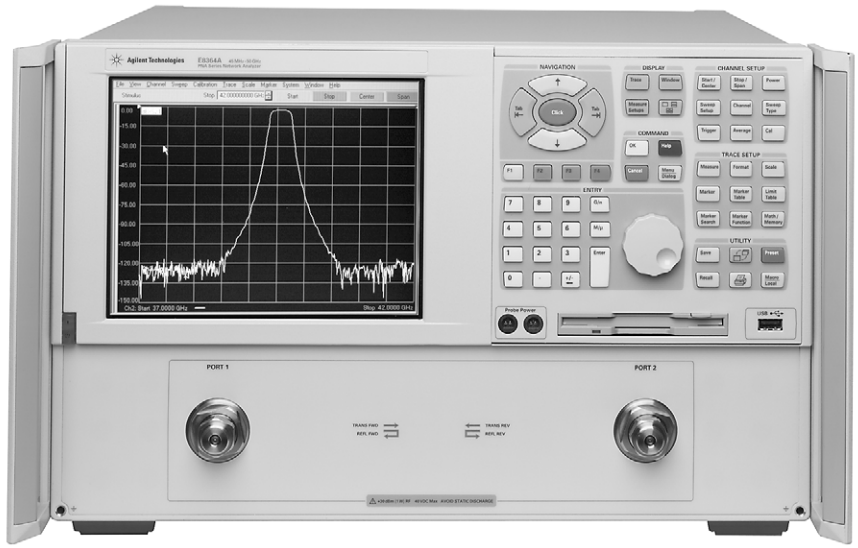
Agilent
PNA Series
Microwave Network Analyzers

Data Sheet



This document describes the performance and features of the Agilent Technologies PNA Series microwave vector network analyzers:

E8362B	**10 MHz to 20 GHz**
E8363B	**10 MHz to 40 GHz**
E8364B	**10 MHz to 50 GHz**
E8361A	**10 MHz to 67 GHz**

Some 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.

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

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.

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.

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

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.

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

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

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

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Corrected System Performance

The specifications in this section apply for measurements made with the Agilent E8362/3/4B PNA Series microwave network analyzer with the following conditions:

- 10 Hz IF bandwidth
- no averaging applied to data
- isolation calibration with an averaging factor of 8

Note: Sample of uncertainty curves are included in this Data Sheet. Please download our free uncertainty calculator (www. agilent .com/find/na_calculator) to generate the curves for your setup.

System Dynamic Range[1]

Description	Specification (dB) at test port[2]	Typical (dB) at direct receiver access input[3]	Supplemental information
Dynamic range			
Standard configuration and standard power range (E8362/3/4B)			
10 MHz to 45 MHz[4]	78	N/A	
45 to 500 MHz[5]	94	N/A	
500 MHz to 2 GHz	119	N/A	
2 to 10 GHz	122	N/A	
10 to 20 GHz	123	N/A	
20 to 30 GHz	114	N/A	
30 to 40 GHz	110	N/A	
40 to 45 GHz	109	N/A	
45 to 50 GHz	104	N/A	
Extended configuration and standard power range (E8362/3/4B-Option 014)			
10 MHz to 45 MHz[4]	78	130	
45 to 500 MHz[5]	94	132	
500 MHz to 2 GHz	119	138	
2 to 10 GHz	122	137	
10 to 20 GHz	121	136	
20 to 30 GHz	111	123	Option 016 degrades performance by 2 dB
30 to 40 GHz	107	119	
40 to 45 GHz	105	116	
45 to 50 GHz	100	111	
Standard configuration and extended power range and bias-tees (E8362/3/4B-Option UNL)			
10 MHz to 45 MHz[4]	76	N/A	
45 to 500 MHz[5]	92	N/A	
500 MHz to 2 GHz	117	N/A	
2 to 10 GHz	120	N/A	
10 to 20 GHz	121	N/A	
20 to 30 GHz	112	N/A	
30 to 40 GHz	108	N/A	
40 to 45 GHz	105	N/A	
45 to 50 GHz	99	N/A	
Extended configuration and extended power range and bias-tees (E8362/3/4B-Option UNL and Option 014)			
10 MHz to 45 MHz[4]	76	128	
45 to 500 MHz[5]	92	130	
500 MHz to 2 GHz	117	136	
2 to 10 GHz	120	135	
10 to 20 GHz	119	134	
20 to 30 GHz	109	121	Option 016 degrades performance by 2 dB
30 to 40 GHz	105	117	
40 to 45 GHz	101	112	
45 to 50 GHz	95	108	

1. The system dynamic range is calculated as the difference between the noise floor and the source maximum output power. The effective dynamic range must take measurement uncertainties and interfering signals into account.
2. The test port system dynamic range is calculated as the difference between the test port noise floor and the source maximum output power. The effective dynamic range must take measurement uncertainties and interfering signals into account.
3. The direct receiver access input system dynamic range is calculated as the difference between the direct receiver access input noise floor and the source maximum output power. The effective dynamic range must take measurement uncertainties and interfering signals into account. This set-up should only be used when the receiver input will never exceed its damage level. When the analyzer is in segment sweep mode, the analyzer can have pre-defined frequency segments which will output a higher power level when the extended dynamic range is required (i.e. devices with high insertion loss), and reduced power when receiver damage may occur (i.e. devices with low insertion loss). The extended range is only available in one-path transmission measurements.
4. Typical performance.
5. May be limited to 100 dB at particular frequencies below 500 MHz due to spurious receiver residuals. Methods are available to regain the full dynamic range.

Receiver Dynamic Range[1]

Description	Specification (dB) at test port[2]	Typical (dB) at direct receiver access input[3]	Supplemental information
Dynamic range			
Standard configuration and standard power range (E8362/3/4B) or standard configuration and extended power range and bias-tees (E8362/3/4B-Option UNL)			
10 MHz to 45 MHz[4]	83	N/A	
45 to 500 MHz[5]	94	N/A	
500 MHz to 2 GHz	119	N/A	
2 to 10 GHz	122	N/A	
10 to 20 GHz	125	N/A	
20 to 30 GHz	114	N/A	Option 016 degrades performance by 2 dB
30 to 40 GHz	111	N/A	Option 016 degrades performance by 2 dB
40 to 50 GHz	111	N/A	Option 016 degrades performance by 2 dB
Extended configuration and standard power range (E8362/3/4B) or extended configuration and extended power range and bias-tees (E8362/3/4B-Option 014 and Option UNL)			
10 MHz to 45 MHz[4]	83	133	
45 to 500 MHz[5]	94	132	
500 MHz to 2 GHz	119	138	
2 to 10 GHz	122	137	
10 to 20 GHz	124	139	
20 to 40 GHz	113	125	Option 016 degrades performance by 2 dB
40 to 45 GHz	110	122	Option 016 degrades performance by 2 dB
45 to 50 GHz	109	120	Option 016 degrades performance by 2 dB

1. The receiver dynamic range is calculated as the difference between the noise floor and the receiver maximum input level. The effective dynamic range must take measurement uncertainties and interfering signals into account.
2. The test port receiver dynamic range is calculated as the difference between the test port noise floor and the receiver maximum input level. The effective dynamic range must take measurement uncertainties and interfering signals into account.
3. The direct receiver access input receiver dynamic range is calculated as the difference between the direct receiver access input noise floor and the receiver maximum input level. The effective dynamic range must take measurement uncertainties and interfering signals into account. This set-up should only be used when the receiver input will never exceed its damage level. When the analyzer is in segment sweep mode, the analyzer can have pre-defined frequency segments which will output a higher power level when the extended dynamic range is required (i.e. devices with high insertion loss), and reduced power when receiver damage may occur (i.e. devices with low insertion loss). The extended range is only available in one-path transmission measurements.
4. Typical performance.
5. May be limited to 100 dB at particular frequencies below 500 MHz due to spurious receiver residuals. Methods are available to regain the full dynamic range.

Corrected System Performance With 2.4 mm Connectors

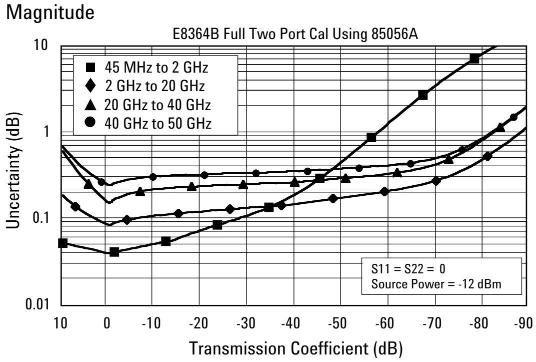
Standard configuration and standard power range (E8363/4B)

Applies to E8363/4B PNA Series analyzer, 85056A (2.4 mm) calibration kit, 85133F flexible test port cable set, and a full two-port calibration. (Specifications apply over environmental temperature of 23° ±3°C, with less than 1°C deviation from calibration temperature.)

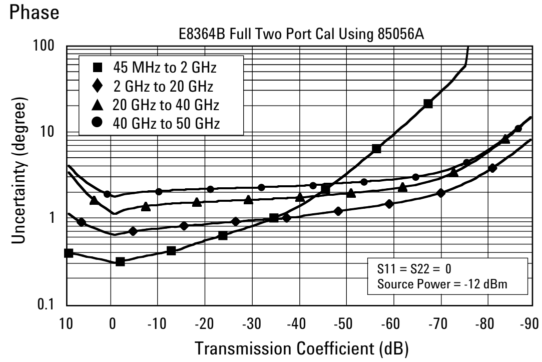
Description	Specification (dB)			
	45 MHz to 2 GHz	2 to 20 GHz	20 to 40 GHz	40 to 50 GHz
Directivity	42	42	38	36
Source match	41	38	33	31
Load match	42	42	37	35
Reflection tracking	0.001	0.008	0.020	0.027
Transmission tracking	0.01	0.049	0.105	0.186

Transmission uncertainty (specifications)

Magnitude

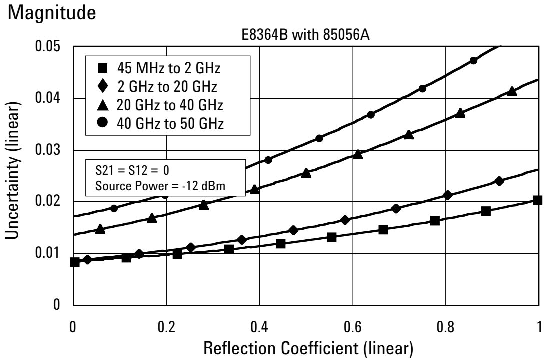


Phase



Reflection uncertainty (specifications)

Magnitude



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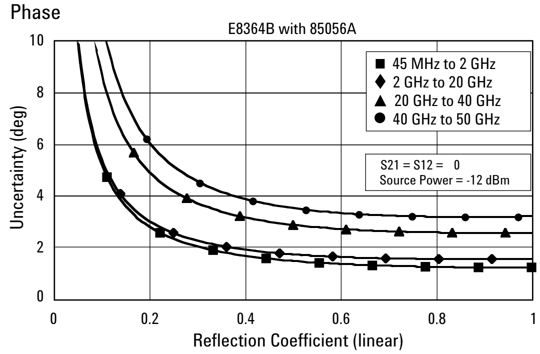


1. Typical performance.

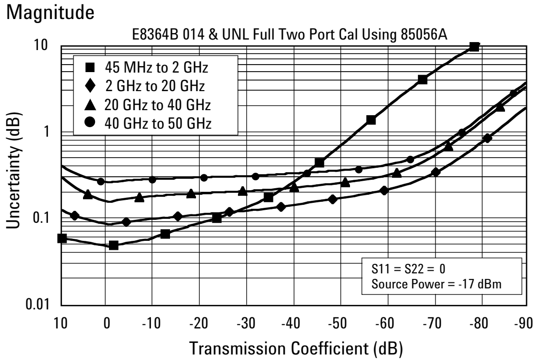
Configurable test set and extended power range (E8363/4B-Option 014/UNL)

Applies to E8363/4B PNA Series analyzer, 85056A (2.4 mm) calibration kit, 85133F flexible test port cable set, and a full two-port calibration. (Specifications apply over environmental temperature of 23°±3°C, with less than 1°C deviation from calibration temperature.)

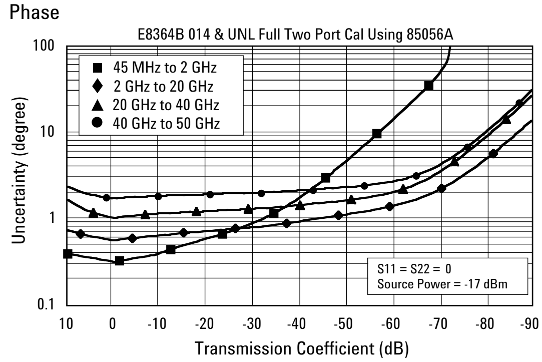
Description	**Specification (dB)**				
	45 MHz to 2 GHz	**2 to 20 GHz**	**20 to 40 GHz**	**40 to 50 GHz**	
Directivity	42	42	42	38	36
Source match	41	38	38	33	31
Load match	42	42	42	37	35
Reflection tracking	0.001	0.008	0.008	0.020	0.027
Transmission tracking	0.019	0.039	0.053	0.114	0.215

Transmission uncertainty (specifications)

Magnitude

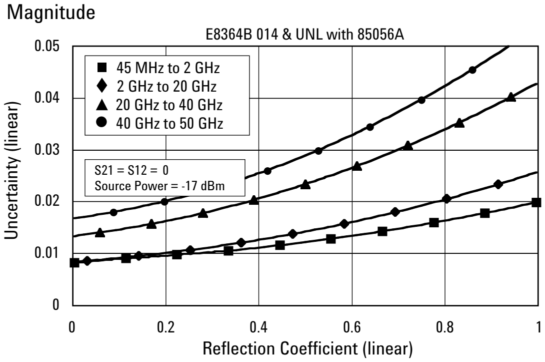


Phase



Reflection uncertainty (specifications)

Magnitude



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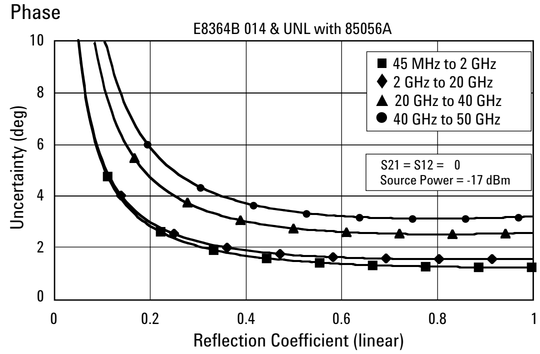


1. Typical performance.

Corrected System Performance With 3.5 mm Connectors

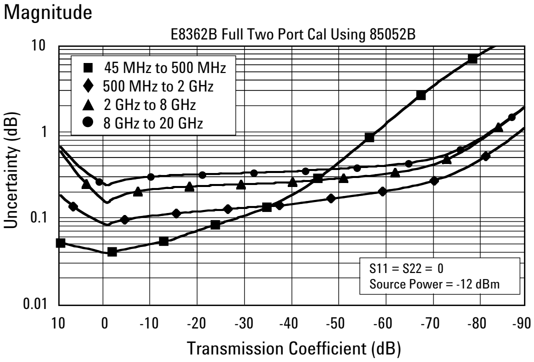
Standard configuration and standard power range (E8362B)

Applies to E8362B PNA Series analyzer, 85052B (3.5 mm) calibration kit, 85131F flexible test port cable set, and a full two-port calibration. (Specifications apply over environmental temperature of 23° ±3°C, with less than 1°C deviation from calibration temperature.)

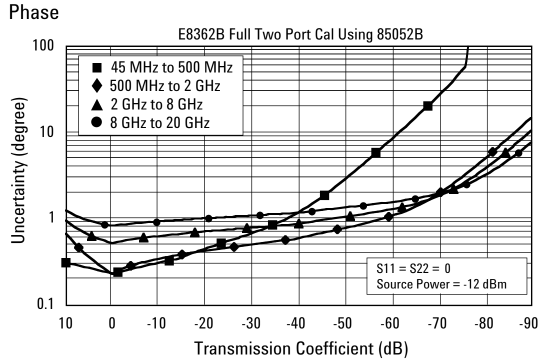
Description	Specification (dB)			
	45 MHz to 500 MHz	500 MHz to 2 GHz	2 to 8 GHz	8 to 20 GHz
Directivity	48	48	44	44
Source match	40	40	33	31
Load match	48	48	44	44
Reflection tracking	0.003	0.003	0.003	0.006
Transmission tracking	0.009	0.009	0.047	0.088

Transmission uncertainty (specifications)

Magnitude

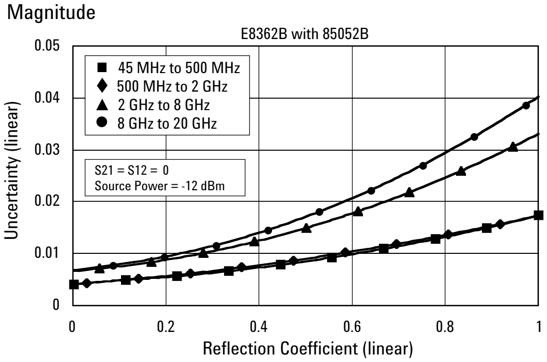


Phase

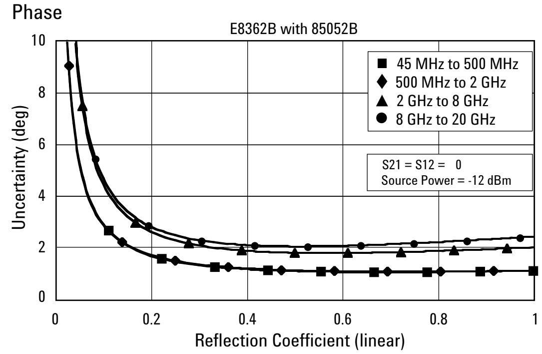


Reflection uncertainty (specifications)

Magnitude



Phase



1. Typical performance.

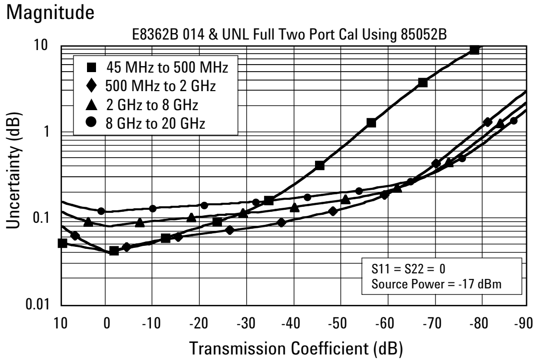
Configurable test set and extended power range (E8362B-Option 014/UNL)

Applies to E8362B PNA Series analyzer, 85052B (3.5 mm) calibration kit, 85131F flexible test port cable set, and a full two-port calibration. (Specifications apply over environmental temperature of 23° ±3°C, with less than 1°C deviation from calibration temperature.)

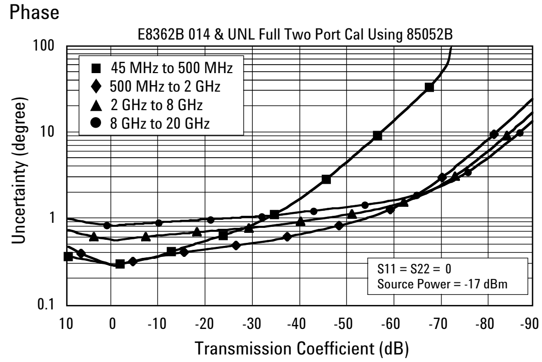
Description	Specification (dB)			
	45 MHz to 500 MHz	500 MHz to 2 GHz	2 to 8 GHz	8 to 20 GHz
Directivity	48	48	44	44
Source match	40	40	33	31
Load match	48	48	44	44
Reflection tracking	0.003	0.003	0.003	0.006
Transmission tracking	0.017	0.017	0.054	0.091

Transmission uncertainty (specifications)

Magnitude

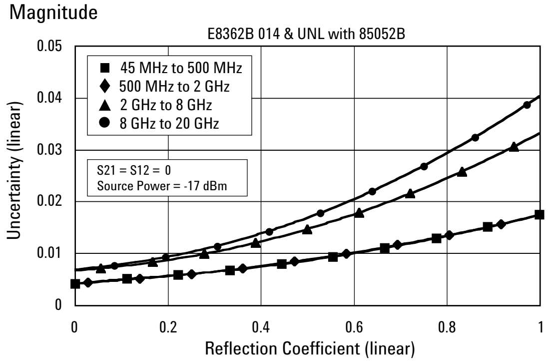


Phase

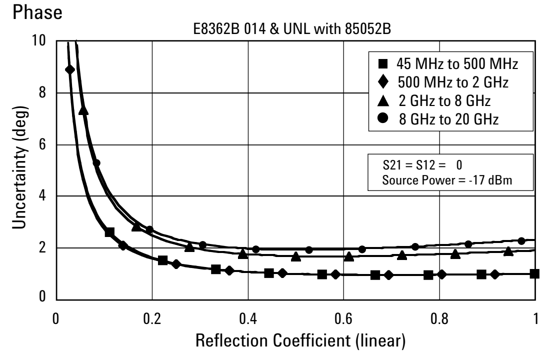


Reflection uncertainty (specifications)

Magnitude



Phase



1. Typical performance.

Uncorrected System Performance[1]

Description	Specification	Supplemental information
Directivity		Typical:
10 MHz to 45 MHz[2]	22 dB	22 dB
45 MHz to 2 GHz	24 dB	29 dB
2 to 10 GHz	22 dB	25 dB
10 to 20 GHz	16 dB	20 dB
20 to 40 GHz	16 dB	20 dB
40 to 45 GHz	15 dB	18 dB
45 to 50 GHz	13 dB	18 dB
Source match - standard		Typical:
10 MHz to 45 MHz[2]	17 dB	17 dB
45 MHz to 2 GHz	23 dB	27 dB
2 to 10 GHz	16 dB	19 dB
10 to 20 GHz	14 dB	19 dB
20 to 40 GHz	10 dB	14 dB
40 to 45 GHz	9 dB	13.5 dB
45 to 50 GHz	5.5 dB	9 dB
Source match - Option UNL, 014, or UNL and 014		Typical:
10 MHz to 45 MHz[2]	12 dB	12 dB
45 MHz to 2 GHz	18 dB	22.5 dB
2 to 10 GHz	14 dB	18 dB
10 to 20 GHz	12 dB	15 dB
20 to 40 GHz	8 dB	10 dB
40 to 45 GHz	7 dB	10 dB
45 to 50 GHz	4 dB	6.5 dB
Load match - standard		Typical:
10 MHz to 45 MHz[2]	20 dB	20 dB
45 MHz to 2 GHz	23 dB	29 dB
2 to 10 GHz	14 dB	16 dB
10 to 20 GHz	10 dB	12 dB
20 GHz to 40 GHz	9 dB	12 dB
40 to 45 GHz	9 dB	13 dB
45 to 50 GHz	7 dB	10 dB
Load match - Option UNL, 014, or UNL and 014		Typical:
10 MHz to 45 MHz[2]	12 dB	12 dB
45 MHz to 2 GHz	17 dB	21.5 dB
2 to 10 GHz	13 dB	16.5 dB
10 to 20 GHz	10 dB	13 dB
20 to 40 GHz	9 dB	11 dB
40 to 45 GHz	8 dB	11 dB
45 to 50 GHz	6 dB	8 dB
Reflection tracking		Typical:
10 MHz to 45 MHz[2]		±1.5 dB
45 MHz to 20 GHz		±1.5 dB
20 to 40 GHz		±1.5 dB
40 to 50 GHz		±2.0 dB
Transmission tracking[3]		Typical:
10 MHz to 45 MHz[2]		±2.0 dB
45 MHz to 2 GHz		±1.5 dB
2 to 10 GHz		±2.0 dB
10 to 20 GHz		±2.5 dB
20 to 40 GHz		±3.5 dB
40 to 45 GHz		±4.0 dB
45 to 50 GHz		±4.5 dB

1. Specifications apply over environment temperature of 23°C ±3°C, with less than 1°C deviation from the calibration temperature.
2. Typical performance.
3. Transmission tracking performance is strongly dependent on cable used; These typical specifications are set based on the use of Agilent through cable part number 85133-60016.

Description	Specification	Supplemental information
Crosstalk[1] - standard		
10 MHz to 45 MHz[2]	85 dB	
45 MHz to 1 GHz	85 dB	
1 to 2 GHz	100 dB	
2 to 20 GHz	110 dB	
20 to 40 GHz	108 dB	
40 to 45 GHz	105 dB	
45 to 50 GHz	100 dB	
Crosstalk[1] - Option UNL or 014		
10 MHz to 45 MHz[2]	85 dB	
45 MHz to 1 GHz	85 dB	
1 to 2 GHz	100 dB	
2 to 20 GHz	109 dB	
20 to 40 GHz	106 dB	
40 to 45 GHz	103 dB	
45 to 50 GHz	98 dB	
Crosstalk[1] - Option UNL and 014		
10 MHz to 45 MHz[2]	85 dB	
45 MHz to 1 GHz	85 dB	
1 to 2 GHz	98 dB	
2 to 10 GHz	108 dB	
10 to 20 GHz	107 dB	
20 to 40 GHz	104 dB	
40 to 45 GHz	100 dB	
45 to 50 GHz	95 dB	
Preliminary Crosstalk - Option 080 enabled[3]		Typical:
10 MHz to 45 MHz[2]		85 dB
45 MHz to 1 GHz		95 dB
1 to 2 GHz		108 dB
2 to 10 GHz		115 dB
10 to 20 GHz		120 dB
20 to 40 GHz		115 dB
40 to 45 GHz		112 dB
45 to 50 GHz		105 dB

1. Measurement conditions: Normalized to a thru, measured with two shorts, 10 Hz IF bandwidth, averaging factor of 8, source power set to the lesser of the maximum power out or the maximum receiver power.
2. Typical performance.
3. 0 Hz offset.

Test Port Output[1]

Description	Specification: Standard	014	UNL	UNL and 014	Supplemental information
Frequency range					
E8362A	10 MHz to 20 GHz				
E8363A	10 MHz to 40 GHz				
E8364A	10 MHz to 50 GHz				
Nominal power[2]	-12 dBm	-17 dBm	-17 dBm	-17 dBm	
Frequency resolution	1 Hz	1 Hz	1 Hz	1 Hz	
CW accuracy	± 1ppm	± 1ppm	± 1ppm	± 1ppm	
Frequency stability					±1 ppm 0 to 40°C, typical ±0.2 ppm/yr, typical
Power level accuracy					
10 MHz to 45 MHz[3]	±1.5 dB	±1.5 dB	±1.5 dB	±1.5 dB	
45 MHz to 10 GHz	±1.5 dB	±1.5 dB	±1.5 dB	±1.5 dB	Variation from nominal
10 to 20 GHz	±2.0 dB	±2.0 dB	±2.0 dB	±2.0 dB	power in range 0
20 to 40 GHz	±3.0 dB	±3.0 dB	±3.0 dB	±3.0 dB	(step attenuator at 0 dB).
40 to 45 GHz	±3.0 dB	±3.5 dB	±3.0 dB	±3.5 dB	
45 to 50 GHz	±3.0 dB	±4.0 dB	±3.0 dB	±4.0 dB	
Power level linearity					
10 MHz to 45 MHz[3]	±0.5 dB	±0.5 dB	±0.5 dB	±0.5 dB	
45 MHz to 20 GHz	±1.0 dB	±1.0 dB	±1.0 dB[4]	±1.0 dB[4]	Test reference is at the
20 to 40 GHz	±1.0 dB	±1.0 dB	±1.0 dB[4]	±1.0 dB[4]	nominal power level
40 to 50 GHz	±1.0 dB	±1.0 dB	±1.0 dB	±1.0 dB	(step attenuator at 0 dB).
Power range[5]					
10 MHz to 45 MHz[3]	-25 to +2 dB	-25 to +2 dBm	-87 to 0 dBm	-87 to 0 dBm	
45 MHz to 10 GHz	-25 to +5 dB	-25 to +5 dBm	-87 to +3 dBm	-87 to +3 dBm	
10 to 20 GHz	-24 to +3 dB	-25 to +2 dBm	-86 to +1 dBm	-87 to 0 dBm	
20 to 30 GHz	-23 to 0 dBm	-25 to -2 dBm	-85 to -2 dBm	-87 to -4 dBm	
30 to 40 GHz	-23 to -4 dBm	-25 to - 6 dBm	-85 to -6 dBm	-87 to -8 dBm	
40 to 45 GHz	-25 to -5 dBm	-27 to -7 dBm	-87 to -9 dBm	-87 to -11 dBm	
45 to 50 GHz	-25 to -10 dBm	-27 to -12 dBm	-87 to -15 dBm	-87 to -17 dBm	
Power sweep range (ALC)					
10 MHz to 45 MHz[3]	27 dB	27 dB	27 dB	27 dB	
45 MHz to 10 GHz	30 dB	30 dB	30 dB	30 dB	ALC range starts at
10 to 20 GHz	27 dB	27 dB	27 dB	27 dB	maximum leveled output
20 to 30 GHz	23 dB	23 dB	23 dB	23 dB	power and goes down to
30 to 40 GHz	19 dB	19 dB	19 dB	19 dB	power level indicated by
40 to 45 GHz	20 dB	20 dB	18 dB	16 dB	dB amount specified.
45 to 50 GHz	15 dB	15 dB	12 dB	10 dB	
Power resolution	0.01 dB	0.01 dB	0.01 dB	0.01 dB	

1. Source output performance on port 1 only. Port 2 output performance is typical.
2. Preset power.
3. Typical performance.
4. ±1.5 dB for power ≤ -23 dBm.
5. Power to which the source can be set and phase lock is assured.

Test Port Output[1] *continued*

Description	Specification	Supplemental information
Phase noise (10 kHz offset from center frequency, nominal power at test port)		
10 MHz to 45 MHz[2]		-70 dBc typical
45 MHz to 10 GHz		-70 dBc typical
10 to 20 GHz		-65 dBc typical
20 to 40 GHz		-55 dBc typical
40 to 50 GHz		-55 dBc typical
Phase noise (10 kHz offset from center frequency, nominal power at test port) – Option 080 must be enabled		
10 MHz to 45 MHz[2]		-70 dBc typical
45 MHz to 10 GHz		-70 dBc typical
10 to 20 GHz		-65 dBc typical
20 to 40 GHz		-55 dBc typical
40 to 50 GHz		-55 dBc typical
Harmonics (2nd or 3rd)		-23 dBc typical, at max power
Non-harmonic spurious (at nominal output power)		
10 MHz to 45 MHz[2]		-50 dBc typical, for offset frequency > 1 kHz
45 MHz to 20 GHz		-50 dBc typical, for offset frequency > 1 kHz
20 to 40 GHz		-30 dBc typical, for offset frequency > 1 kHz
40 to 50 GHz		-30 dBc typical, for offset frequency > 1 kHz

1. Source output performance on port 1 only. Port 2 output performance is typical.
2. Typical performance.

Test Port Input

Description	Specification				Supplemental information
	Standard	014	UNL	UNL and 014	
Test port noise floor[1]					
10 Hz IF bandwidth					
10 MHz to 45 MHz[2]	< -78 dBm	< -78 dBm	< -78 dBm	< -78 dBm	
45 to 500 MHz[3]	< -89 dBm	< -89 dBm	< -89 dBm	< -89 dBm	
500 MHz to 2 GHz	< -114 dBm	< -114 dBm	< -114 dBm	< -114 dBm	
2 to 10 GHz	< -117 dBm	< -117 dBm	< -117 dBm	< -117 dBm	
10 to 20 GHz	< -120 dBm	< -119 dBm	< -120 dBm	< -119 dBm	
20 to 40 GHz	< -114 dBm	< -113 dBm	< -114 dBm	< -113 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz	< -114 dBm	< -112 dBm	< -114 dBm	< -112 dBm	Option 016 degrades performance by 2 dB
1 kHz IF bandwidth					
10 MHz to 45 MHz[2]	< -58 dBm	< -58 dBm	< -58 dBm	< -58 dBm	
45 to 500 MHz[3]	< -69 dBm	< -69 dBm	< -69 dBm	< -69 dBm	
500 MHz to 2 GHz	< -94 dBm	< -94 dBm	< -94 dBm	< -94 dBm	
2 to 10 GHz	< -97 dBm	< -97 dBm	< -97 dBm	< -97 dBm	
10 to 20 GHz	< -100 dBm	< -99 dBm	< -100 dBm	< -99 dBm	
20 to 40 GHz	< -94 dBm	< -93 dBm	< -94 dBm	< -93 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz	< -94 dBm	< -92 dBm	< -94 dBm	< -92 dBm	Option 016 degrades performance by 2 dB
Preliminary Test port noise floor[1,2] **- Option 080 enabled**[4]					
10 Hz IF bandwidth					
10 MHz to 45 MHz[2]	< -78 dBm	< -78 dBm	< -78 dBm	< -78 dBm	
45 to 500 MHz[3]	< -98 dBm	< -98 dBm	< -98 dBm	< -98 dBm	
500 MHz to 2 GHz	< -115 dBm	< -115 dBm	< -115 dBm	< -115 dBm	
2 to 10 GHz	< -118 dBm	< -118 dBm	< -118 dBm	< -118 dBm	
10 to 20 GHz	< -121 dBm	< -120 dBm	< -121 dBm	< -120 dBm	
20 to 40 GHz	< -113 dBm	< -112 dBm	< -113 dBm	< -112 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz	< -114 dBm	< -112 dBm	< -114 dBm	< -112 dBm	Option 016 degrades performance by 2 dB
1 kHz IF bandwidth					
10 MHz to 45 MHz[2]	< -58 dBm	< -58 dBm	< -58 dBm	< -58 dBm	
45 to 500 MHz[3]	< -78 dBm	< -78 dBm	< -78 dBm	< -78 dBm	
500 MHz to 2 GHz	< -95 dBm	< -95 dBm	< -95 dBm	< -95 dBm	
2 to 10 GHz	< -98 dBm	< -98 dBm	< -98 dBm	< -98 dBm	
10 to 20 GHz	< -101 dBm	< -100 dBm	< -101 dBm	< -100 dBm	
20 to 40 GHz	< -93 dBm	< -92 dBm	< -93 dBm	< -92 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz	< -94 dBm	< -92 dBm	< -94 dBm	< -92 dBm	Option 016 degrades performance by 2 dB
Direct receiver access input noise floor[1,2]					
10 Hz IF bandwidth					
10 MHz to 45 MHz		< -128 dBm		< -128 dBm	
45 to 500 MHz		< -127 dBm		< -127 dBm	
500 MHz to 2 GHz		< -133 dBm		< -133 dBm	
2 to 10 GHz		< -132 dBm		< -132 dBm	
10 to 20 GHz		< -134 dBm		< -134 dBm	
20 to 40 GHz		< -125 dBm		< -125 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz		< -123 dBm		< -123 dBm	Option 016 degrades performance by 2 dB
1 kHz IF bandwidth					
10 MHz to 45 MHz		< -108 dBm		< -108 dBm	
45 to 500 MHz		< -107 dBm		< -107 dBm	
500 MHz to 2 GHz		< -113 dBm		< -113 dBm	
2 to 10 GHz		< -112 dBm		< -112 dBm	
10 to 20 GHz		< -114 dBm		< -114 dBm	
20 to 40 GHz		< -105 dBm		< -105 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz		< -103 dBm		< -103 dBm	Option 016 degrades performance by 2 dB

1. Total average (rms) noise power calculated as mean value of a linear magnitude trace expressed in dBm.
2. Typical performance.
3. Noise floor may be degraded by 10 dB at particular frequencies (multiples of 5 MHz) due to spurious receiver residuals.
4. 0 Hz offset.

Test Port Input *continued*

Description	Standard	014	UNL	UNL and 014	Supplemental information
Preliminary Direct receiver access input noise floor[1,2] - Option 080 enabled[4]					
10 Hz IF bandwidth					
10 MHz to 45 MHz		< -128 dBm		< -128 dBm	
45 to 500 MHz[3]		< -136 dBm		< -136 dBm	
500 MHz to 2 GHz		< -134 dBm		< -134 dBm	
2 to 10 GHz		< -133 dBm		< -133 dBm	
10 to 20 GHz		< -136 dBm		< -135 dBm	
20 to 40 GHz		< -125 dBm		< -124 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz		< -123 dBm		< -123 dBm	Option 016 degrades performance by 2 dB
1 kHz IF bandwidth					
10 MHz to 45 MHz		< -108 dBm		< -108 dBm	
45 to 500 MHz[3]		< -106 dBm		< -106 dBm	
500 MHz to 2 GHz		< -114 dBm		< -114 dBm	
2 to 10 GHz		< -110 dBm		< -110 dBm	
10 to 20 GHz		< -116 dBm		< -115 dBm	
20 to 40 GHz		< -105 dBm		< -104 dBm	Option 016 degrades performance by 2 dB
40 to 50 GHz		< -103 dBm		< -103 dBm	Option 016 degrades performance by 2 dB
Receiver compression level					
10 MHz to 45 MHz[2]		< 0.5 dB compression at +5 dBm			
45 MHz to 20 GHz		< 0.6 dB compression at +5 dBm			
20 to 30 GHz		< 0.6 dB compression at 0 dBm			
30 to 40 GHz		< 0.6 dB compression at -3 dBm			
40 to 50 GHz		< 0.6 dB compression at -3 dBm			
System compression level		max output power			See dynamic accuracy chart
Preliminary Third Order Intercept – Tone spacing from 100 kHz – 5 MHz					
		Typical:			
10 MHz to 500 MHz		+21 dBm with two – 7 dBm tones			
500 MHz to 20 GHz		+21 dBm with two – 7 dBm tones			
20 to 40 GHz		+18 dBm with two – 15 dBm tones			
40 to 50 GHz		+16 dBm with two – 21 dBm tones			
Preliminary Third Order Intercept – Tone spacing from 5 kHz – 20 MHz					
					Typical:
10 MHz to 500 MHz					+16 dBm with two – 7 dBm tones
500 MHz to 20 GHz					+16 dBm with two – 7 dBm tones
20 to 40 GHz					+15 dBm with two – 15 dBm tones
40 to 50 GHz					+15 dBm with two – 21 dBm tones
Preliminary Third Order Intercept – Tone spacing from 20 MHz – 50 MHz					
					Typical:
10 MHz to 500 MHz					+24 dBm with two – 7 dBm tones
500 MHz to 20 GHz					+24 dBm with two – 7 dBm tones
20 to 40 GHz					+20 dBm with two – 15 dBm tones
40 to 50 GHz					+20 dBm with two – 21 dBm tones

1. Total average (rms) noise power calculated as mean value of a linear magnitude trace expressed in dBm.
2. Typical performance.
3. Noise floor may be degraded by 10 dB at particular frequencies (multiples of 5 MHz) due to spurious receiver residuals.
4. 0 Hz offset.

Test Port Input *continued*

Description	Specification				Supplemental information
	Standard	014	UNL	UNL and 014	
Trace noise magnitude					
10 MHz to 45 MHz[1]		< 0.035 dB rms			
45 to 500 MHz		< 0.010 dB rms			1 kHz IF bandwidth
500 MHz to 20 GHz		< 0.006 dB rms			Ratio measurement, nominal
20 to 40 GHz		< 0.006 dB rms			power at test port
40 to 50 GHz		< 0.006 dB rms			
Preliminary Trace noise magnitude – Option 080 enabled[4]					
10 MHz to 45 MHz		< 0.03 dB rms			
45 to 500 MHz		< 0.006 dB rms			1 kHz IF bandwidth
500 MHz to 20 GHz		< 0.0025 dB rms			Ratio measurement, nominal
20 to 40 GHz		< 0.006 dB rms			power at test port
40 to 50 GHz		< 0.0075 dB rms			
Trace noise phase					
10 MHz to 45 MHz[1]		< 0.025° rms			
45 to 500 MHz[2]		< 0.100° rms			1 kHz IF bandwidth
500 MHz to 20 GHz		< 0.060° rms			Ratio measurement, nominal
20 to 40 GHz		< 0.100° rms			power at test port
40 to 50 GHz		< 0.100° rms			
Preliminary Trace noise phase – Option 080 enabled[4]					
10 MHz to 45 MHz		< 0.2° rms			
45 to 500 MHz		< 0.03° rms			1 kHz IF bandwidth
500 MHz to 20 GHz		< 0.02° rms			Ratio measurement, nominal
20 to 40 GHz		< 0.045° rms			power at test port
40 to 50 GHz		< 0.05° rms			
Reference level magnitude					
Range	±200 dB	±200 dB	±200 dB	±200 dB	
Resolution	0.001 dB	0.001 dB	0.001 dB	0.001 dB	
Reference level phase					
Range	±500°	±500°	±500°	±500°	
Resolution	0.01°	0.01°	0.01°	0.01°	
Stability magnitude[3]					Typical ratio measurement:
					Measured at the test port
10 MHz to 45 MHz					±0.05 dB/°C
45 MHz to 20 GHz					±0.02 dB/°C
20 to 40 GHz					±0.03 dB/°C
40 to 50 GHz					±0.04 dB/°C
Stability phase[3]					Typical ratio measurement:
					Measured at the test port
10 MHz to 45 MHz					±0.5 dB/°C
45 MHz to 20 GHz					±0.2°/°C
20 to 40 GHz					±0.5°/°C
40 to 50 GHz					±0.8°/°C
Damage input level					
Test port 1 and 2					20 dBm or ±40 VDC, typical
R1, R2 in					15 dBm or ±15 VDC, typical
A, B in					15 dBm or ±15 VDC, typical
Coupler thru (option 014 or UNL and 014)					30 dBm or ±40 VDC, typical
Coupler arm (option 014 or UNL and 014)					30 dBm or ±7 VDC, typical

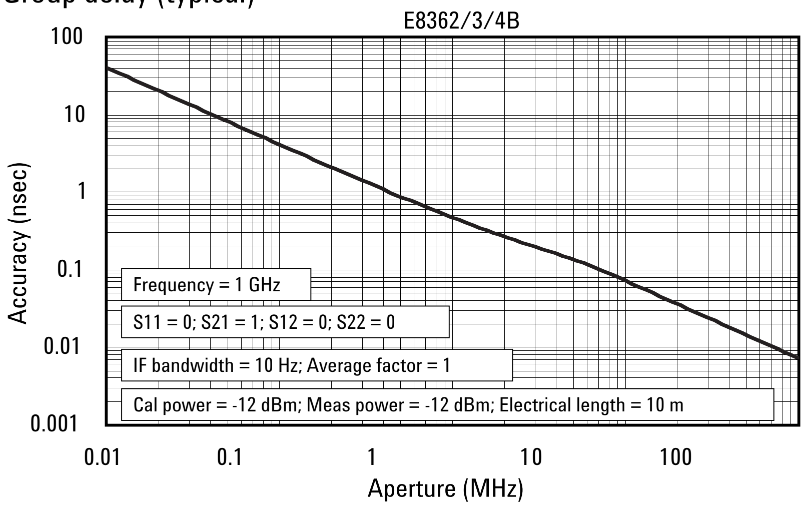
1. Typical performance.
2. Trace noise magnitude may be degraded to 20 mdB rms at harmonic frequencies of the first IF (8.33 MHz) below 80 MHz.
3. Stability is defined as a ratio measurement measured at the test port.
4. 0 Hz offset.

Group Delay[1]

Description	Specification	Supplemental information
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 graph shows characteristic group delay accuracy with type-N full 2-port calibration and a 10 Hz IF bandwidth. Insertion loss is assumed to be less than 2 dB and electrical length to be 10 m.

Group delay (typical)



In general, the following formula can be used to determine the accuracy, in seconds, of a specific group delay measurement:

±Phase accuracy (deg)/[360 x Aperture (Hz)]

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

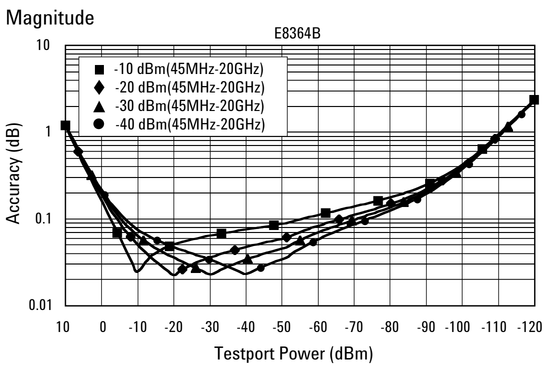
1. Group delay is computed by measuring the phase change within a specified frequency step (determined by the frequency span and the number of points per sweep).

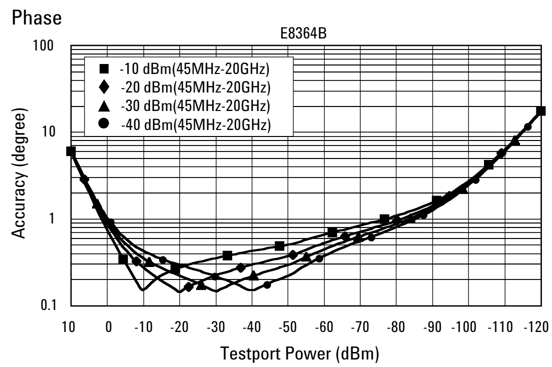
Test Port Input *continued*

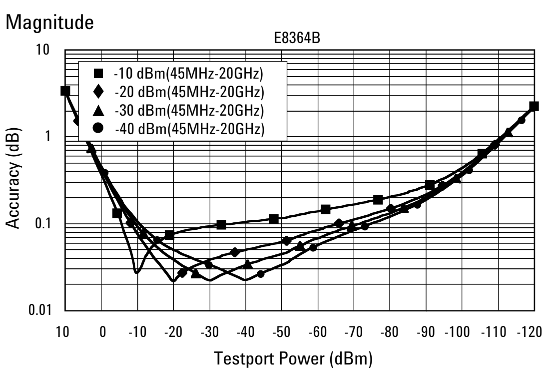
Dynamic accuracy

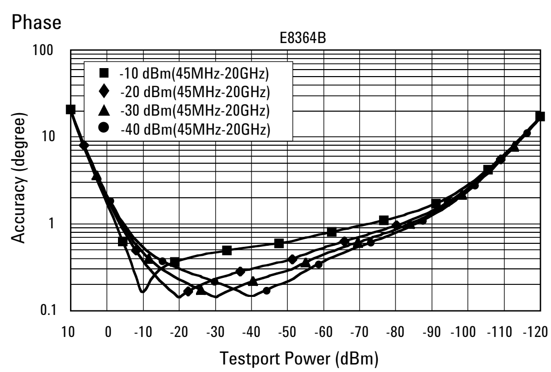
Applies to input ports 1 and 2, accuracy of the test port input power reading relative to the reference input power level. Also applies to the following conditions:

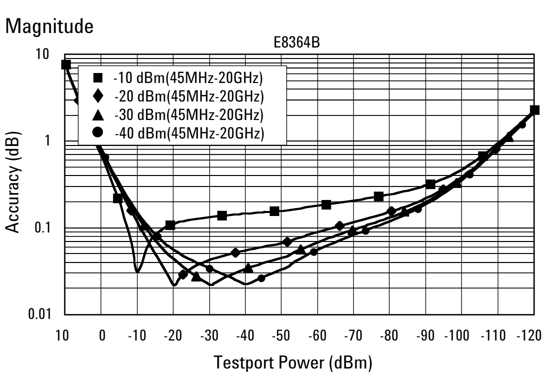
- IF bandwidth = 10 Hz
- test port input powers = > –50 dBm and < 0 dBm

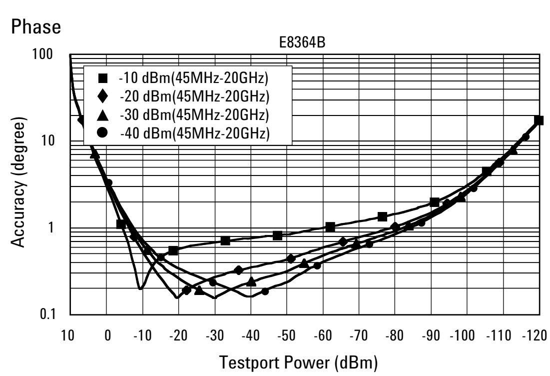












Preliminary Corrected System Performance

The specifications in this section apply for measurements made with the Agilent E8361A PNA Series microwave network analyzer with the following conditions:

- 10 Hz IF bandwidth
- no averaging applied to data
- isolation calibration with an averaging factor of 8

Preliminary system dynamic range[1]

Description	Specification (dB) at test port[2]	Typical (dB) at direct receiver access input[3]	Supplemental information
Dynamic range			
Standard configuration (E8361A)			
10 MHz to 45 MHz[4]	70	N/A	
45 to 500 MHz[5]	89	N/A	
500 MHz to 2 GHz	114	N/A	
2 to 10 GHz	117	N/A	
10 to 24 GHz	118	N/A	
24 to 30 GHz	109	N/A	
30 to 40 GHz	106	N/A	
40 to 45 GHz	99	N/A	
45 to 50 GHz	98	N/A	
50 to 60 GHz	97	N/A	
60 to 67 GHz	93	N/A	
67 to 70 GHz[4]	93	N/A	
Extended configuration (E8361A - Option 014 or Option 014 and 080)			
10 MHz to 45 MHz[4]	70	104	
45 to 500 MHz[5]	89	101	
500 MHz to 2 GHz	114	125	
2 to 10 GHz	117	128	
10 to 24 GHz	117	127	
24 to 30 GHz	108	118	
30 to 40 GHz	104	114	
40 to 45 GHz	97	106	
45 to 50 GHz	96	105	
50 to 60 GHz	94	102	
60 to 67 GHz	89	96	
67 to 70 GHz[4]	89	96	

1. The system dynamic range is calculated as the difference between the noise floor and the source maximum output power. The effective dynamic range must take measurement uncertainties and interfering signals into account, as well as the insertion loss resulting from a thru cable connected between port 1 and port 2.
2. The test port system dynamic range is calculated as the difference between the test port noise floor and the source maximum output power. The effective dynamic range must take measurement uncertainties and interfering signals into account, as well as the insertion loss resulting from a thru cable connected between port 1 and port 2.
3. The direct receiver access input system dynamic range is calculated as the difference between the direct receiver access input noise floor and the source maximum output power. The effective dynamic range must take measurement uncertainties and interfering signals into account. This set-up should only be used when the receiver input will never exceed its damage level. When the analyzer is in segment sweep mode, the analyzer can have pre-defined frequency segments which will output a higher power level when the extended dynamic range is required (i.e. devices with high insertion loss), and reduced power when receiver damage may occur (i.e. devices with low insertion loss). The extended range is only available in one-path transmission measurements.
4. Typical performance.
5. May be degraded by 10 dB at particular frequencies (multiples of 5 MHz) below 500 MHz due to spurious receiver residuals. Methods are available to regain the full dynamic range.

Preliminary Uncorrected System Performance[1]

Description	Specification
Directivity	
10 MHz to 45 MHz[2]	24 dB
45 MHz to 2 GHz	24 dB
2 to 10 GHz	20 dB
10 to 20 GHz	16 dB
20 to 50 GHz	15 dB
50 to 60 GHz	13 dB
60 to 67 GHz	12 dB
67 to 70 GHz[2]	12 dB
Source match - standard	
10 MHz to 45 MHz[2]	18 dB
45 MHz to 2 GHz	18 dB
2 to 10 GHz	14 dB
10 to 20 GHz	12 dB
20 to 45 GHz	7 dB
45 to 67 GHz	5 dB
67 to 70 GHz[2]	5 dB
Source match - Option 014	
10 MHz to 45 MHz[2]	18 dB
45 MHz to 2 GHz	18 dB
2 to 10 GHz	12 dB
10 to 20 GHz	12 dB
20 to 45 GHz	7 dB
45 to 67 GHz	5 dB
67 to 70 GHz[2]	5 dB
Load match - standard	
10 MHz to 45 MHz[2]	5 dB
45 MHz to 2 GHz	5 dB
2 to 10 GHz	8 dB
10 to 45 GHz	6 dB
45 to 50 GHz	5 dB
50 to 67 GHz	4 dB
67 to 70 GHz[2]	4 dB
Load match - Option 014	
10 MHz to 45 MHz[2]	5 dB
45 MHz to 2 GHz	5 dB
2 to 10 GHz	7 dB
10 to 45 GHz	6 dB
45 to 50 GHz	5 dB
50 to 67 GHz	4 dB
67 to 70 GHz[2]	4 dB

1. Specifications apply over environment temperature of 23°C ± 3°C, with less than 1°C deviation from the calibration temperature.
2. Typical performance.

Preliminary Uncorrected System Performance[1]

Description	Specification	Supplemental information
Reflection tracking		Typical:
10 MHz to 45 MHz		±1.5 dB
45 MHz to 20 GHz		±1.5 dB
20 to 40 GHz		±2.0 dB
40 to 50 GHz		±2.5 dB
50 to 67 GHz		±4.0 dB
67 to 70 GHz		±5.0 dB
Transmission tracking[3]		Typical:
10 MHz to 45 MHz		±1.5 dB
45 MHz to 20 GHz		±1.5 dB
20 to 40 GHz		±2.0 dB
40 to 50 GHz		±2.5 dB
50 to 67 GHz		±4.0 dB
67 to 70 GHz		±5.0 dB
Crosstalk[4] - standard		
10 MHz to 45 MHz	65 dB	
45 MHz to 1 GHz	85 dB	
1 to 2 GHz	100 dB	
2 to 24 GHz	110 dB	
24 to 40 GHz	104 dB	
40 to 50 GHz	98 dB	
50 to 60 GHz	97 dB	
60 to 67 GHz	93 dB	
67 to 70 GHz[2]	93 dB	
Crosstalk[4] - Option 014		
10 MHz to 45 MHz	65 dB	
45 MHz to 1 GHz	85 dB	
1 to 2 GHz	100 dB	
2 to 24 GHz	109 dB	
24 to 40 GHz	102 dB	
40 to 50 GHz	96 dB	
50 to 60 GHz	94 dB	
60 to 67 GHz	89 dB	
67 to 70 GHz[2]	89 dB	
Crosstalk - Option 014 with 080 enabled[5]		
		Typical:
10 MHz to 45 MHz[2]		65 dB
45 MHz to 1 GHz		85 dB
1 to 2 GHz		100 dB
2 to 24 GHz		109 dB
24 to 40 GHz		102 dB
40 to 50 GHz		96 dB
50 to 60 GHz		94 dB
60 to 67 GHz		89 dB
67 to 70 GHz[2]		89 dB

1. Specifications apply over environment temperature of 23°C ± 3°C, with less than 1°C deviation from the calibration temperature.
2. Typical performance.
3. Transmission tracking performance noted here is normalized to the insertion loss characteristcs of the cable used, so that the indicated performance is independent of cable use.
4. Measurement conditions: Normalized to a thru, measured with two shorts, 10-Hz IF bandwidth, averaging factor of 8, alternate mode, source power set to the lesser of the maximum power out or the maximum receiver power.
5. 0 Hz offset.

Preliminary Test Port Output

Description	Specification		Supplemental information
	Standard	**014**	
Frequency range			
E8361A	10 MHz to 67 GHz (Operation up to 70 GHz)		
Nominal power	-15 dBm	-15 dBm	
Frequency resolution	1 Hz	1 Hz	
CW accuracy	± 1ppm	± 1ppm	
Frequency stability			±1 ppm 0 to 40°C, typical ±0.2 ppm/yr, typical
Power level accuracy[1]			
10 MHz to 45 MHz[2]	±1.5 dB	±1.5 dB	
45 MHz to 10 GHz	±1.5 dB	±1.5 dB	Variation from nominal
10 to 20 GHz	±2.0 dB	±2.0 dB	power in range 0.
20 to 40 GHz	±3.0 dB	±3.0 dB	
40 to 45 GHz	±3.0 dB	±3.5 dB	
45 to 67 GHz	±4.5 dB	±4.5 dB	
67 to 70 GHz[2]	±6.0 dB	±6.0 dB	
Power level linearity[3]			
10 MHz to 45 MHz[2]	±1.5 dB	±1.5 dB	
45 MHz to 67 GHz	±1.0 dB	±1.0 dB	Test reference is at the
67 to 70 GHz[2]	±1.0 dB	±1.0 dB	nominal power level.
Power range[1,4]			
10 MHz to 45 MHz[2]	-27 to -10 dBm	-27 to -10 dBm	
45 MHz to 10 GHz	-27 to 0 dBm	-27 to 0 dBm	
10 to 30 GHz	-27 to +1 dBm	-27 to +1 dBm	
30 to 40 GHz	-27 to -2 dBm	-27 to -3 dBm	
40 to 45 GHz	-27 to -4 dBm	-27 to -5 dBm	
45 to 50 GHz	-27 to -5 dBm	-27 to -6 dBm	
50 to 60 GHz	-27 to -6 dBm	-27 to -7 dBm	
60 to 67 GHz	-27 to -10 dBm	-27 to -12 dBm	
67 to 70 GHz[2]	-25 to -10 dBm	-25 to -12 dBm	
Power sweep range (ALC)			
10 MHz to 45 MHz[2]	17 dB	17 dB	
45 MHz to 10 GHz	27 dB	27 dB	ALC range starts at
10 to 30 GHz	28 dB	28 dB	maximum leveled output
30 to 40 GHz	25 dB	24 dB	power and goes down to
40 to 45 GHz	23 dB	22 dB	power level indicated by
45 to 50 GHz	22 dB	21 dB	dB amount specified.
50 to 60 GHz	21 dB	20 dB	
60 to 67 GHz	17 dB	15 dB	
67 to 70 GHz[2]	15 dB	13 dB	
Power resolution	0.01 dB	0.01 dB	

1. Performance specified on port 1 only. Port 2 output performance is a characteristic.
2. Typical performance.
3. Power Level Linearity specified on Port 1 only; port 2 performance is typical.
4. Power to which the source can be set and phase lock is assured.

Preliminary Test Port Output *continued*

Description	Specification	Supplemental information
Phase noise (10 kHz offset from center frequency, nominal power at test port)		
10 MHz to 45 MHz		-70 dBc typical
45 MHz to 10 GHz		-70 dBc typical
10 to 20 GHz		-65 dBc typical
20 to 70 GHz		-55 dBc typical
Harmonics (2nd or 3rd)		-23 dBc typical, in power
Non-harmonic spurious (at nominal output power)		
10 MHz to 20 GHz		
20 MHz to 70 GHz		-50 dBc typical, for offset frequency > 1 kHz
		-30 dBc typical, for offset frequency > 1 kHz

Preliminary Test Port Input

Description	Specification		Supplemental information
	Standard	014	
Test port noise floor[1]			
10 Hz IF bandwidth			
10 MHz to 45 MHz[5]	< -80 dBm	< -80 dBm	
45 to 500 MHz[2]	< -89 dBm	< -89 dBm	
500 MHz to 2 GHz	< -114 dBm	< -114 dBm	
2 to 10 GHz	< -117 dBm	< -117 dBm	
10 to 24 GHz	< -117 dBm	< -116 dBm	
24 to 40 GHz	< -108 dBm	< -107 dBm	
40 to 50 GHz	< -103 dBm	< -102 dBm	
50 to 67 GHz	< -103 dBm	< -101 dBm	
67 to 70 GHz[5]	< -103 dBm	< -101 dBm	
1 kHz IF bandwidth			
10 MHz to 45 MHz[5]	< -60 dBm	< -60 dBm	
45 to 500 MHz[2]	< -69 dBm	< -69 dBm	
500 MHz to 2 GHz	< -94 dBm	< -94 dBm	
2 to 10 GHz	< -97 dBm	< -97 dBm	
10 to 24 GHz	< -97 dBm	< -96 dBm	
24 to 40 GHz	< -88 dBm	< -87 dBm	
40 to 50 GHz	< -83 dBm	< -82 dBm	
50 to 67 GHz	< -83 dBm	< -81 dBm	
67 to 70 GHz[5]	< -83 dBm	< -81 dBm	
Preliminary Test port noise floor[1] - Option 080 enabled[4]			
10 Hz IF bandwidth			Typical:
10 MHz to 45 MHz[5]			< -80 dBm
45 to 500 MHz[2]			< -89 dBm
500 MHz to 2 GHz			< -114 dBm
2 to 10 GHz			< -117 dBm
10 to 24 GHz			< -116 dBm
24 to 40 GHz			< -107 dBm
40 to 50 GHz			< -102 dBm
50 to 67 GHz			< -101 dBm
67 to 70 GHz[5]			< -101 dBm
1 kHz IF bandwidth			Typical:
10 MHz to 45 MHz[5]			< -60 dBm
45 to 500 MHz[2]			< -69 dBm
500 MHz to 2 GHz			< -94 dBm
2 to 10 GHz			< -97 dBm
10 to 24 GHz			< -96 dBm
24 to 40 GHz			< -87 dBm
40 to 50 GHz			< -82 dBm
50 to 67 GHz			< -81 dBm
67 to 70 GHz[5]			< -81 dBm

1. Total average (rms) noise power calculated as mean value of a linear magnitude trace expressed in dBm.
2. Noise floor may be degraded by 10 dB at particular frequencies (multiples of 5 MHz) due to spurious receiver residuals.
3. Coupler roll-off below 45 MHz makes input power into receiver so low that there is negligible compression at maximum test port output power.
4. 0 Hz offset.
5. Typical performance.

Preliminary Test Port Input *continued*

Description	Specification		Supplemental information
	Standard	**014**	
Direct receiver access input noise floor[1]			
10 Hz IF bandwidth			
10 MHz to 45 MHz[5]	< -114 dBm	< -114 dBm	
45 to 500 MHz[3]	< -101 dBm	< -101 dBm	
500 MHz to 2 GHz	< -125 dBm	< -125 dBm	
2 to 10 GHz	< -128 dBm	< -128 dBm	
10 to 24 GHz	< -126 dBm	< -126 dBm	
24 to 40 GHz	< -118 dBm	< -117 dBm	
40 to 50 GHz	< -112 dBm	< -111 dBm	
50 to 67 GHz	< -110 dBm	< -107 dBm	
67 to 70 GHz[5]	< -110 dBm	< -108 dBm	
1 kHz IF bandwidth			
10 MHz to 45 MHz[5]	< -94 dBm	< -94 dBm	
45 to 500 MHz[3]	< -81 dBm	< -81 dBm	
500 MHz to 2 GHz	< -105 dBm	< -105 dBm	
2 to 10 GHz	< -108 dBm	< -108 dBm	
10 to 24 GHz	< -107 dBm	< -107 dBm	
24 to 40 GHz	< -98 dBm	< -97 dBm	
40 to 50 GHz	< -92 dBm	< -91 dBm	
50 to 67 GHz	< -91 dBm	< -89 dBm	
67 to 70 GHz[5]	< -90 dBm	< -88 dBm	
Preliminary Direct receiver access input noise floor[1] - Option 080 enabled[3]			
10 Hz IF bandwidth			Typical:
10 MHz to 45 MHz[5]			< -114 dBm
45 to 500 MHz[3]			< -101 dBm
500 MHz to 2 GHz			< -125 dBm
2 to 10 GHz			< -128 dBm
10 to 24 GHz			< -127 dBm
24 to 40 GHz			< -117 dBm
40 to 50 GHz			< -111 dBm
50 to 67 GHz			< -109 dBm
67 to 70 GHz[5]			< -108 dBm
1 kHz IF bandwidth			Typical:
10 MHz to 45 MHz[5]			< -94 dBm
45 to 500 MHz[3]			< -81 dBm
500 MHz to 2 GHz			< -105 dBm
2 to 10 GHz			< -108 dBm
10 to 24 GHz			< -107 dBm
24 to 40 GHz			< -97 dBm
40 to 50 GHz			< -91 dBm
50 to 67 GH			< -89 dBm
67 to 70 GHz[5]			< -88 dBm
Preliminary Third Order Intercept[4] – Tone spacing from 1 MHz to 20 MHz			
			Typical:
10 MHz to 500 MHz			+22 dBm with two – 7 dBm tones
500 MHz to 20 GHz			+19 dBm with two – 7 dBm tones
20 to 40 GHz			+20 dBm with two – 15 dBm tones
40 to 50 GHz			+20 dBm with two – 21 dBm tones
50 to 67 GHz			+22 dBm with two – 7 dBm tones
Preliminary Third Order Intercept[4] – Tone spacing from 20 MHz to 50 MHz			
			Typical:
10 MHz to 500 MHz			+25 dBm with two – 7 dBm tones
500 MHz to 20 GHz			+24 dBm with two – 7 dBm tones
20 to 40 GHz			+24 dBm with two – 15 dBm tones
40 to 50 GHz			+24 dBm with two – 21 dBm tones
50 to 67 GHz			+26 dBm with two – 7 dBm tones

1. Total average (rms) noise power calculated as mean value of a linear magnitude trace expressed in dBm.
2. Noise floor may be degraded by 10 dB at particular frequencies (multiples of 5 Mhz) due to spurious receiver residuals.
3. 0 Hz offset.
4. TOI is a typical specification that applies while the network anayzer receiver is in its linear range.
5. Typical performance

Preliminary Test Port Input *continued*

Description	Specification		Supplemental information
	Standard	014	
System compression level – at maximum leveled output power			
10 MHz to 45 MHz	Negligible[2]		See dynamic accuracy chart
45 to 67 MHz	< 0.2 dB mag compression and < 1.5 degrees phase compression		
Preliminary trace noise magnitude			
10 MHz to 45 MHz[4]	< 0.100 dB rms		
45 to 500 MHz	< 0.010 dB rms		1 kHz IF bandwidth
500 MHz to 24 GHz	< 0.006 dB rms		Ratio measurement, nominal
24 to 67 GHz	< 0.006 dB rms		power at test port
67 to 70 GHz[4]	< 0.006 dB rms		
Preliminary trace noise magnitude[2] – Option 080 enabled[3]			
10 MHz to 45 MHz[4]	< 0.100 dB rms		1 kHz IF bandwidth
45 to 500 MHz	< 0.010 dB rms		Ratio measurement, nominal
500 MHz to 24 GHz	< 0.060 dB rms		power at test port
24 to 67 GHz	< 0.085 dB rms		
67 to 70 GHz[4]	< 0.085 dB rms		
Preliminary trace noise phase			
10 MHz to 45 MHz[4]	< 0.500° rms		
45 to 500 MHz	< 0.100° rms		1 kHz IF bandwidth
500 MHz to 24 GHz	< 0.060° rms		Ratio measurement, nominal
24 to 67 GHz	< 0.100° rms		power at test port
67 to 70 GHz[4]	< 0.100° rms		
Preliminary trace noise phase[2] – Option 080 enabled[3]			
10 MHz to 45 MHz[4]	< 0.500° rms		1 kHz IF bandwidth
45 to 500 MHz	< 0.100° rms		Ratio measurement, nominal
500 MHz to 24 GHz	< 0.060° rms		power at test port
24 to 67 GHz	< 0.100° rms		
67 to 70 GHz[4]	< 0.100° rms		

1. Trace noise magnitude may be degraded to 20 mdB rms at harmonic frequencies of the first IF (8.33 MHz) below 80 MHz.
2. Coupler roll-off below 45 MHz makes input power into receiver so low that there is negligible compression at maximum test port output power.
3. 0 Hz offset.
4. Typical performance.

Preliminary Test Port Input *continued*

Description	Specification		Supplemental information
	Standard	**014**	
Reference level magnitude			
Range	±200 dB	±200 dB	
Resolution	0.001 dB	0.001 dB	
Reference level phase			
Range	±500°	±500°	
Resolution	0.01°	0.01°	
Stability magnitude[1]			Typical ratio measurement: Measured at the test port
10 MHz to 45 MHz			±0.02 dB/°C
45 MHz to 20 GHz			±0.02 dB/°C
20 to 40 GHz			±0.03 dB/°C
40 to 50 GHz			±0.04 dB/°C
50 to 67 GHz			±0.06 dB/°C
67 to 70 GHz			±0.06°/°C
Stability phase[1]			Typical ratio measurement: Measured at the test port
10 MHz to 45 MHz			±0.2°/°C
45 MHz to 20 GHz			±0.2°/°C
20 to 40 GHz			±0.5°/°C
40 to 50 GHz			±0.8°/°C
50 to 67 GHz			±0.8°/°C
67 to 70 GHz			±0.8°/°C
Damage input level			
Test port 1 and 2			+27 dBm or ±40 VDC, typical
R1, R2 in			+15 dBm or ±15 VDC, typical
A, B in			+15 dBm or ±15 VDC, typical
Coupler thru (option 014 or UNL and 014)			+27 dBm or ±40 VDC, typical
Coupler arm (option 014 or UNL and 014)			+30 dBm or ±7 VDC, typical

1. Stability is defined as a ratio measurement measured at the test port.

Group Delay[1]

Description	Specification	Supplemental information
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.

General Information

Description	Supplemental information
System IF bandwidth range	1 Hz to 40 kHz, nominal
RF connectors	
E8362A	3.5 mm (male), 50 Ω, (nominal), center pin recession flush to .002 in. (characteristic)
E8363/4A	2.4 mm (male), 50 Ω, (nominal), center pin recession flush to .002 in. (characteristic)
E8361A	1.85 mm (male), 50 Ω, (nominal), center pin recession flush to .002 in. (characteristic)
Display	8.4 in diagonal color active matrix LCD; 640 (horizontal) x 480 (vertical) resolution; 59.83 Hz vertical refresh rate; 31.41 Hz horizontal refresh rate
Display range	
Magnitude	±200 dB (at 20 dB/div), max
Phase	±180°, max
Polar	10 pico units, min; 1000 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	0.01 mUnit, min; 0.01°, min
CPU	Intel® 500 MHz Pentium® III
Rear panel	
10 MHz reference in	
Input frequency	10 MHz ±10 ppm, typ.
Input power	–15 dBm to +20 dBm, typ.
Input impedance	200 Ω, nom.
10 MHz reference out	
Output frequency	10 MHz ±10 ppm, typ.
Signal type	Sine wave, typ.
Output power	10 dB ± 4 dB into 50 Ω, typ.
Output impedance	50 Ω, nom.
Harmonics	< -40 dBc, typ.
VGA video output	15-pin mini D-Sub; Drives VGA compatible monitors
GPIB	Type D-24, 24-pin; female compatible with IEEE-488
Parallel port (LPT1)	25-pin D-sub miniature connector; provides connection to printers or any other parallel port peripheral
Serial port (COM1)	9-pin D-Sub; male compatible with RS-232
USB port	1 port on front panel and 4 ports on rear panel, Type-A configuration (4 contacts inline, contact 1 on left); female
Contact 1	Vcc: 4.75 to 5.25 VDC, 500 mA max
Contact 2	-Data
Contact 3	+Data
Contact 4	Ground
LAN	10/100 BaseT Ethernet; 8-pin configuration
Test set I/O	25-pin D-sub; available for external test set control
Handler I/O	36-pin, parallel I/O port; all input/output signals are default set to negative logic; can be rest to positive logic via GPIB command
Auxiliary I/O	25-pin connector; analog and digital I/O

General Information *continued*

Description	Supplemental information
Line power[1]	
Frequency	48 Hz to 66 Hz
Voltage at 115-V setting	90 to 132 VAC; 120 VAC, nom.
Voltage at 220-V setting	198 to 264 VAC; 240 VAC, nom.
VA max	600 VA max
General environmental	
RFI/EMI susceptibility	Defined by CISPR Pub. 11, Group 1, Class A, and IEC 50082-1
ESD	Minimize using static-safe work procedures and an antistatic bench mat
Dust	Minimize for optimum reliability
Operating environment	
Temperature	0°C to +40°C; Instrument powers up, phase locks, and displays no error messages within this temperature range. (Except for 'source unleveled' error message that may occur at temperature extremes.)
Error-corrected temperature range	System specifications valid from 25°C ±5°C, with less than 1°C deviation from the calibration temperature
Humidity	5 to 95% at +40°C
Altitude	0 to 4500 m (14,760 ft)
Non-operating storage environment	
Temperature	-40°C to +70°C
Humidity	0 to 90% at +65°C (non-condensing)
Altitude	0 to 15,240 m (50,000 ft)

Cabinet dimensions

	Height	Width	Depth
Excluding front and rear panel hardware and feet	222 mm 8.75 in	425 mm 16.75 in	426 mm 16.8 in
As shipped - includes front panel connectors, rear panel bumpers, and feet.	242 mm 9.5 in	425 mm 16.75 in	472 mm 18.6 in
As shipped plus handles	242 mm 9.5 in	458 mm 18 in	453 mm 17.8 in
As shipped plus rack mount flanges	242 mm 9.5 in	483 mm 19 in	472 mm 18.6 in
As shipped plus handles and rack mount flanges	242 mm 9.5 in	483 mm 19 in	453 mm 17.8 in

Description	Supplemental information
Weight	
Net	29 kg (64 lb), nom.
Shipping	36 kg (80 lb), nom.

1. A third-wire ground is required.

Measurement Throughput Summary

Cycle time vs. IF bandwidth[1]

Instrument state: preset condition, 201 points, CF = 28 GHz, Span = 100 MHz, correction off. Add 21 ms for display on. Cycle time includes sweep and re-trace time.

IF bandwidth (Hz)	Cycle time (ms)	Cycle time (ms) Option 080 enabled
40,000	11	100
35,000	12	101
30,000	13	102
20,000	16	106
10,000	30	127
7,000	38	138
5,000	50	152
3,000	74	182
1,000	274	326
300	694	782
100	1905	2054
30	6091	6355
10	17916	18372

Cycle time vs. number of points[1]

Instrument state: preset condition, 35 kHz IF bandwidth, CF = 28 GHz, Span = 100 MHz, correction off. Add 21 ms for display on. Cycle time includes sweep and re-trace time.

Number of points	Cycle time (ms)
3	6
11	6
51	7
101	9
201	12
401	18
801	30
1601	55
16,001	497

Cycle time (ms)[1,2]

	Number of points			
	201	**401**	**1601**	**16,001**
Start 28 GHz, stop 30 GHz, IFBW = 35 kHz				
Uncorrected and one-port cal	12	19	55	503
Two-port cal	29	44	124	1112
Start 10 MHz kHz, stop 10 GHz, IFBW = 35 kHz				
Uncorrected and one-port cal	86	93	121	583
Two-port cal	179	199	267	1301
Start 10 MHz, stop 20 GHz, IFBW = 35 kHz				
Uncorrected and one-port cal	126	130	153	597
Two-port cal	264	275	335	1321
Start 10 MHz, stop 40 GHz, IFBW = 35 kHz				
Uncorrected and one-port cal	185	190	213	621
Two-port cal	382	401	459	1374
Start 10 MHz, stop 50 GHz, IFBW = 35 kHz				
Uncorrected and one-port cal	210	216	243	643
Two-port cal	436	450	522	1405
Start 10 MHz, stop 67 GHz, IFBW = 35 kHz				
Uncorrected	244	254	300	645
Corrected	502	524	591	1423

1. Typical performance.
2. 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.
3. Option 010 only. Analyzer display turned off with DISPLAY:ENABLE OFF. Add 21 ms for display on.

Data transfer time (ms)[1]

	Number of points			
	201	401	1601	16,001
SCPI over GPIB (program executed on external PC)				
32-bit floating point	7	12	43	435
64-bit floating point	12	22	84	856
ASCII	64	124	489	5054
SCPI (program executed in the analyzer)				
32-bit floating point	1	2	3	30
64-bit floating point	2	2	4	40
ASCII	29	56	222	2220
COM (program executed in the analyzer)				
32-bit floating point	1	1	1	6
Variant type	1	2	6	68
DCOM over LAN (program executed on external PC)				
32-bit floating point	1	1	2	121
Variant type	3	6	19	939

1. Typical performance.

Measurement Capabilities

Number of measurement channels
Sixteen independent measurement channels. A measurement channel is coupled to stimulus settings including frequency, IF bandwidth, power level, and number of points.

Number of display windows
Up to four display windows. Each window can be sized and re-arranged. Up to four measurement channels can be displayed per window.

Number of traces
Up to four active traces and four memory traces per window. Sixteen total active traces and 16 memory traces can be displayed. Measurement traces include S-parameters, as well as relative and absolute power measurements.

Measurement choices
S11, S21, S12, S22, A/R1, A/R2, A/B, B/R1, B/R2, B/A, R1/A, R1/B, R1/R2, R2/A, R2/B, R2/R1, A, B, R1, R2

Formats
Log or linear magnitude, SWR, phase, group delay, real and imaginary, Smith chart, polar.

Data markers
Ten independent markers per trace. Reference marker available for delta marker operation. Marker formats include log or linear magnitude, phase, real, imaginary, SWR, delay, R + jX, and G + jB.

Marker functions
Marker search
Maximum value, minimum value, target, next peak, peak right, peak left, target, and bandwidth with user-defined target values

Marker-to functions
Set start, stop, and center to active marker stimulus value; set reference to active marker response value; set electrical delay to active marker phase response value.

Trace statistics
Calculates and displays mean, standard deviation and peak-to-peak deviation of the data trace.

Tracking
Performs new search continuously or on demand.

Source Control

Measured number of points per sweep
User definable from 2 to 1601.

Sweep type
Linear, CW (single frequency), power or segment sweep.

Segment sweep
Define up to 101 different, sub-sweep frequency ranges in any combination of start-stop sweep modes. Set number of points, test port power levels, IF bandwidth, and dwell time independently for each segment.

Sweep trigger
Set to continuous, hold, single, or group sweep with internal or external trigger.

Power
Power slope can be set in dBm/GHz. Control the test port signal by setting the internal attenuator of the test set over a 60-dB range.

Trace Functions

Display data
Display current measurement data, memory data, or current measurement with measurement and memory data simultaneously.

Trace math
Vector addition, subtraction, multiplication or division of current linear measurement values and memory data.

Display annotations
Start/stop, center/span, or CW frequency, scale/div, reference level, marker data, warning and caution messages, trace status, and pass/fail indication.

Title
Add custom titles (50 characters maximum) to the display. Titles will be printed when making hardcopies of displayed measurements.

Autoscale
Automatically selects scale resolution and reference value to center the trace.

Electrical delay
Offset measured phase or group delay by a defined amount of electrical delay, in seconds.

Phase offset
Offset measured phase or group delay by a defined amount in degrees.

Automation

	GPIB	LAN	Internal
SCPI	X	X	X
COM/DCOM		X	X

Methods

Controlling via internal analyzer execution
Write applications that can be executed from within the analyzer via COM (component object model) or SCPI standard-interface commands. These applications can be developed in a variety of languages, including Visual Basic, Visual C++, Agilent VEE, or LabView™ programming languages.

Controlling via GPIB
The GPIB interface operates to IEEE 488.2 and SCPI standard-interface commands. The analyzer can either be the system controller, or talker/listener.

Controlling via LAN
The built-in LAN interface and firmware support data transfer and control via direct connection to a 10 Base-T network.

SICL/LAN Interface

The analyzer's support for SICL (standard instrument control library) over the LAN provides control of the network analyzer using a variety of computing platforms, I/O interfaces, and operating systems. With SICL/LAN, the analyzer is controlled remotely over the LAN with the same methods used for a local analyzer connected directly to the computer via a GPIB interface.

DCOM Interface

The analyzer's support for DCOM (distributed component object model) over the LAN provides control of the network analyzer using a variety of platforms. DCOM acts as an interface to the analyzer for external applications. With DCOM, applications can be developed or executed from an external computer. During development, the application can interface to the analyzer over the LAN through the DCOM interface. Once development is completed, the application can be distributed to the analyzer and interfaced using COM.

Data Accuracy Enhancement

Measurement calibration

Measurement calibration significantly reduces measurement uncertainty due to errors caused by system directivity, source and load match, tracking and crosstalk. Full two-port calibration removes all the systematic errors to obtain the most accurate measurements.

Calibration types available

Frequency response

Simultaneous magnitude and phase correction of frequency response errors for either reflection or transmission measurements.

Response and isolation

Compensates for frequency response and directivity (reflection) or frequency response and crosstalk errors.

One-port calibration

Uses test set port 1 or port 2 to correct for directivity, frequency response and source match errors.

Two-port calibration

Compensates for directivity, source match, reflection frequency response, load match, transmission frequency response and crosstalk. Crosstalk calibration can be omitted.

TRL/TRM calibration

Compensates for directivity, reflection and transmission frequency response and crosstalk in both forward and reverse directions. Provides the highest accuracy for both coaxial and non-coaxial environments, such as on-wafer probing, in-fixture or waveguide measurements.

Interpolated error correction

With any type of accuracy enhancement applied, interpolated mode recalculates the error coefficients when the test frequencies are changed. The number of points can be increased or decreased and the start/stop frequencies can be changed, but the resulting frequency range must be within the original calibration frequency. System performance is not specified for measurements with interpolated error correction applied.

Velocity factor

Enters the velocity factor to calculate the equivalent electrical length.

Reference plane extension

Redefine the plane-of-measurement reference to other than port 1 or port 2.

Storage

Internal hard disk drive

Store and recall binary instrument states and calibration data on 10 GB, minimum, internal hard drive. Instrument data can also be saved in ASCII (including S2P) format. All files are MS-DOS®-compatible. Instrument states include all control settings, active limit lines, active list frequency tables, memory trace data.

Disk drive

Instrument data, instrument states, and calibration data can be stored on internal 3.5-in, 1.4 MB floppy disk in MS-DOS-compatible format.

Data hardcopy

Printouts of instrument data are directly produced on any printer with the appropriate Windows® 2000 printer driver. The analyzer provides USB, Centronics (parallel), serial and LAN interfaces.

System Capabilities

Familiar graphical user interface

The PNA employs a graphical user interface based on Windows 2000. There are two fundamental ways to operate the instrument manually: you can use a hardkey interface, or use drop-down menus driven from a mouse (or another standard USB pointing device). Hardkey navigation brings up active toolbars that perform most of the operations required to configure and view measurements. Front-panel navigation keys allow for use of the instrument without a mouse. In addition, mouse-driven pull-down menus provide easy access to both standard and advanced features. Both methods employ dialog boxes to display all the choices needed to make measurement set-ups.

Built-in information system

Embedded documentation provides measurement assistance in five different languages (English, French, German, Japanese, and Spanish). A thorough index of help topics and context-sensitive help available from dialog boxes.

Limit lines

Define test limit lines that appear on the display for go/no go testing. Lines may be any combination of horizontal, sloping lines, or discrete data points.

Time-domain (Option 010)

With the time-domain option, data from transmission or reflection measurements in the frequency domain are converted to the time domain using a Fourier transformation technique (chirp Z) and presented on the display. The time-domain response shows the measured parameter value versus time. Markers may also be displayed in electrical length (or physical length if the relative propagation velocity is entered).

Time stimulus modes

Two types of time excitation stimulus waveforms can be simulated during the transformations, a step and an impulse.

Low-pass step

This stimulus, similar to a traditional time-domain reflectometer (TDR) stimulus waveform, is used to measure low-pass devices. The frequency-domain data should extend from DC (extrapolated value) to a higher value. The step response is typically used for reflection measurements only.

Low-pass impulse

This stimulus is also used to measure low-pass devices. The impulse response can be used for reflection or transmission measurements.

Bandpass impulse

The bandpass impulse stimulates a pulsed RF signal (with an impulse envelope) and is used to measure the time-domain response of band-limited devices. The start and stop frequencies are selectable by the user to any values within the limits of the test set used. Bandpass time-domain responses are useful for both reflection and transmission measurements.

Time-domain range

The "alias-free" range over which the display is free of response repetition depends on the frequency span and the number of points. Range, in nanoseconds, is determined by: Time-domain range = (number of points - 1)/frequency span [in GHz]

Range resolution

The time resolution of a time-domain response is related to range as follows: Range resolution = time span/(number of points - 1)

Windows

The windowing function can be used to modify (filter) the frequency-domain data and thereby reduce over-shoot and ringing in the time-domain response. Kaiser Beta windows are available.

Gating

The gating function can be used to selectively remove reflection or transmission time-domain responses. In converting back to the frequency-domain the effects of the responses outside the gate are removed.

Configurable test set (Option 014)

With the configurable test set option, front panel access loops are provided to the signal path between the source output and coupler input.

Extended dynamic range configuration

Reverse the signal path in the coupler and bypass the loss typically associated with the coupled arm. Change the port 2 switch and coupler jumper configurations to increase the forward measurement dynamic range. When making full two-port error corrected measurements, the reverse dynamic range is degraded by 12 to 15 dB.

High power measurement configuration

Add external power amplifier(s) between the source output and coupler input to provide up to +30 dBm of power at the test port(s). Full two-port error correction measurements possible. When the DUT output is expected to be greater than +30 dBm, measure directly at the B input and use an external fixed or step attenuator to prevent damage to the receiver. For measurements greater than +30 dBm, add external components such as couplers, attenuators, and isolators.

Option UNL

Extended power range and bias tees (Currently unavailable on the E8361A) – Adds two 70 dB step attenuators and two bias tees. A step attenuator and bias tee set is inserted between the source and test port one and another set between the source and test port two.

Option 080

Frequency offset – This option enables the PNA Series microwave network analyzers to set the source frequency independently from where the receivers are tuned. This ability is important for two general classes of devices: mixers (and converters) and amplifiers. For frequency-translating devices like mixers or converters, frequency-offset capability is necessary for conversion loss/gain measurements (both amplitude and phase), since, by definition, the input and output frequency of the DUT are different. For amplifier measurements, frequency offset capability is required to measure amplifier harmonics or when using the internal source as one of the stimuli of a third-order intercept (TOI) or IP3 measurement. Option 080 provides a very basic user interface. The user may enter multiplier and offset values to describe how the instrument's receivers track the source frequency. While flexible, the user interface requires the user to calculate the correct values. The frequency-converter application (Option 083) provides a much more intuitive and easy-to-use user interface, designed specifically for mixer and converter measurements.

Option 081
External reference switch (Currently unavailable on the E8361A) – Option 081 adds a solid-state internal RF transfer switch in the R1 reference=receiver path. The switch allows the instrument to easily switch between standard S-parameter (non-frequency-offset) measurements and frequency offset measurements such as relative phase of absolute group delay that require an external reference mixer. The user can set the switch manually or remotely, but it is best used with the frequency-converter application (Option 083), where it is controlled automatically during the vector-mixer calibration procedure.

Option 083
Frequency converter measurement application – The frequency converter application adds an intuitive and easy-to-use user interface, advanced calibration choices that provide exceptional amplitude and phase accuracy, and control of external signal sources for use as local oscillators (both fixed and swept-LO measurements are supported). A graphical set-up dialog box lets you quickly set up the instrument for single or dual conversion devices. This set-up screen also helps you calculate and choose where mixing and image products will fall.

Option 016
Add receiver attenuator (Currently unavailable on the E8361A) – A 35dB attenuator is added between both test ports and their corresponding receiver. See XX for a basic block diagram.

Option 022
Extended memory – Adds more RAM for a total or 512MB

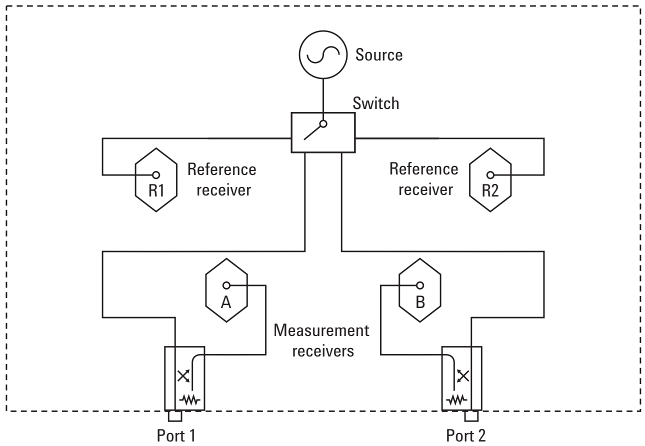
Option UK6
Complete set of measurements which tests unit to manufacturer's published specifications. Includes calibration label, calibration certificate, and data report. Conforms to ISO 9001.

Option 1A7
Complete set of measurements which tests unit to manufacturer's published specifications. Includes calibration label, ISO 17025 calibration certificate, and data report, measurement uncertainties and guardbands on all customer specifications. Conforms to ISO 17025 and ISO 9001.

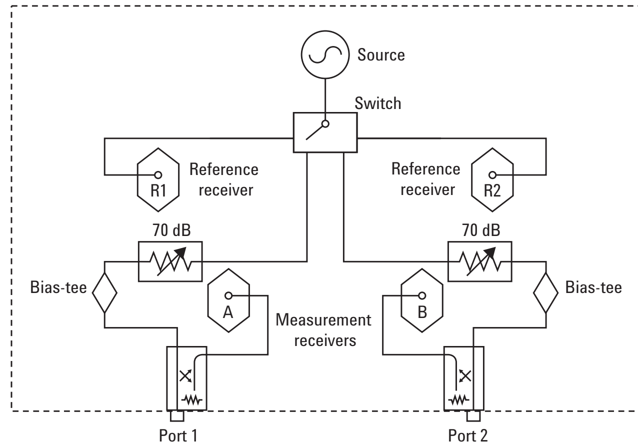
Supplemental performance
Minimum reference channel input level: -35 dBm

PNA Series Simplified Test Set Block Diagram

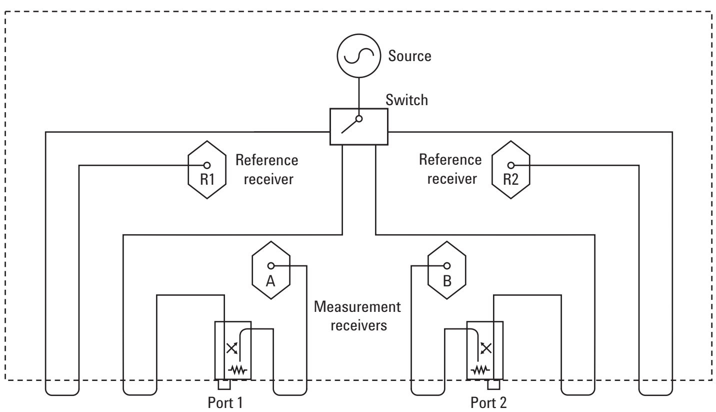
Standard power range



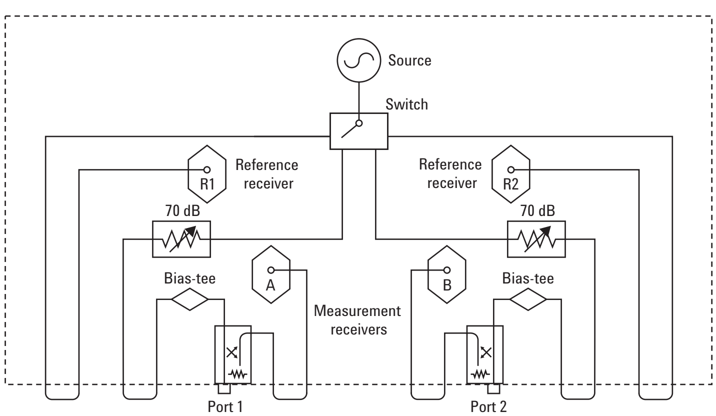
Extended power range and bias-tees (Option UNL)



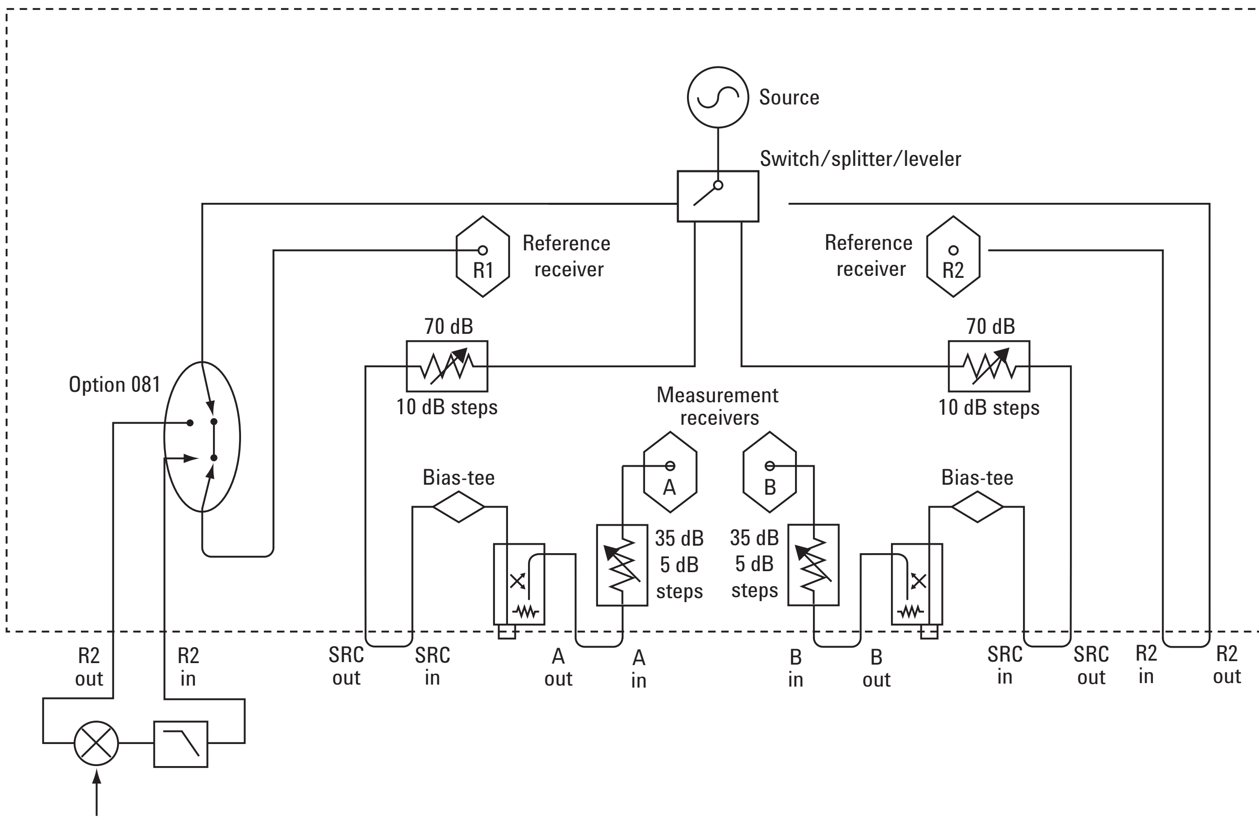
Extended configuration, source access, receiver (Option 014)



Extended configuration with extended power range and bias-tees (Option UNL and 014)



Fully optioned (Options 014, UNL, 016, 080, 081)



Information resources

Literature

PNA Series RF and Microwave Network Analyzers Brochure,
literature number 5968-8472E
PNA Series Microwave Network Analyzer Configuration Guide,
literature number 5988-7989EN

Web

PNA Series: **www.agilent.com/find/pna**
Application and product resources:
www.agilent.com/find/test

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