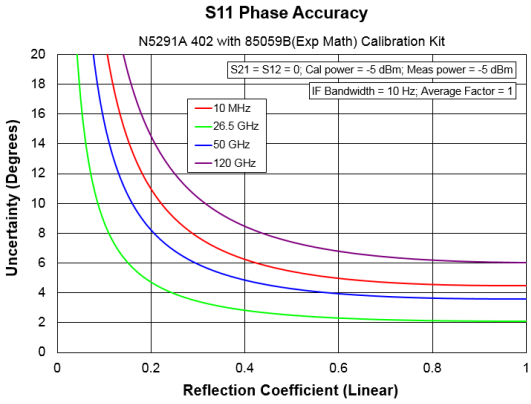
Transmission Uncertainty, (LFE Disabled)





Reflection Uncertainty, (LFE Disabled)



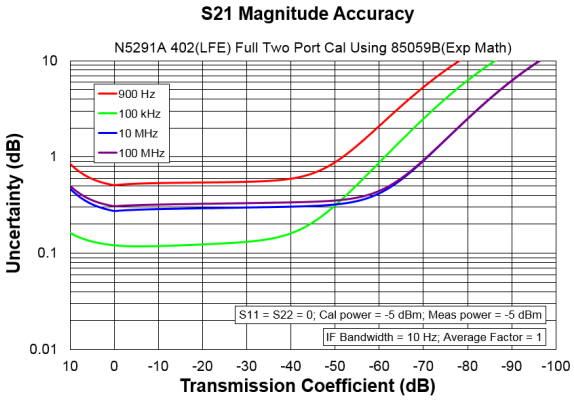


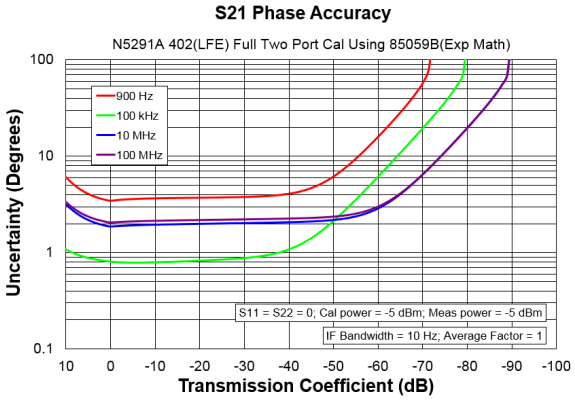
N5291A System (900 Hz to 100 MHz) (LFE Enabled)

Table 6. Error Terms (dB), All Ports, All Options – Specifications (LFE Enabled)

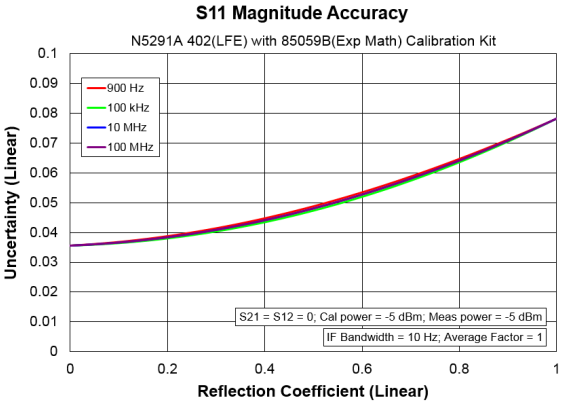
Description	Directivity	Source Match	Load Match	Transmission Tracking		Reflection Tracking	
				Mag	Phase (°)	Mag	Phase (°)
900 Hz to 1 kHz	29	28	29	±0.490	±3.234	±0.020	±0.132
1 kHz to 100 kHz	29	28	29	±0.366	±2.417	±0.020	±0.132
100 kHz to 1 MHz	29	28	29	±0.206	±1.362	±0.020	±0.132
1 MHz to 5 MHz	29	28	29	±0.260	±1.713	±0.020	±0.132
5 MHz to 10 MHz	29	28	29	±0.260	±1.713	±0.020	±0.132
10 MHz to 50 MHz	29	28	29	±0.291	±1.922	±0.020	±0.132
50 MHz to 100 MHz	29	28	29	±0.291	±1.922	±0.020	±0.132

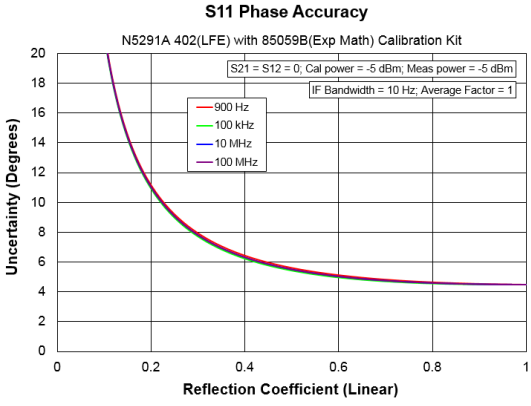
Transmission Uncertainty, (LFE Enabled)





Reflection Uncertainty, (LFE Enabled)





Uncorrected System Performance

Table 7. Error Terms (dB), All Ports, All Options – Specification

Description	Directivity	Source Match	Load Match
10 MHz to 50 MHz[1]	18	8	8
50 MHz to 200 MHz[1]	19	14	5
200 MHz to 500 MHz	18	13	5
500 MHz to 2 GHz	17	12	5
2 GHz to 3.2 GHz	18	12	10
3.2 GHz to 10 GHz	15	13	8
10 GHz to 13.5 GHz	14	12	9
13.5 GHz to 16 GHz	14	12	9
16 GHz to 20 GHz	11	12	7
20 GH to 24 GHz	11	12	8
24 GHz to 26.5 GHz	10	7	7
26.5 GHz to 40 GHz	9	7	5
40 GHz to 43.5 GHz	8	5	7
43.5 GHz to 50 GHz	6	4	6
50 GHz to 60 GHz	6	4	5
60 GHz to 64 GHz	6	4	6
64 GHz to 67 GHz	6	4	5
67 GHz to 75 GHz	7	4	6
75 GHz to 100 GHz	6	3	6
100 GHz to 110 GHz	4	3	4
110 GHz to 120 GHz	2	2	3

[1] With PNA/PNA-X Option 205 or 425 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 8 and Table 10.

Table 8. Error Terms (dB), All Ports, All Options – Specification (LFE Enabled)

Description	Directivity	Source Match	Load Match
900 Hz to 1 kHz	-8	4	4
1 kHz to 10 kHz	-7	5	5
10 kHz to 1 MHz	12	16	14
1 MHz to 5 MHz	6	10	9
5 MHz to 50 MHz	-3	8	8
50 MHz to 100 MHz	-5	7	7

Table 9. 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]	25	17	10	±1.5	±1.5	-80
50 MHz to 200 MHz[1]	26	24	7	±1.5	±1.5	-102
200 MHz to 500 MHz	26	25	7	±1.5	±1.5	-113
500 MHz to 2 GHz	23	23	7	±1.5	±1.5	-116
2 GHz to 3.2 GHz	25	25	13	±1.5	±1.5	-125
3.2 GHz to 10 GHz	22	22	11	±1.5	±1.5	-125
10 GHz to 13.5 GHz	28	20	13	±1.5	±1.5	-125
13.5 GHz to 16 GHz	19	21	13	±1.5	±1.5	-125
16 GHz to 20 GHz	16	19	11	±1.75	±1.5	-125
20 GH to 24 GHz	18	19	11	±1.5	±1.5	-125
24 GHz to 26.5 GHz	16	19	10	±1.5	±1.5	-125
26.5 GHz to 40 GHz	11	15	10	±1.5	±1.5	-119
40 GHz to 43.5 GHz	11	10	12	±1.5	±1.5	-119
43.5 GHz to 50 GHz	10	9	10	±1.75	±1.5	-119
50 GHz to 60 GHz	9	10	10	±1.75	±1.5	-119
60 GHz to 64 GHz	9	10	11	±1.75	±1.5	-119
64 GHz to 67 GHz	11	11	10	±1.75	±1.5	-119
67 GHz to 75 GHz	9	10	11	±1.75	±1.5	-119
75 GHz to 100 GHz	7	11	11	±1.75	±1.5	-118
100 GHz to 110 GHz	5	10	9	±2	±1.5	-116
110 GHz to 120 GHz	6	9	7	±2	±1.5	-109
120 GHz to 125 GHz	2	8	7	±2.5	±1.5	-102

[1] With PNA/PNA-X Option 205 or 425 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 8 and Table 10.

Table 10. Error Terms (dB), All Ports, All Options – Typical (LFE Enabled)

Description	Directivity	Source Match	Load Match	Transmission Tracking	Reflection Tracking	Crosstalk
500 Hz to 900 Hz	-13	3	3	±1.5	±1.5	-92
900 Hz to 1 kHz	-6	5	6	±1.5	±1.5	-99
1 kHz to 10 kHz	-4	6	6	±1.5	±1.5	-94
10 kHz to 100 kHz	15	20	18	±1.5	±1.5	-99
100 kHz to 1 MHz	15	20	18	±1.5	±1.5	-116
1 MHz to 5 MHz	11	11	11	±1.5	±1.5	-117
5 MHz to 10 MHz	2	9	9	±1.5	±1.5	-111
10 MHz to 50 MHz	2	9	9	±1.5	±1.5	-105
50 MHz to 100 MHz	-2	9	9	±1.5	±1.5	-108

Test Port Output - 500 Hz to 125 GHz

Maximum Power

Table 11. Test Port Maximum Power[1] (dBm), All Models, All Options

Description	Specification		Typical	
	Ports 1, 3	Ports 2, 4	Ports 1, 3	Ports 2, 4
10 MHz to 50 MHz[2]	0	0	4	3
50 MHz to 100 MHz[2]	7	7	10	10
100 MHz to 500 MHz	7	7	10	10
500 MHz to 1 GHz	8	8	11	11
1 GHz to 2 GHz	10	10	12	12
2 GHz to 2.5 GHz	5	7	10	12
2.5 GHz to 3.2 GHz	5	7	9	12
3.2 GHz to 5 GHz	10	9	13	13
5 GHz to 8 GHz	7	8	12	12
8 GHz to 10 GHz	7	7	12	11
10 GHz to 12 GHz	6	7	11	10
12 GHz to 13.5 GHz	5	5	10	9
13.5 GHz to 15 GHz	5	5	10	9
15 GHz to 16 GHz	6	5	10	9
16 GHz to 18 GHz	3	2	8	8
18 GHz to 20 GHz	3	1	8	6
20 GHz to 24 GHz	3	0	8	5
24 GHz to 26.5 GHz	6	6	9	9
26.5 GHz to 30 GHz	6	6	9	9
30 GHz to 35 GHz	6	6	10	10
35 GHz to 40 GHz	4	4	8	8
40 GHz to 45 GHz	6	6	10	10
45 GHz to 50 GHz	5	5	10	10
50 GHz to 52 GHz[3]	5	4	9	8
52 GHz to 60 GHz	6	6	10	10
60 GHz to 64 GHz	4	4	9	9
64 GHz to 67 GHz	1	1	5	5
67 GHz to 70 GHz	1	1	5	5
70 GHz to 75 GHz	1	1	5	5
75 GHz to 80 GHz	1	1	5	5
80 GHz to 85 GHz	1	1	5	5
85 GHz to 90 GHz	1	1	5	5

Description	Specification		Typical	
90 GHz to 95 GHz	1	1	5	5
95 GHz to 100 GHz	1	1	6	6
100 GHz to 105 GHz	1	1	6	6
105 GHz to 110 GHz	1	1	6	6
110 GHz to 115 GHz	1	1	6	6
115 GHz to 120 GHz	-2	-2	4	4
120 GHz to 125 GHz	--	--	2	2

[1] When the N524xB PNA-X is used, the numbers are valid only when the high power mode is selected for the signal source.
[2] With PNA/PNA-X Option 205 or 425 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 12.
[3] When the N5242B/22B unit is used, specification numbers are reduced by 2 dB and typical numbers are reduced by 4 dB.

Table 12. Maximum Power (dBm), All Ports (LFE Enabled)

Description	Specification	Typical[1]
500 Hz to 900 Hz	--	8
900 Hz to 1 kHz	4	11
1 kHz to 10 kHz	8	11
10 kHz to 100 kHz	8	12
100 kHz to 1 MHz	10	12
1 MHz to 5 MHz	7	10
5 MHz to 10 MHz	3	8
10 MHz to 50 MHz	2	5
50 MHz to 100 MHz	2	5

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

Port Power Level Accuracy

Table 13. Port Power Level Accuracy[1] (dB), All Ports, All Options

Description	Typical[1]
10 MHz to 50 MHz[2]	±0.7
50 MHz to 100 MHz[2]	±0.6
100 MHz to 500 MHz	±0.7
500 MHz to 1 GHz	±1.6
1 GHz to 2 GHz	±0.6
2 GHz to 5 GHz	±0.5
5 GHz to 20 GHz	±0.7
20 GHz to 24 GHz	±0.7
24 GHz to 26.5 GHz	±0.6
26.5 GHz to 32 GHz	±1.0
32 GHz to 40 GHz	±1.1
40 GHz to 50 GHz	±1.0
50 GHz to 60 GHz	±0.8
60 GHz to 67 GHz	±1.1
67 GHz to 70 GHz	±1.0
70 GHz to 75 GHz	±1.1
75 GHz to 80 GHz	±1.2
80 GHz to 100 GHz	±1.5
100 GHz to 110 GHz	±1.8
110 GHz to 120 GHz	±1.8
120 GHz to 125 GHz	±2.2

[1] Nominal preset power (-5 dBm).
[2] With PNA/PNA-X Option 205 or 425 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 14.

Table 14. Port Power Level Accuracy[1] (dB), All Ports, All Options (LFE Enabled)

Description	Typical
500 Hz to 900 Hz	±0.3
900 Hz to 1 kHz	±0.3
1 kHz to 10 kHz	±0.3
10 kHz to 100 kHz	±0.3
100 kHz to 1 MHz	±0.3
1 MHz to 5 MHz	±0.4
5 MHz to 10 MHz	±0.4
10 MHz to 50 MHz	±0.4
50 MHz to 100 MHz	±0.4

[1] Nominal preset power (-5 dBm).

Port Power Linearity

NOTE Port power linearity listed is a receiver based measurement and absolute linearity may be better than shown.

Table 15. Port Power Linearity[1] (dB), All Ports, Option 201, 202, 401, 402, 403

Description	Typical
	-25 dBm to Max Power
10 MHz to 50 MHz[2, 3]	≤±0.5
50 MHz to 500 MHz[2, 3]	≤±0.5
500 MHz to 1 GHz2, 3	≤±0.5
1 GHz to 2 GHz2, 3	≤±0.5
2 GHz to 24 GHz2	≤±0.5
24 GHz to 64 GHz	≤±0.5
64 GHz to 120 GHz	≤±0.5
120 GHz to 125 GHz	≤±0.5

[1] Referenced to nominal power (-5 dBm), from -25 dBm to max power.
[2] With PNA/PNA-X Option 205 or 425 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 16.
[3] For Option 401, 402, 403, Port 1 and Port 3, referenced to nominal power (-5 dBm), from -25 dBm to max power minus 3 dB.

Table 16. Power Level Linearity[1] (dB), All Ports (LFE Enabled)

Description	Specification	Typical[1]
500 Hz to 900 Hz	--	±0.3
900 Hz to 1 kHz	±1.0	±0.2
1 kHz to 10 kHz	±1.0	±0.2
10 kHz to 100 kHz	±1.0	±0.2
100 kHz to 1 MHz	±1.0	±0.2
1 MHz to 5 MHz	±1.0	±0.2
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	±0.3

[1] Referenced to nominal power (-5 dBm), from -25 dBm to max power.

Port Harmonics

Table 17. Harmonics, All Options – Typical

Description[1]	2nd Harmonic	3rd Harmonic Ports 1, 3[2]	3rd Harmonic Ports 2, 4[2]
10 MHz to 50 MHz[3]	-20	-27	-22
50 MHz to 100 MHz[3]	-23	-27	-23
100 MHz to 500 MHz	-19	-27	-23
500 MHz to 1 GHz	-17	-32	-23
1 GHz to 2 GHz	-20	-33	-23
2 GHz to 5 GHz	-25	-33	-23
5 GHz to 20 GHz	-26	-34	-22
20 GHz to 24 GHz	-46	-40	-32
24 GHz to 26.5 GHz	-42	-42	-32
26.5 GHz to 32 GHz	-44	-61	-32
32 GHz to 40 GHz	-44	-61	-45
40 GHz to 50 GHz	-43	--	--
50 GHz to 60 GHz	-42	--	--
60 GHz to 67 GHz	-36	--	--
67 GHz to 70 GHz	-31	--	--
70 GHz to 75 GHz	--	--	--

Description[1]	2nd Harmonic	3rd Harmonic Ports 1, 3[2]	3rd Harmonic Ports 2, 4[2]
75 GHz to 80 GHz	--	--	--
80 GHz to 100 GHz	--	--	--
100 GHz to 110 GHz	--	--	--
110 GHz to 120 GHz	--	--	--
120 GHz to 125 GHz	--	--	--

[1] Listed frequency is fundamental frequency; test at max specified power.
[2] Any port can be used as the source port. Source in Filtered mode where applicable.
[3] With PNA/PNA-X Option 205 or 425 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 18.

Table 18. 2nd and 3rd Harmonics at Max Specified Power (dBc), All Ports – Typical (LFE Enabled)

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

Description	2nd Harmonic	3rd Harmonic
500 Hz to 900 Hz	-29	-27
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	-29	-22
1 MHz to 5 MHz	-33	-26
5 MHz to 10 MHz	-26	-22
10 MHz to 33 MHz	-22	-15
33 MHz to 50 MHz	-22	--

Source Phase Noise

Table 19. 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
3 GHz	-103	-123	-132	-135	-147	-150
10 GHz	-96	-116	-126	-130	-142	-146
20 GHz	-91	-111	-118	-123	-135	-139
50 GHz	-81	-100	-109	-115	-125	-129
60 GHz	-81	-101	-108	-113	-125	-129
75 GHz	-79	-99	-106	-111	-123	-127
90 GHz	-79	-99	-106	-111	-123	-127
110 GHz	-75	-95	-102	-107	-119	-123
125 GHz	-75	-95	-102	-107	-119	-123

Table 20. 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
3 GHz	-103	-122	-128	-134	-145	-149
10 GHz	-96	-112	-120	-127	-140	-147
20 GHz	-90	-108	-116	-123	-134	-139
50 GHz	-80	-100	-108	-115	-125	-129
60 GHz	-80	-98	-106	-113	-124	-129
75 GHz	-78	-96	-104	-111	-122	-127
90 GHz	-78	-96	-104	-111	-122	-127
110 GHz	-74	-92	-100	-107	-118	-123
125 GHz	-74	-92	-100	-107	-118	-123

Table 21. 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	-144
3 GHz	-83	-106	-119	-128	-139	-147
10 GHz	-78	-100	-113	-122	-133	-142
20 GHz	-72	-94	-107	-116	-127	-135
50 GHz	-61	-84	-98	-108	-118	-126
60 GHz	-62	-84	-97	-106	-117	-125
75 GHz	-60	-82	-95	-104	-115	-123
90 GHz	-60	-82	-95	-104	-115	-123
110 GHz	-56	-78	-91	-100	-111	-119
125 GHz	-56	-78	-91	-100	-111	-119

Table 22. Phase Noise (dBc/Hz), All Ports – Typical (LFE Enabled)

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 – 500 Hz to 125 GHz

Noise Floor

Table 23. Test Port Noise Floor (dBm) @ 10 Hz IFBW, All Options

Description	Specification	Typical
10 MHz to 50 MHz[1]	-66	-82
50 MHz to 100 MHz[1]	-82	-95
100 MHz to 500 MHz	-91	-107
500 MHz to 1 GHz	-104	-115
1 GHz to 2 GHz	-110	-119
2 GHz to 2.5 GHz	-114	-119
2.5 GHz to 3.2 GHz	-115	-119
3.2 GHz to 5 GHz	-115	-119
5 GHz to 8 GHz	-115	-120
8 GHz to 10 GHz	-115	-120
10 GHz to 12 GHz	-115	-120
12 GHz to 13.5 GHz	-115	-120
13.5 GHz to 15 GHz	-115	-120
15 GHz to 16 GHz	-115	-120
16 GHz to 18 GHz	-115	-120
18 GHz to 20 GHz	-115	-120
20 GHz to 24 GHz	-113	-120
24 GHz to 26.5 GHz	-113	-120
26.5 GHz to 30 GHz	-107	-112
30 GHz to 35 GHz	-107	-112
35 GHz to 40 GHz	-107	-112
40 GHz to 45 GHz	-107	-112
45 GHz to 50 GHz	-106	-112
50 GHz to 60 GHz	-108	-113
60 GHz to 64 GHz	-108	-113
64 GHz to 67 GHz	-108	-114
67 GHz to 70 GHz	-108	-114
70 GHz to 75 GHz	-105	-113
75 GHz to 80 GHz	-103	-109
80 GHz to 85 GHz	-103	-110
85 GHz to 90 GHz	-103	-110
90 GHz to 95 GHz	-103	-111
95 GHz to 100 GHz	-103	-110

Description	Specification	Typical
100 GHz to 105 GHz	-100	-107
105 GHz to 110 GHz	-101	-108
110 GHz to 115 GHz	-95	-108
115 GHz to 120 GHz	-94	-103
120 GHz to 125 GHz	--	-101

[1] With PNA/PNA-X Option 205 or 425 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 24.

Table 24. Test Port Noise Floor (dBm) @ 10 Hz IFBW, All Options (LFE Enabled)

Description	Specification	Typical
500 Hz to 900 Hz	--	-88
900 Hz to 1 kHz	-84	-92
1 kHz to 10 kHz	-85	-93
10 kHz to 100 kHz	-98	-104
100 kHz to 1 MHz	-102	-108
1 MHz to 5 MHz	-103	-110
5 MHz to 10 MHz	-95	-101
10 MHz to 50 MHz	-95	-101
50 MHz to 100 MHz	-95	-101

Trace Noise

Table 25. Trace Noise, Magnitude (dB rms), All Options

Description	Specification	Typical		
	1 kHz IFBW	1 kHz IFBW	100 kHz IFBW	600 kHz IFBW
10 MHz to 50 MHz[1]	0.2	0.073	0.735	1.770
50 MHz to 100 MHz[1]	0.02	0.012	0.12	0.26
100 MHz to 200 MHz	0.007	0.003	0.031	0.076
200 MHz to 1 GHz	0.005	0.002	0.018	0.046
1 GHz to 26.5 GHz	0.003	0.000	0.004	0.009
26.5 GHz to 67 GHz	0.004	0.001	0.008	0.020
67 GHz to 75 GHz	0.004	0.001	0.007	0.016
75 GHz to 110 GHz	0.005	0.001	0.011	0.027
110 GHz to 120 GHz	0.006	0.002	0.018	0.043
120 GHz to 125 GHz	--	0.004	0.038	0.093

[1] With PNA/PNA-X Option 205 or 425 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 26.

Table 26. Trace Noise, Magnitude[1] (dB rms), All Ports, All 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	--	0.002	0.017	0.041

[1] Ratioed measurement, -5 dBm at test port.

Table 27. Trace Noise, Phase (deg rms), All Ports, All Options

Description	Specification	Typical		
	1 kHz IFBW	1 kHz IFBW	100 kHz IFBW	600 kHz IFBW
10 MHz to 50 MHz[1]	1.50	0.556	4.90	11.9
50 MHz to 100 MHz[1]	0.14	0.083	0.83	1.89
100 MHz to 200 MHz	0.080	0.023	0.205	0.514
200 MHz to 1 GHz	0.050	0.014	0.125	0.309
1 GHz to 26.5 GHz	0.050	0.005	0.024	0.060
26.5 GHz to 67 GHz	0.080	0.008	0.060	0.144
67 GHz to 75 GHz	0.100	0.012	0.049	0.116
75 GHz to 110 GHz	0.100	0.013	0.085	0.205
110 GHz to 120 GHz	0.100	0.018	0.138	0.324
120 GHz to 125 GHz	--	0.037	0.316	0.735

[1] With PNA/PNA-X Option 205 or 425 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 28.

Table 28. Trace Noise, Phase[1] (deg rms), All Ports, All 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	--	--	0.016	--	--	--
900 Hz to 4 kHz	0.035	--	0.01	--	--	--
4 kHz to 300 kHz	--	0.035	--	0.016	--	--
300 kHz to 2 MHz	--	0.035	--	0.006	0.061	--
2 MHz to 100 MHz	--	0.035	--	0.011	0.106	0.258

[1] Ratioed measurement, -5 dBm at test port.

Compression

Table 29. Compression[1], All Ports - Typical

Description	Test Port Power (dBm)	Receiver Compression	
	All Options	Magnitude (dB)	Phase (degrees)
10 MHz to 50 MHz[2]	+5	0.04	0.2
50 MHz to 100 MHz[2]	+5	0.05	0.3
100 MHz to 500 MHz	+5	0.05	0.3
500 MHz to 1 GHz	+5	0.04	0.1
1 GHz to 2 GHz	+5	0.04	0.1
2 GHz to 5 GHz	+5	0.05	0.1
5 GHz to 10 GHz	+5	0.05	0.1
10 GHz to 20 GHz	+5	0.05	0.2
20 GHz to 24 GHz	+5	0.05	0.4
24 GHz to 26.5 GHz	+5	0.05	0.4
26.5 GHz to 32 GHz	+5	0.05	0.4
32 GHz to 40 GHz	+5	0.05	0.4
40 GHz to 50 GHz	+5	0.05	0.4
50 GHz to 60 GHz	+5	0.05	0.4
60 GHz to 64 GHz	+5	0.05	0.4
64 GHz to 67 GHz	+5	0.05	0.4
67 GHz to 70 GHz	+5	0.09	1.1
70 GHz to 75 GHz	+5	0.09	1.1
75 GHz to 80 GHz	+5	0.10	1.2
80 GHz to 90 GHz	+5	0.16	2.0
90 GHz to 100 GHz	+5	0.17	2.0
100 GHz to 110 GHz	+5	0.17	2.0
110 GHz to 115 GHz	+5	0.15	2.0
115 GHz to 120 GHz	0	0.10	1.0
120 GHz to 125 GHz	0	0.10	1.0

[1] Data represents the transmission compression with a negligible level of compression in the Reference Receivers.
[2] With PNA/PNA-X Option 205 or 425 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. Compression, All Ports (LFE Enabled) - Typical

Description	Test Port Power (dBm)	Receiver Compression	
	All Options	Magnitude (dB)	Phase (degrees)
500 Hz to 900 Hz	4	0.13	1.29
900 Hz to 1 kHz	4	0.09	0.52
1 kHz to 10 kHz	8	0.06	0.37
10 kHz to 100 kHz	8	0.06	0.37
100 kHz to 1 MHz	10	0.03	0.14
1 MHz to 5 MHz	7	0.04	0.10
5 MHz to 10 MHz	3	0.03	0.15
10 MHz to 50 MHz	3	0.03	0.15
50 MHz to 100 MHz	3	0.02	0.17

Table 31. 0.1 dB Compression, All Options, All Ports - Typical

Description	Test Port Power (dBm)
10 MHz to 50 MHz[1]	10
50 MHz to 100 MHz[1]	10
100 MHz to 500 MHz	10
500 MHz to 1 GHz	10
1 GHz to 2 GHz	9
2 GHz to 5 GHz	8
5 GHz to 10 GHz	8
10 GHz to 20 GHz	8
20 GHz to 24 GHz	7
24 GHz to 26.5 GHz	8
26.5 GHz to 32 GHz	7
32 GHz to 40 GHz	7
40 GHz to 50 GHz	7
50 GHz to 60 GHz	8
60 GHz to 64 GHz	9
64 GHz to 67 GHz	6
67 GHz to 70 GHz	6
70 GHz to 75 GHz	6
75 GHz to 80 GHz	5
80 GHz to 90 GHz	4
90 GHz to 100 GHz	2
100 GHz to 110 GHz	1
110 GHz to 120 GHz	0
120 GHz to 125 GHz	0

[1] With PNA/PNA-X Option 205 or 425 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 32.

Table 32. 0.1 dB Compression, All Ports, All 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

Damage Input Level

Table 33. Damage Input Level, All Options

Description	1 mm Test Port		BNC Bias Port	
	RF (dBm)	DC (V)	DC (V)	Max Current (A)
All Options	>20	>50	>50	>1

Bias Tee Leakage Current

Table 34. Leakage Current (Average Typical)

Description	
Leakage Current	<18 nA

NOTE Leakage current measured with test port open circuit and is typical.

NOTE When using the bias-tees on N5295AX03/53 frequency extender modules, users may see errors for measurements below 100 MHz. This is due to the interaction between the built-in LFE bias combiner and the output match of the DC-bias supply being used.

Dynamic Accuracy

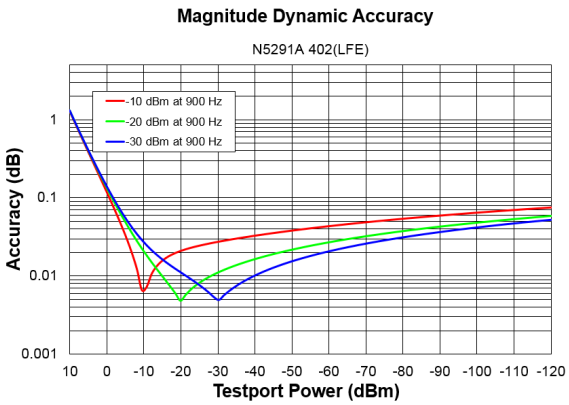
Dynamic accuracy is verified with the following measurements:

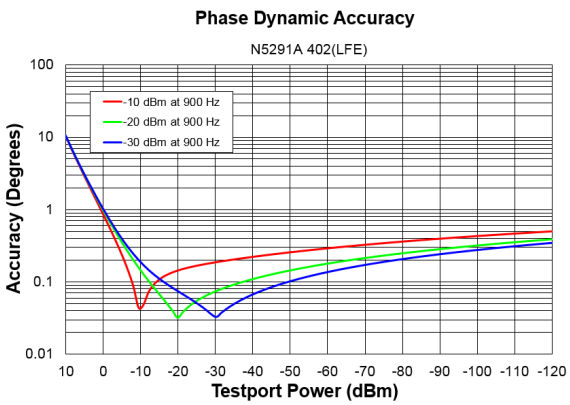
- Compression over frequency.
- IF linearity at a single frequency of 99.6 MHz using a reference level of -20 dBm for an input power range of +4 to -55 dBm.

For values below -55 dBm, refer to "VNA Receiver Dynamic Accuracy Specifications and Uncertainties".

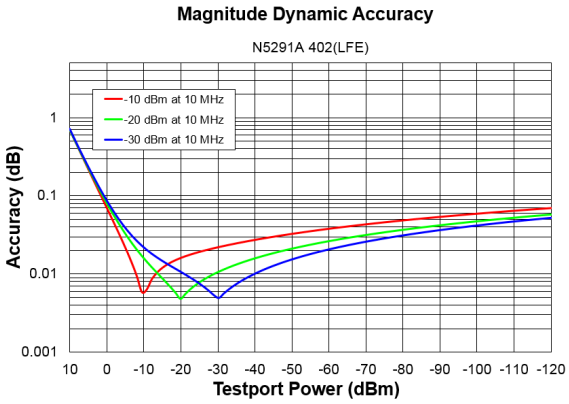
Table 35. Dynamic Accuracy - Specification

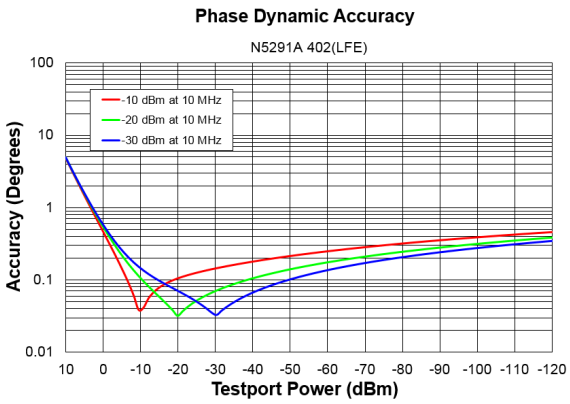
N5291A Dynamic Accuracy, 900 Hz (LFE Enabled) - Specification



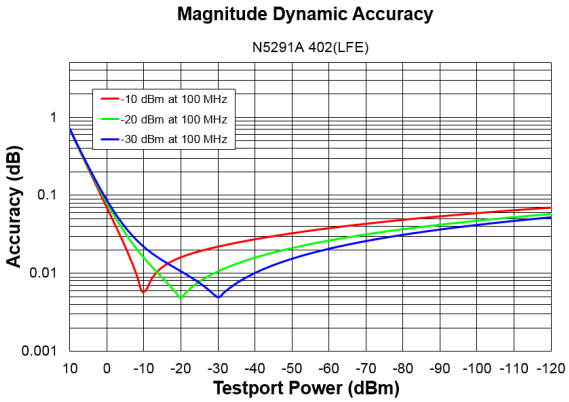


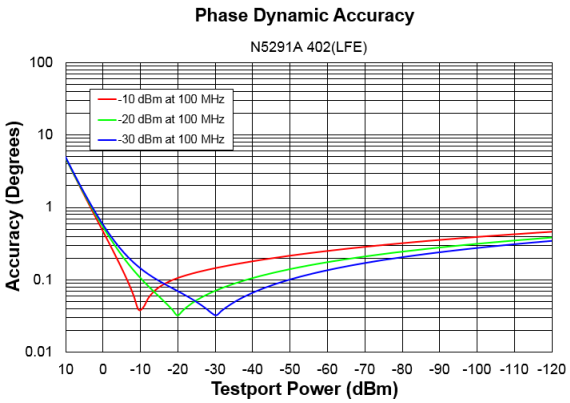
N5291A Dynamic Accuracy, 10 MHz (LFE Enabled) - Specification



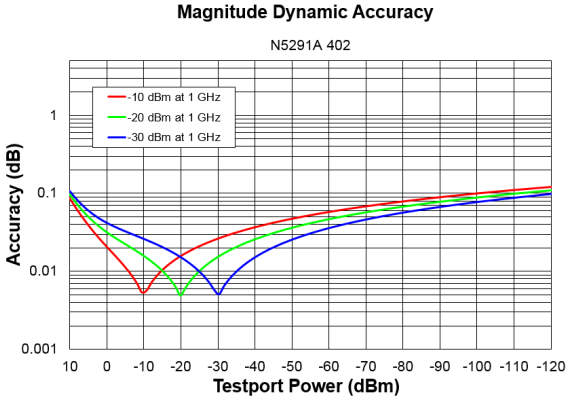


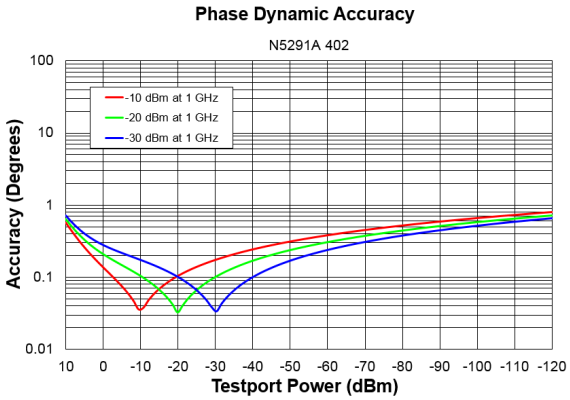
N5291A Dynamic Accuracy, 100 MHz (LFE Enabled) - Specification



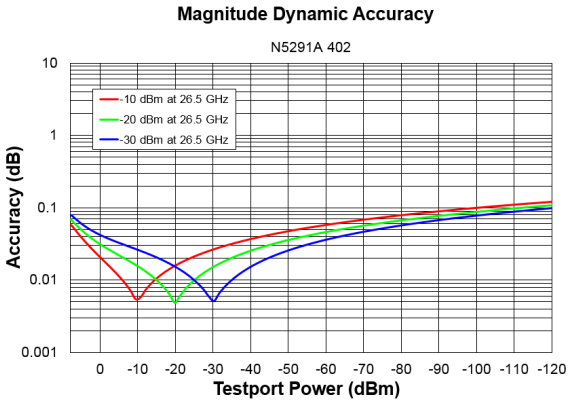


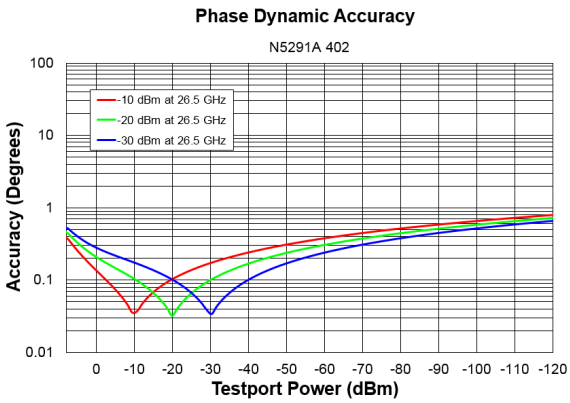
N5291A Dynamic Accuracy, 1 GHz - Specification



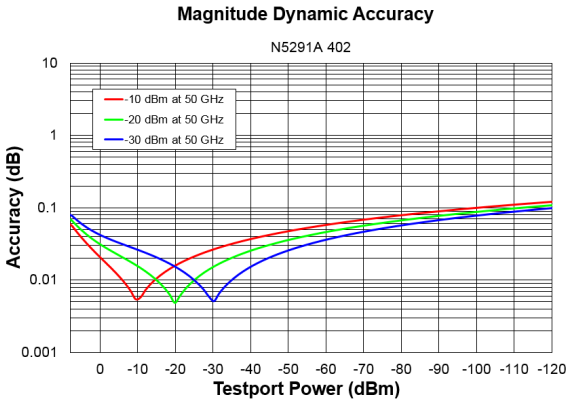


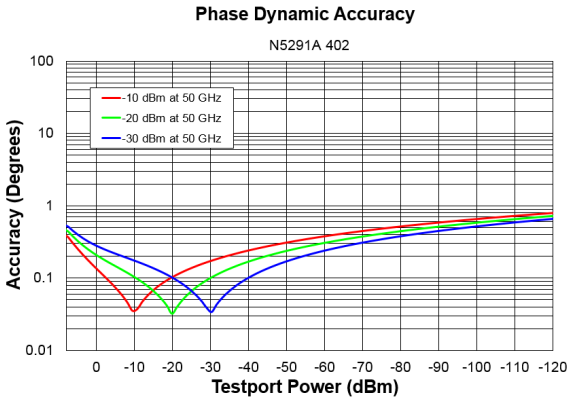
N5291A Dynamic Accuracy, 26.5 GHz - Specification



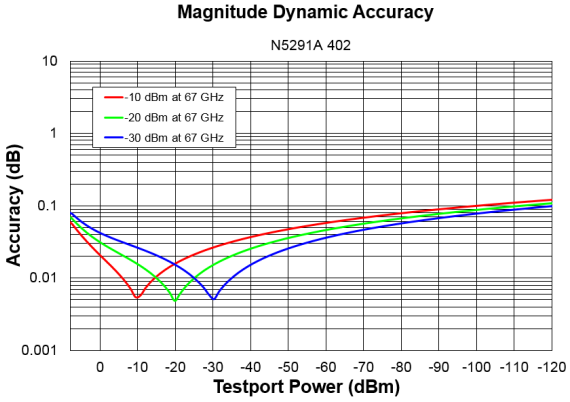


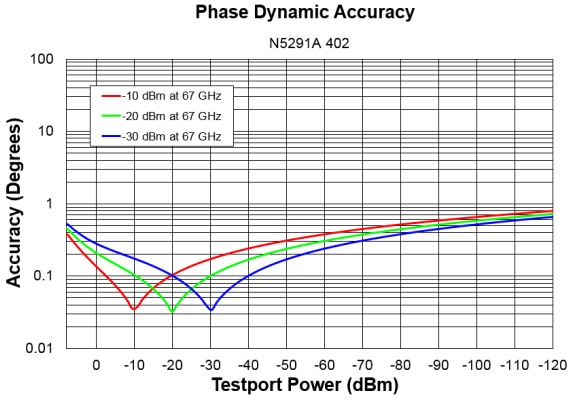
N5291A Dynamic Accuracy, 50 GHz - Specification



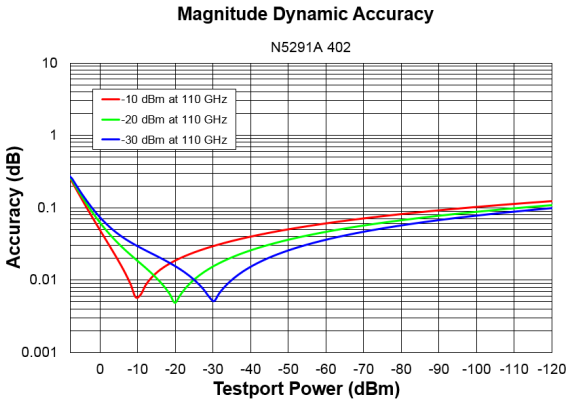


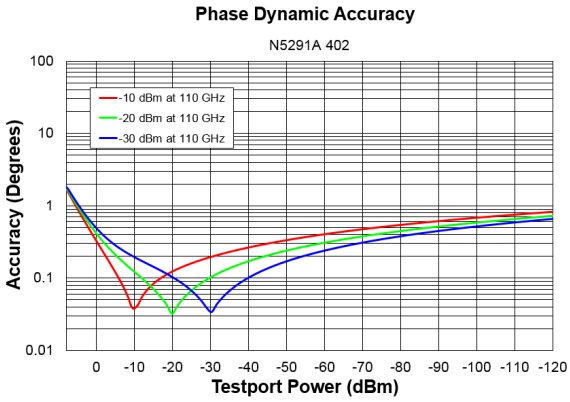
N5291A Dynamic Accuracy, 67 GHz - Specification



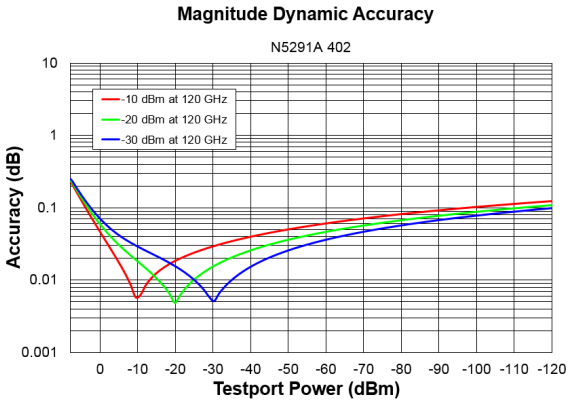


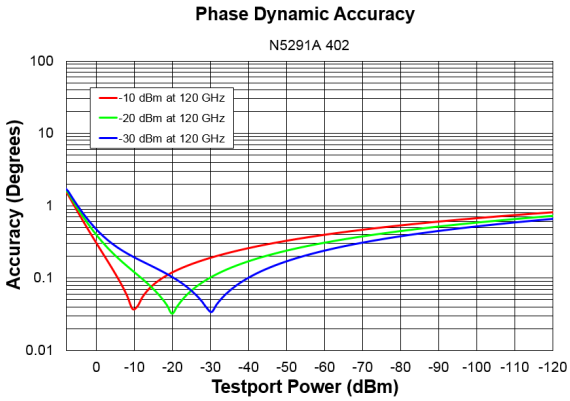
N5291A Dynamic Accuracy, 110 GHz – Specification





N5291A Dynamic Accuracy, 120 GHz – Specification

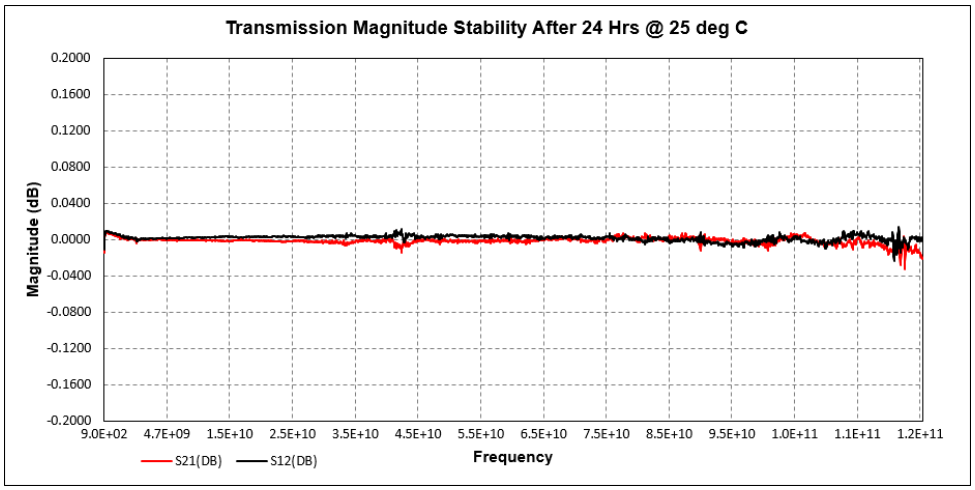




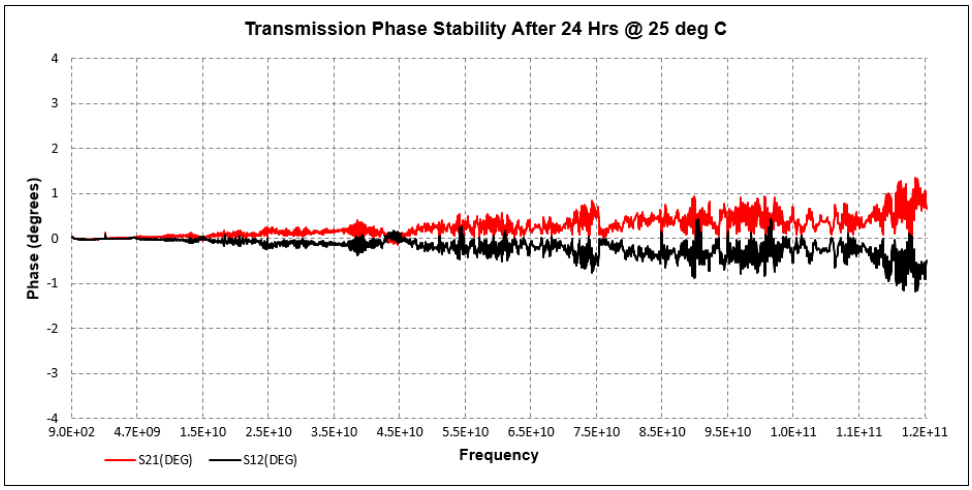
Group Delay - Typical

N5291A Stability

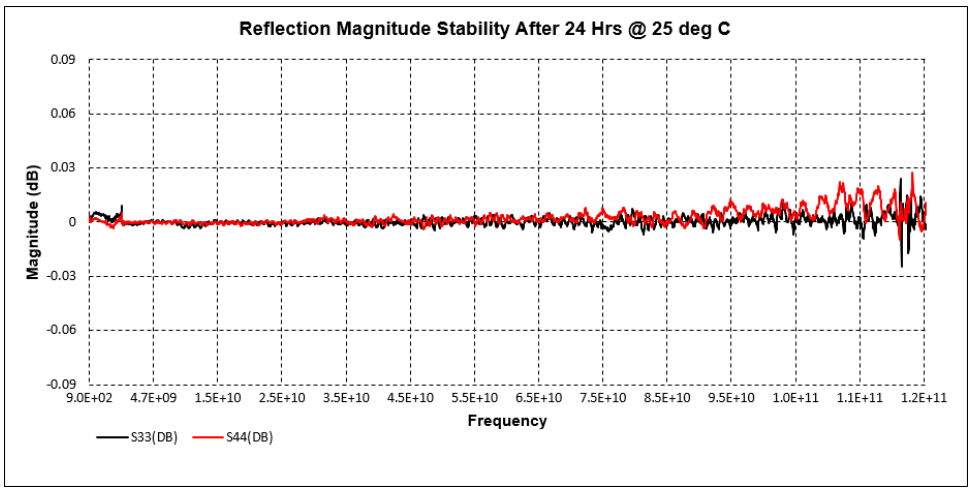
Transmission Magnitude Stability (Nominal)



Transmission Phase Stability (Nominal)



Reflection Magnitude Stability (Nominal)



Reflection Phase Stability (Nominal)

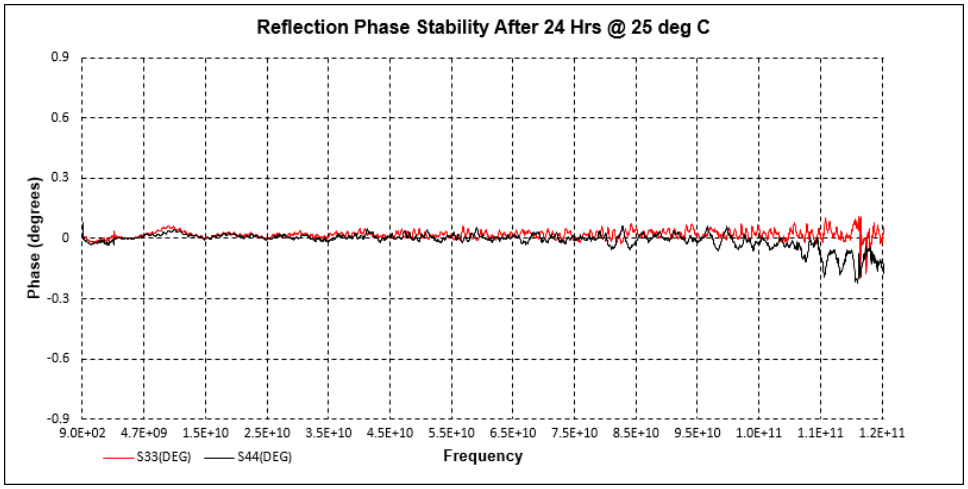


Table 36. N5291A Stability – Typical (10 MHz to 125 GHz) (LFE Disabled)

Description	Magnitude (dB/°C)	Phase (°/°C)
10 MHz to 2.5 GHz	0.01	0.02
2.5 GHz to 24 GHz	0.01	0.03
24 GHz to 54 GHz	0.01	0.10
54 GHz to 80 GHz	0.01	0.20
80 GHz to 110 GHz	0.015	0.25
110 GHz to 120 GHz	0.03	0.40
120 GHz to 125 GHz	0.04	0.50

Table 37. Receiver Stability (LFE Enabled) - Typical

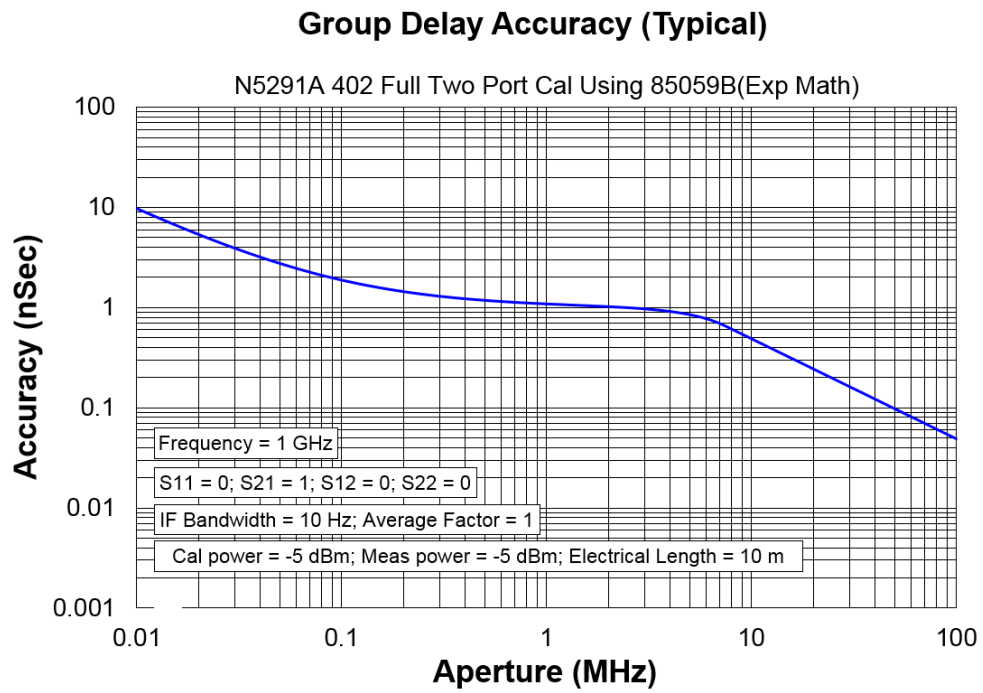
Description	Magnitude (dB/°C)	Phase (°/°C)
500 Hz to 900 Hz	0.015	0.15
900 Hz to 1 kHz	0.015	0.15
1 kHz to 10 kHz	0.015	0.15
10 kHz to 100 kHz	0.015	0.15
100 kHz to 1 MHz	0.015	0.15
1 MHz to 5 MHz	0.03	0.3
5 MHz to 10 MHz	0.1	0.3
10 MHz to 50 MHz	0.1	0.3
50 MHz to 100 MHz	0.1	0.55

General Information

Table 38. Test Port Input (Group Delay)[1]

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 $kl \neq ij$



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.

[1] 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).

Table 39. Miscellaneous Information

Description	Supplemental Information	
System IF Bandwidth Range	1 Hz to 15 MHz, nominal	
CPU	For the latest information on CPUs and associated hard drives, visit: PNA Hard Drives and CPUs (keysight.com)	
LXI	CPU version 7.0, 8.0	CPU version 9.0
	Class C	LXI 1.5 Extended Functions: HiSLIP; VSI-11 Discovery and Identification
Maximum Number of Points	100003	

Table 40. N5295AXxx Frequency Extenders

Description	Typical Performance
Connector	1 mm, male
Sense Connector	Lemo K connector, 2 contacts
BNC Bias Input	BNC, female
Cable/Connector	Integrated N5292A Test Set front port connector
LED States	Blue: Connected and addressed by N5292A Test Set Green: Standby Orange: Standby or warmup Red: Error condition Off: N5295AXxx is turned off
Max Bias Voltage[1]	50 VDC
Max Bias Current[1]	1 amp
Rise/fall time[2]	<1 usec

[1] Applies to N5295AX02/52 and N5295AX03/53 frequency extenders.
[2] Applies to N5295AX02/52 frequency extenders.

Table 41. N5292A Test Set Front Panel

Description	Typical Performance
NA Src Out	3.5 mm, female
NA Port	3.5 mm, female
Integrated Connector	Integrated N5292A Test Set front port connector
IF Ref Out	3.5 mm, female
IF Test Out	3.5 mm, female

Table 42. N5292A Test Set Rear Panel

Description	Typical Performance
LO IN	Connected to LO OUT from VNA
IF OUTPUTS	SMA (female); A, B, C, D, R
Test Set I/O	25-pin D-Sub connector
Line Power	
Frequency, Voltage	50/60/400 Hz for 100/120 VAC 50/60 Hz for 220/240 VAC
Fuse	5 A/250 V

Table 43. VNA 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 44. VNA Rear Panel Information, All Options

Description	Typical Performance
10 MHz Reference In	
Connector	BNC, female
Input Frequency	10 MHz ±1 ppm, 100 MHz ±1 ppm
Input Level	10 MHz: -15 dBm to +20 dBm 100 MHz: -10 dBm to +20 dBm
Input Impedance	50 Ω, nom.
10 MHz Reference Out	
Connector	BNC, female
Output Frequency	10 MHz ±0.7 ppm, 100 MHz ±0.7 ppm
Signal Type	Sine Wave
Output Level	+10 dBm ±4 dB into 50 Ω
Output Impedance	50 Ω, nominal
Harmonics	<-40 dBc, typical
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 Narrowband IF path	 RF < 53 MHz: IF = 826.446 KHz RF >= 53 MHz: IF = 7.438 MHz 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 I/O Connector	15-pin mini D-sub (for pin assignment information, refer to the PNA online help)
Pulse Inputs (IF Gates)	
Function	Internal receiver gates used for point-in-pulse and pulse-profile measurements
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

Description	Typical Performance	
RF Pulse Modulator Input (Source Modulator)		
On/Off Ratio		
10 MHz to 3.2 GHz	-64 dB	
3.2 GHz to 67 GHz	-80 dB	
Pulse Period		
Minimum	33 ns	
Maximum	70 s	
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	1.76 GHz to 26.5 GHz	
Rear Panel LO Power	**Upper Limit, Typical (dBm)**	**Lower Limit, Typical (dBm)**
10 MHz to 1.7 GHz	--	--
1.7 GHz to 16 GHz	5	-3
16 GHz to 21 GHz	0	-6
21 GHz to 26.5 GHz	4	-5
Rear Panel RF1/RF2 Power	**Maximum Output Power, Typical (dBm)**	
3.2 GHz to 5 GHz	+3	
5 GHz to 19 GHz	+8	
Bias Tee Inputs		
Connectors	Triaxial - 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	

Description	Typical Performance	
CPU Version	**CPU version 7.0, 8.0**	**CPU version 9.0**
PCIe	Cabled PCIe x4 connector is a 4-lane slot	N/A
USB Ports	Two SuperSpeed USB ports (900 mA each), one USB port below LAN connector, and one USB device port. There are also four USB ports (500 mA each) on the front panel. The total current limit for all rear panel USB ports is 2.3 amps. The total current limit for all front panel USB ports is 2 amps.	Four SuperSpeed USB ports (900 mA each) and one USB device port. There are also four USB ports (500 mA each) on the front panel. The total current limit for all rear panel USB ports is 3.6 amps. The total current limit for all front panel USB ports is 2 amps.
USB-C (Host)	N/A	Two USB-C connectors with support for USB-3.1 (max Power Delivery of 5V@1A), Thunderbolt3 (max Power Delivery of 5V@1A)[1], and Display Port (port TB1 only)
LAN	1G port; 10/100/1000 BaseT Ethernet, 8-pin configuration; auto selects between the data rates	1G and 10G ports; 10GBASE-T, Ethernet, 8-pin configuration; auto selects between the data rates. Works with Cat6/Cat7 cable.
VGA Video Output	15-pin mini D-Sub; Drives VGA compatible monitors	N/A
Mini DisplayPort	Miniature DisplayPort connector for connection to external displays	N/A
DisplayPort	N/A	Standard DisplayPort connector for connection to external displays
Line Power		
Frequency, Voltage	50/60/400 Hz for 100 to 120 VAC 50/60 Hz for 220 to 240 VAC	
	Power supply is auto switching	
Max	575 watts	

[1] High power devices require external power supply.

System Dimensions and Weight

For System Dimensions and Weight, refer to the N5291A System Installation Manual, located online at http://literature.cdn.Keysight.com/litweb/pdf/N5292-90002.pdf.

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 45. Cycle Time (ms) for Measurement Completion, All Models, All Options - Typical

Sweep Range	IF Bandwidth[1]		Number of Points				
			201	401	1601	16001	32001
50 kHz to 100 MHz	10 kHz	Uncorrected	75	141	515	4726	9243
		2-Port cal	155	285	1050	9505	18440
	1 kHz	Uncorrected	306	599	2339	23000	46003
		2-Port cal	611	1200	4715	46185	91960
	100 Hz	Uncorrected	2543	5085	20293	202691	405085
		2-Port cal	5120	10200	40640	405200	809800
40 GHz to 50 GHz	10 kHz	Uncorrected	86	143	477	4182	8098
		2-Port cal	175	290	1000	8500	16380
	1 kHz	Uncorrected	250	471	1795	17332	34414
		2-Port cal	520	962	3621	34840	69011
	100 Hz	Uncorrected	1853	3669	14555	144890	289519
		2-Port cal	3720	7363	29156	289957	579200
80 GHz to 100 GHz	10 kHz	Uncorrected	86	145	487	4289	8312
		2-Port cal	175	296	1000	8700	16800
	1 kHz	Uncorrected	251	474	1800	17441	34628
		2-Port cal	525	974	3620	35000	69420
	100 Hz	Uncorrected	1855	3666	14563	145000	289754
		2-Port cal	3742	7363	29220	290113	579700
100 GHz to 125 GHz	10 kHz	Uncorrected	86	156	502	4320	8379
		2-Port cal	175	352	1044	8765	16940
	1 kHz	Uncorrected	250	487	1808	17473	34695
		2-Port cal	520	998	3680	35085	69545
	100 Hz	Uncorrected	1853	3682	14578	145035	289816
		2-Port cal	3742	7425	29200	290200	579762
900 Hz to 125 GHz	10 kHz	Uncorrected	221	293	667	4730	9051
		2-Port cal	433	614	1360	9609	18128
	1 kHz	Uncorrected	374	615	1980	17880	35555
		2-Port cal	750	1270	3996	35760	70965
	100 Hz	Uncorrected	1990	3830	14757	145550	290770
		2-Port cal	4000	7720	29540	291000	581275

[1] Automatic IF reduction turned on.

Table 46. 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	N5291A	
IF Bandwidth (Hz)	Cycle Time (ms)	Trace Noise Magnitude (dB rms)
10 Hz	17832	0.18
100 Hz	1824	0.18
1 kHz	227	0.18
10 kHz	67	0.18
100 kHz	49	0.18

Table 47. 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	100	1,000	10,000	100,000
	Cycle Time (ms)			
51	478	72	29	25
201	1832	230	67	49
401	3652	455	125	80
1601	14476	1719	402	250
16001	144285	16582	3418	2000
32001	288242	33043	6614	3742

Table 48. Data Transfer Time[1] (ms) - Typical

- Measured with the analyzer display off.
- Values will increase slightly if the analyzer display is on.

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

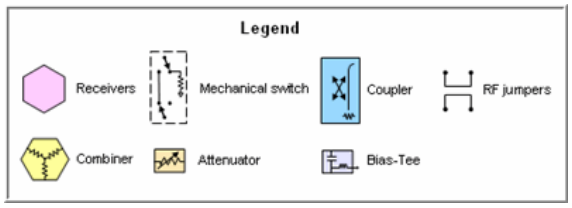
Description	Number of Points				
	201	401	1601	16,001	32,001
SCPI over GPIB (Program executed on external PC[2])					
32-bit floating point	4.6	9.3	38	352	720
64-bit floating point	9.4	18.8	73.4	730	1455
ASCII	36.7	72.5	288	2882	5762
SCPI over SICL/LAN or TCP/IP Socket[3] (Program executed in the analyzer)					
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[3] (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] Measured with the analyzer display off. Values will increase slightly if the analyzer display is on.
[2] Measured when using the SCPI command DISPlay: VISible OFF.
[3] Values are for real and imaginary pairs, with the analyzer display off, using Gigabit Ethernet.

Test Set Block Diagrams

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

Legend



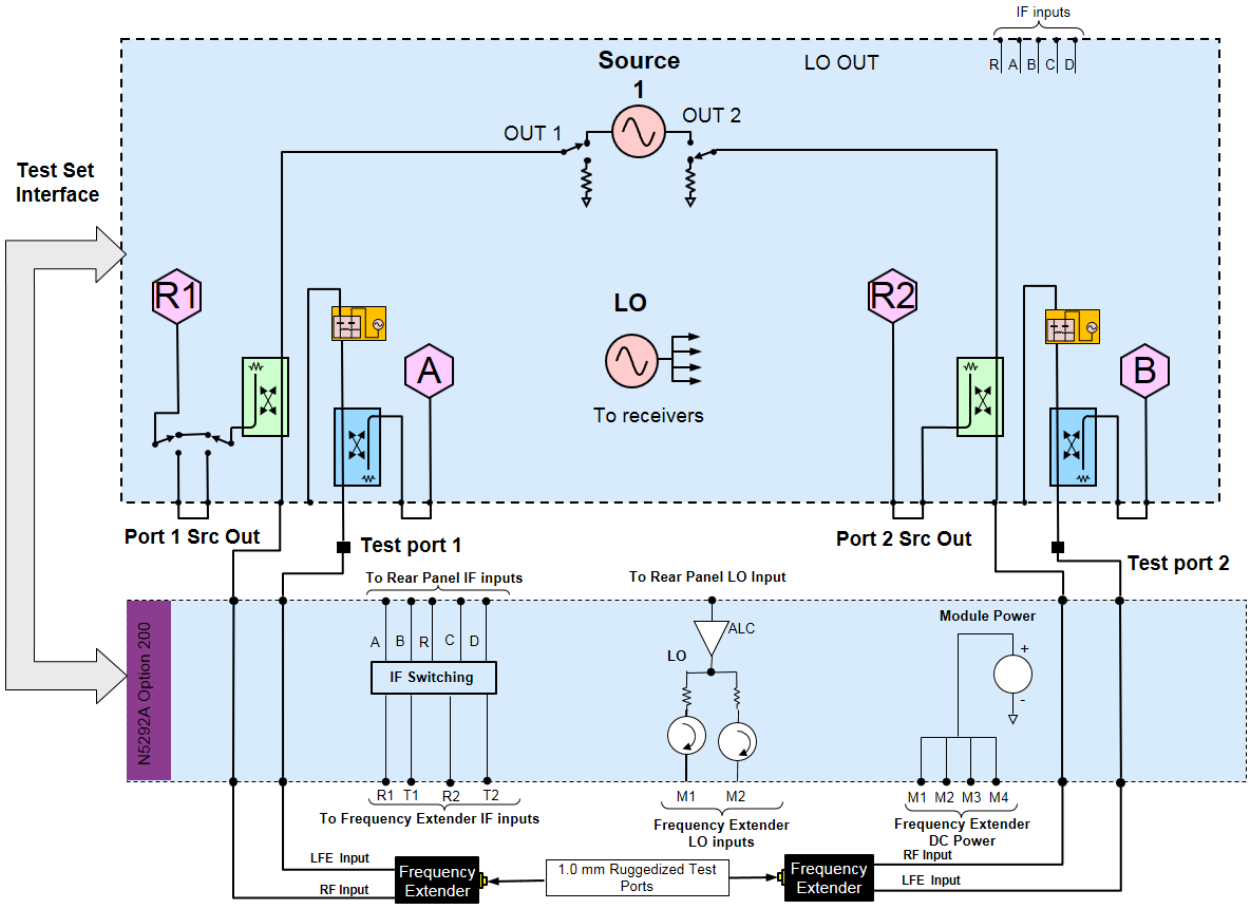


Figure 1. N5291A Option 201, 205 System Level Block Diagram

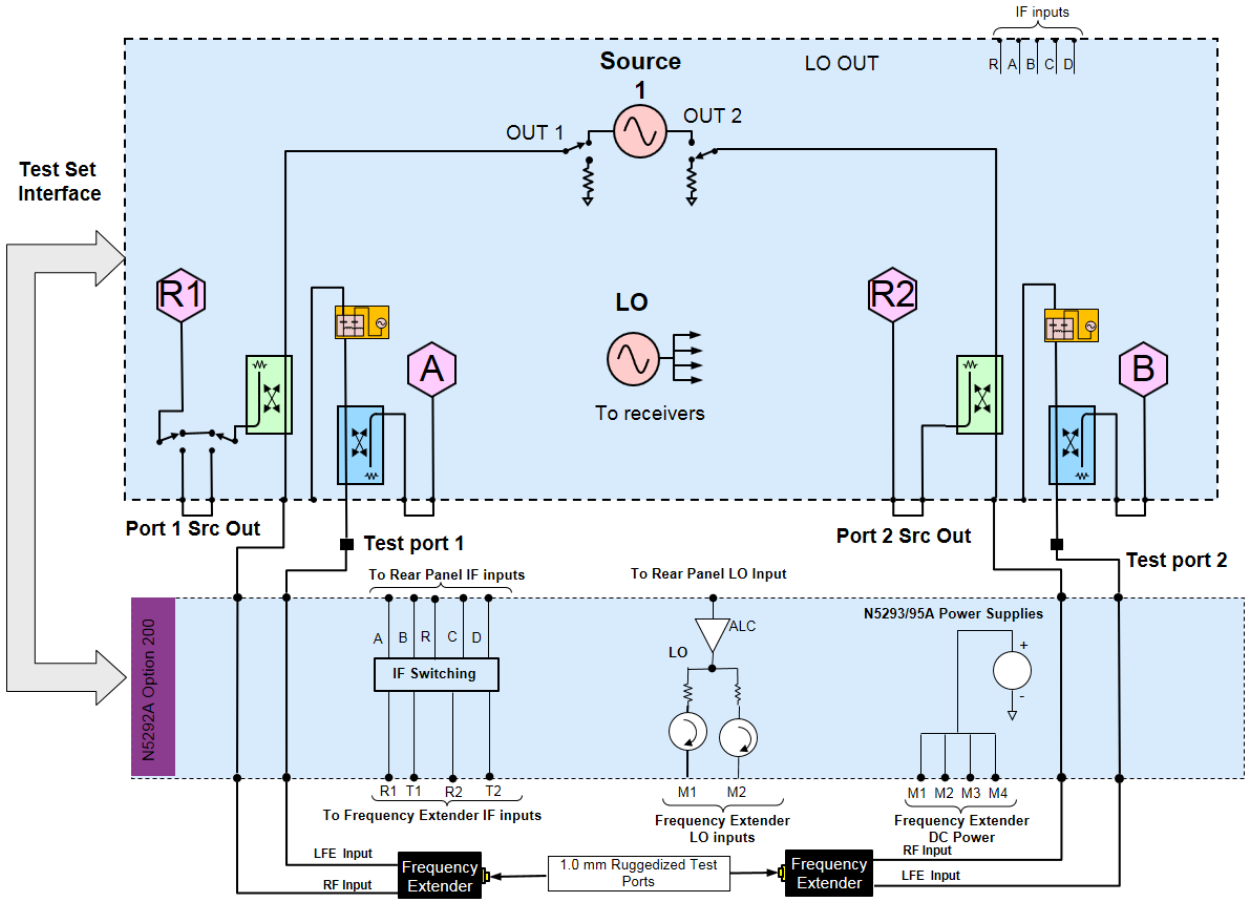


Figure 2. N5291A Option 202, 205 System Level Block Diagram

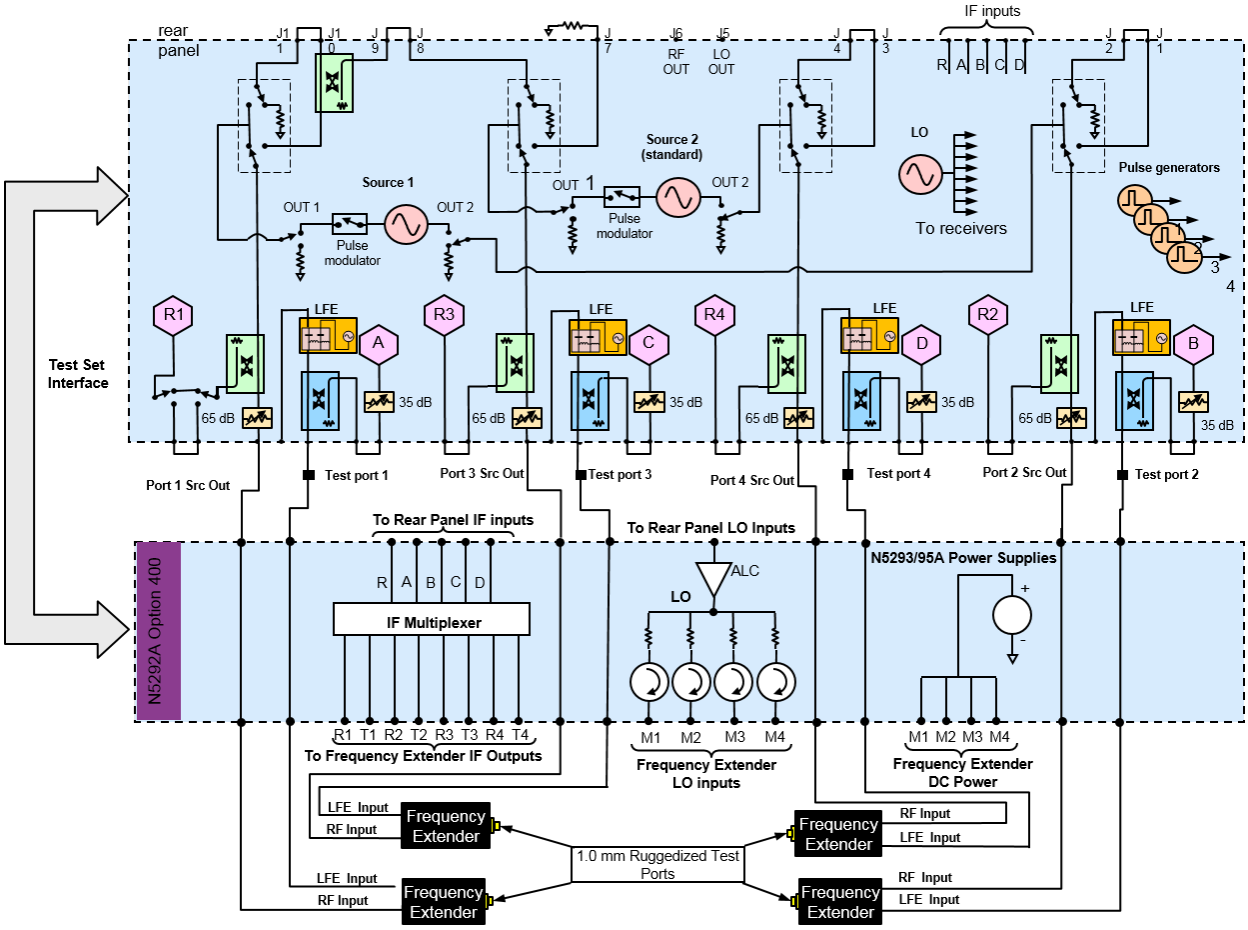


Figure 3. N5291A Option 401 System Level Block Diagram

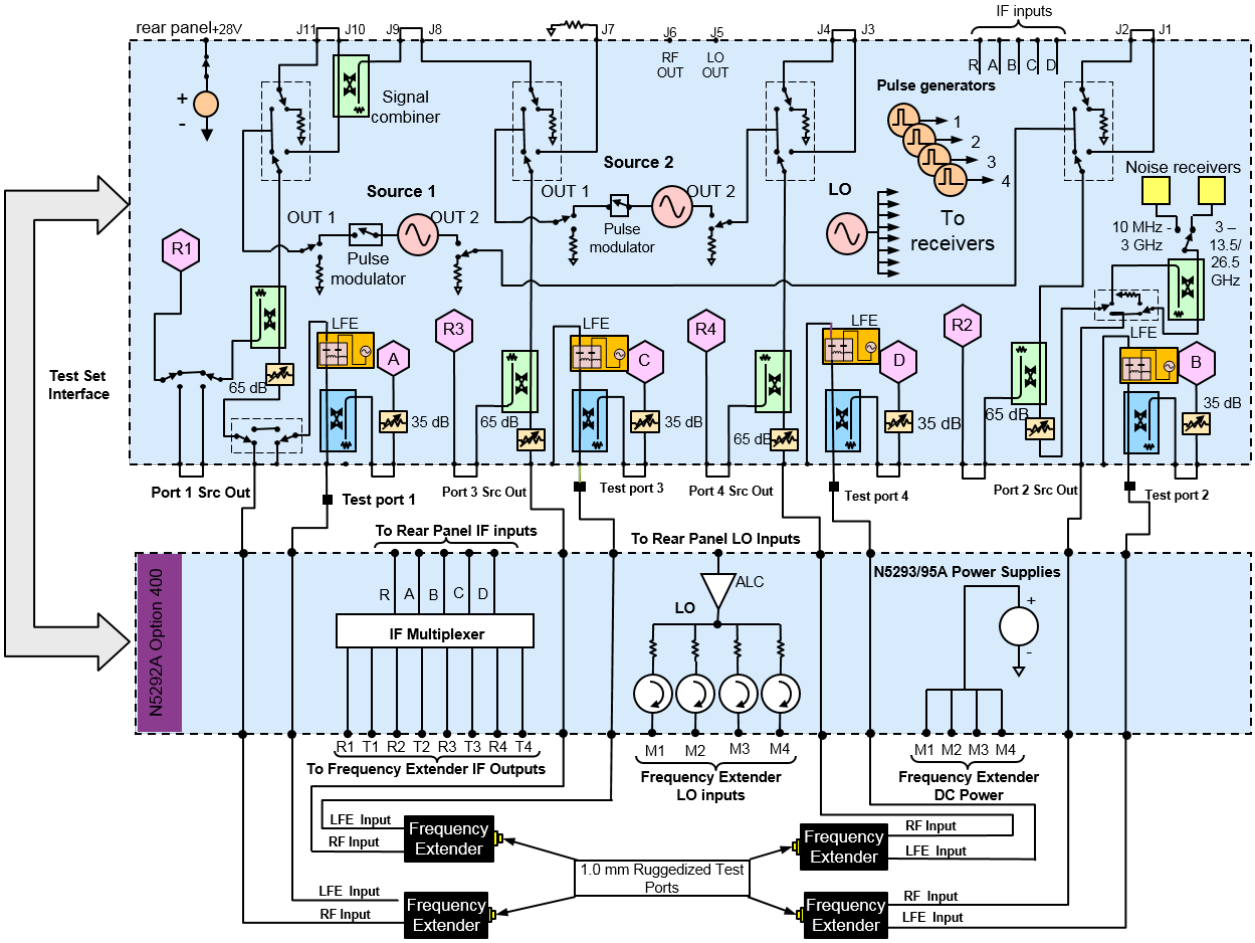


Figure 4. N5291A Option 402 System Level Block Diagram

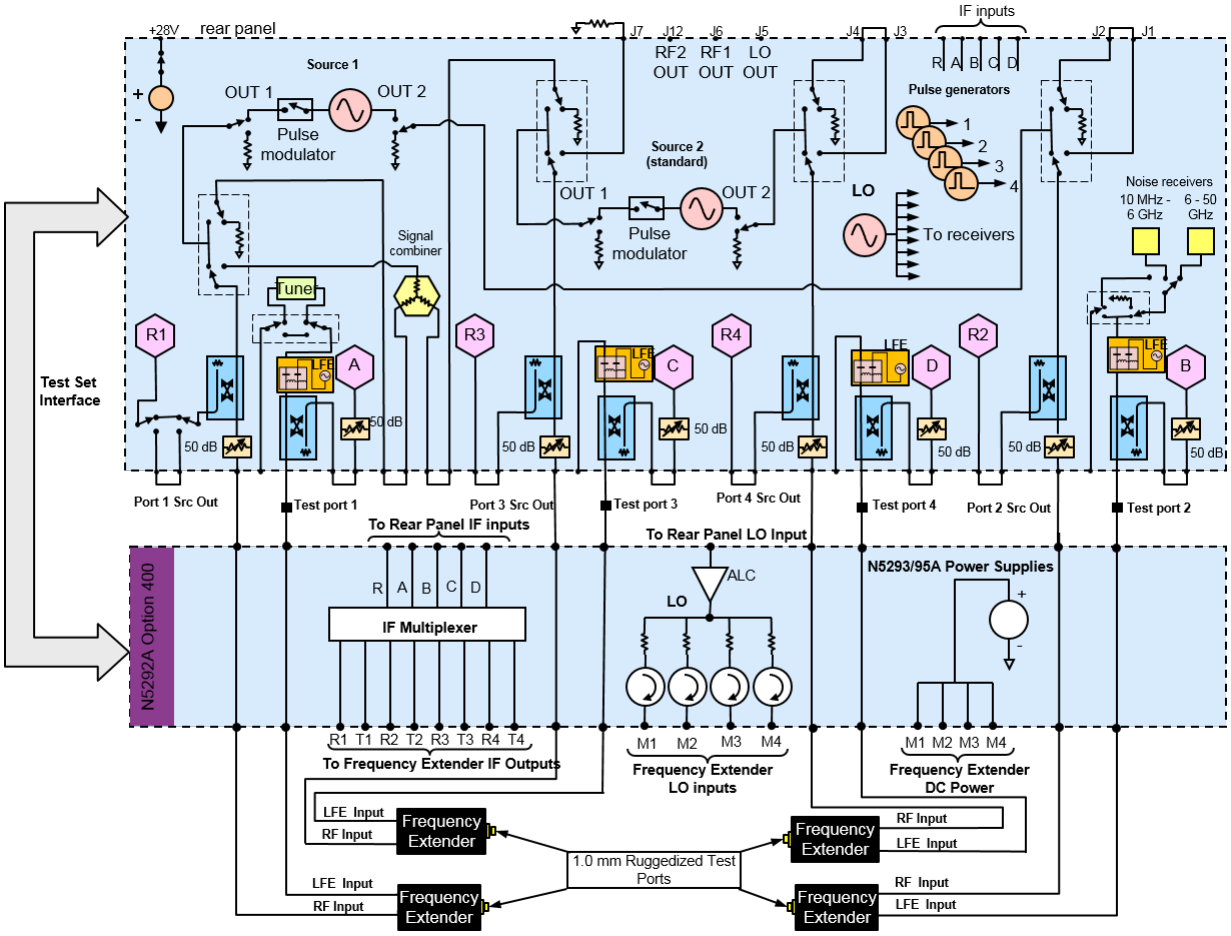


Figure 5. N5291A Option 403 System Level Block Diagram

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