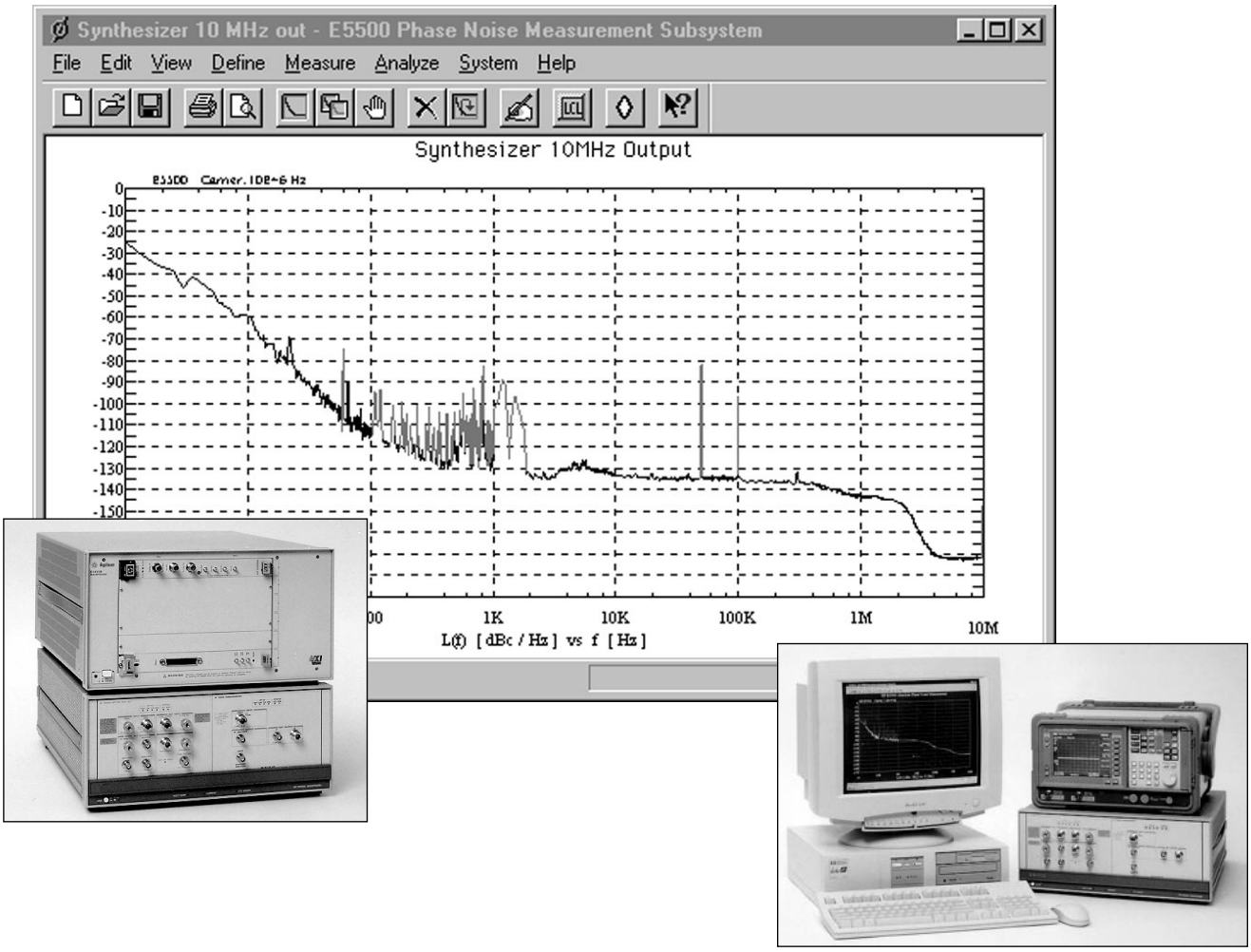
Agilent E5500 Series

Phase Noise Measurement Solutions

Configuration and Performance Guide

50 kHz to 110 GHz

The Agilent Technologies E5500 series is a modular family of phase noise measurement solutions. For flexibility in configuring a solution that meets your exact needs, system components can be ordered as separate line items. Convenient, preconfigured solutions that meet a wide range of needs are also available. The E5500 series solution software requires a Pentium® PC running Windows NT® 4.0.



Agilent Technologies

Innovating the HP Way

ATE Focused Preconfigured Solutions

- ❑ **E5501A** 50 kHz to 1.6 GHz carrier frequency
- ❑ **E5502A** 50 kHz to 6.0 GHz carrier frequency
- ❑ **E5503A** 50 kHz to 18.0 GHz carrier frequency
- ❑ **E5504A** 50 kHz to 26.5 GHz carrier frequency

Solution components include:

- ❑ **E1430A** DC to 4 MHz VXI digitizer
- ❑ **E1421B** 6-slot, high power VXI mainframe
- ❑ **70420A** MMS baseband phase noise test set
- ❑ **70001A** MMS mainframe
- ❑ **E5480A** LTU ACM software
- ❑ **E5495A** LTU remote SCPI client software
- ❑ High speed VXI-PC digital interface

Agilent E5502/03/04A solutions also include a low noise 6, 18, or 26.5 GHz downconverter respectively.

- ❑ **Option 001** add high power input capability (includes 26.5 GHz microwave phase detector and AM detector)
- ❑ **Option 201** add 26.5 GHz microwave phase detector only
- ❑ **Option W30** add two additional years of return-to-Agilent service
- ❑ **Option W50** add four additional years of return-to-Agilent service
- ❑ **Option +24D** on-site customer training (contact SSV microwave systems engineer)

Select a low noise RF reference source:

- ❑ **Option 401** add 8662A (includes E5485A LTU ACM software)
- ❑ **Option 402** add 8663A (includes E5485A LTU ACM software)
- ❑ **Option 403** add 8643A (includes E5486A LTU ACM software)
- ❑ **Option 404** add 8644B (includes E5486A LTU ACM software)
- ❑ **Option 405** add 8644B/002 (includes E5486A LTU ACM software)
- ❑ **Option 406** add 8664A/004 (includes E5486A LTU ACM software)
- ❑ **Option 407** add 8665A/004 (includes E5486A LTU ACM software)
- ❑ **Option 408** add 8665B/004 (includes E5486A LTU ACM software)
- ❑ **Option 409** add ESG1000 (includes E5488A LTU ACM software)
- ❑ **Option 410** add 8657A (includes E5488A LTU ACM software)

Select additional components:

- ❑ **Option 420** add E1437A DC to 8 MHz digitizer (includes E5491A LTU ACM software)
- ❑ **Option 430** add E4411A 9 kHz to 1.5 GHz RFSA (includes E5483A LTU ACM software)
- ❑ **Option 440** add E1420B counter (includes E5492A LTU ACM software)
- ❑ **Option S50** add programmable delay line
- ❑ **Option N60** add system rack
- ❑ **Option F01** add Pentium® PC with Windows NT® 4.0 (specify exact requirements)
- ❑ **Option N70** add mm mixers and miscellaneous hardware

Benchtop Focused Preconfigured Solutions

- ❑ **E5501B** 50 kHz to 1.6 GHz carrier frequency
- ❑ **E5502B** 50 kHz to 6.0 GHz carrier frequency
- ❑ **E5503B** 50 kHz to 18.0 GHz carrier frequency
- ❑ **E5504B** 50 kHz to 26.5 GHz carrier frequency

Solution components include:

- ❑ **E4411A** 1.5 GHz RFSA
- ❑ **70420A** MMS baseband phase noise test set
- ❑ **70001A** MMS mainframe
- ❑ **E5481A** LTU ACM software
- ❑ **E5483A** LTU ACM software
- ❑ Pentium® PC with Windows NT® 4.0 (32 MB ram, 1 GB hard drive, 82341C, digitizer)

Agilent E5502/03/04B solutions also include a low noise 6, 18, or 26.5 GHz downconverter respectively.

- ❑ **Option 001** add high power input capability (includes 26.5 GHz microwave phase detector and AM detector)
- ❑ **Option 110** delete E4411A spectrum analyzer only
- ❑ **Option 201** add 26.5 GHz microwave phase detector only
- ❑ **Option W30** add two additional years of return-to-Agilent service
- ❑ **Option W50** add four additional years of return-to-Agilent service
- ❑ **Option +24D** on-site customer training (contact SSV microwave systems engineer)
- ❑ **Option 1FF** delete computer and GPIB card only

Select a low noise RF reference source:

- ❑ **Option 401** add 8662A (includes E5485A LTU ACM software)
- ❑ **Option 402** add 8663A (includes E5485A LTU ACM software)
- ❑ **Option 403** add 8643A (includes E5486A LTU ACM software)
- ❑ **Option 404** add 8644B (includes E5486A LTU ACM software)
- ❑ **Option 405** add 8644B/002 (includes E5486A LTU ACM software)
- ❑ **Option 406** add 8664A/004 (includes E5486A LTU ACM software)
- ❑ **Option 407** add 8665A/004 (includes E5486A LTU ACM software)
- ❑ **Option 408** add 8665B/004 (includes E5486A LTU ACM software)
- ❑ **Option 409** add ESG1000 (includes E5488A LTU ACM software)
- ❑ **Option 410** add 8657A (includes E5488A LTU ACM software)

Select additional components:

- ❑ **Option S21** add 89410A DC to 10 MHz FFT analyzer (includes E5482A LTU ACM software)
- ❑ **Option N31** add 8560E RFSA (includes E5484A LTU ACM software)
- ❑ **Option 440** add 53181A counter (includes E5489A LTU ACM software)
- ❑ **Option S50** add programmable delay line
- ❑ **Option N60** add system rack
- ❑ **Option F01** add Pentium® PC with Windows NT® 4.0 (specify exact requirements)
- ❑ **Option N20** add E5495A LTU remote SCPI client software
- ❑ **Option N70** add mm mixers and miscellaneous hardware

Configuring a Specific Phase Noise Measurement Solution

Agilent E5500A Exx

Generic phase noise solution ordering convenience; must obtain a specific option quote from Agilent sales representative and factory

Select a baseband test set (required component):

- ❑ **70420A** 50 kHz to 1.6 GHz carrier frequency four-slot MMS module
- ❑ **Option 001** add high power input capability (includes 26.5 GHz microwave phase detector and AM detector)
- ❑ **Option 201** add 26.5 GHz microwave phase detector only

MMS mainframe (one required):

- ❑ **70001A** MMS mainframe

Select a baseband analyzer and appropriate control software (required):

- ❑ **89410A** DC to 10 MHz analyzer
- ❑ **E5482A** LTU ACM software for 89410A
- ❑ **E4411A** 9 kHz to 1.5 GHz RFSA
- ❑ **E5483A** LTU ACM software for E4411A
- ❑ **E1430A** DC to 4 MHz digitizer
- ❑ **E5480A** LTU ACM software for E1430A
- ❑ **E1437A** DC to 8 MHz digitizer
- ❑ **E5491A** LTU ACM software for E1437A
- ❑ **71209A**
- ❑ **E5484A** LTU ACM software for 71000 series
- ❑ **8560E**
- ❑ **E5484A** LTU ACM software for 8560 series
- ❑ **8563E**
- ❑ **E5484A** LTU ACM software for 8560 series

VXI mainframe (one required for E1430A or 1437A):

- ❑ **E1421B** 6-slot high power VXI mainframe
- ❑ **E1401B** 13-slot high power VXI mainframe
- ❑ High speed VXI-PC digital interface

Select a low noise RF reference signal generator and appropriate control software (recommended):

- ❑ **8662A**
- ❑ **E5485A** LTU ACM software for 8662/63A
- ❑ **8663A**
- ❑ **E5485A** LTU ACM software for 8662/63A
- ❑ **8643A**
- ❑ **E5486A** LTU ACM software for 8643/44/64/65
- ❑ **8644B**
- ❑ **E5486A** LTU ACM software for 8643/44/64/65
- ❑ **8664A**
- ❑ **E5486A** LTU ACM software for 8643/44/64/65
- ❑ **8665A**
- ❑ **E5486A** LTU ACM software for 8643/44/64/65
- ❑ **8642A**
- ❑ **E5487A** LTU ACM software for 8642A/B
- ❑ **8657A**
- ❑ **E5488A** LTU ACM software for 8657A
- ❑ **ESG1000**
- ❑ **E5488A** LTU ACM software for ESG series

Select a low noise microwave MMS downconverter:

- ❑ **70422A** 1 GHz to 18 GHz downconverter four-slot MMS module
- ❑ **70427A** 1.5 GHz to 26.5 GHz downconverter four-slot MMS module

Select other system components:

- ❑ **E1420B** frequency counter
- ❑ **E5492A** VXI frequency counter ACM
- ❑ **53181A** frequency counter
- ❑ **E5489A** frequency counter ACM for 531xx family
- ❑ programmable delay line
- ❑ on-site customer training
- ❑ include a Pentium® PC
- ❑ **VXI E6490A** series RF switch matrix
- ❑ **MMS 70000** series RF switch matrix
- ❑ system rack
- ❑ on-site installation

Determining Overall Solution Performance

Measurement accuracy

Measurement of all noise and spurious present at the phase detector inputs and system contribution, provided the following conditions are met:

- Source return loss >9.5 dB (<2:1 VSWR)
- Source harmonic distortion <–20 dB (or square wave)
- Nonharmonic spurious <–26 dBc (except for PM close to carrier)
- Supported measurement configuration (PLL verification)
- ±2 dB for <1.0 MHz offsets
- ±4 dB for <100 MHz offsets

Overall phase noise measurement system sensitivity is a combination of noise contributions from the baseband test set, the RF reference source, and the microwave downconverter used and is normally dominated by either the RF reference source or the microwave downconverter:

Baseband test set noise floor + RF reference noise floor + microwave DC noise floor

When the dominant noise contributions (RF reference and the downconverter) are close to each other, a noise floor correction factor (dB) is added to the most dominant noise contributor in order to determine overall system noise floor:

Magnitude difference (dB)	16	10	6	3	2	1	0
Noise correction factor (dB)	0.1	0.4	1.2	1.8	2.1	2.5	3

Offset frequency	Baseband TS (dBc/Hz)	RF reference (dBc/Hz)	Microwave DC (dBc/Hz)	Difference (dB)	Factor (dB)	System total (dBc/Hz)
1						
10						
100						
1 K						
10 K						
100 K						
1 M						
10 M						
100 M						

Examples:

Offset frequency = 1 MHz
RF reference = –140 dBc/Hz
Downconverter = –140 dBc/Hz
Mag difference (dB) = 0
Noise correction factor = 3 dB
Dominant + factor = –140 + 3
Overall noise floor = –137 dBc/Hz

Offset frequency = 1 MHz
RF reference = –130 dBc/Hz
Downconverter = –140 dBc/Hz
Difference (dB) = 10
Noise factor = 0.4 dB
Dominant + factor = –130 + 0.4
Overall noise floor = –129.6 dBc/Hz

Agilent 70420A Specification Summary

Phase detector input ports

	Low frequency inputs	Options 001 & 201 High frequency inputs	Option 001 AM noise
Carrier frequency range	50 kHz to 1.6 GHz	1.2 GHz to 26 GHz	50 kHz to 26.5 GHz
R input power	0 dBm to +23 dBm	0 dBm to +5 dBm	N/A
With Option 001	0 dBm to +30 dBm	0 dBm to +30 dBm	0 dBm to 30 dBm
L input power	+15 dBm to +23 dBm	+7 dBm to +10 dBm	

Offset frequency range

Offset frequency	Detector input frequency
0.01 Hz to 20 kHz	50 kHz to 500 kHz
0.01 Hz to 200 kHz	500 kHz to 5 MHz
0.01 Hz to 2 MHz	5 MHz to 25 MHz
0.01 Hz to 20 MHz	25 MHz to 250 MHz
0.01 Hz to 100 MHz	250 MHz to 26.5 GHz

Noise Input Port

Frequency:	0.01 Hz to 100 MHz
Amplitude:	1 volt peak max
Input impedance:	50 ohm (typical), (DC coupled, RL < 9.5 dB (typical))

Tuning voltage output

Voltage range	–12 volts, open circuit
Current	–20 mA, max
Output impedance	50 ohm, typical +5 dBm (High frequency input)

Noise Floor Degradation

Degrade system noise floor 1 dB for every dB reduction in R input levels less than:
+15 dBm (Low frequency input)

Residual phase noise and spurious responses

(does not include phase noise and spurious signals from a reference source)

Carrier frequency: 50 kHz to 1.6 GHz

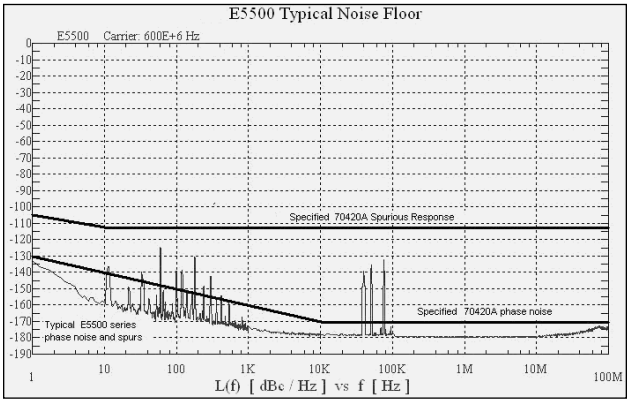
Offset frequency	System noise floor
0.01 Hz	70 dBc/Hz
1.0 Hz	130 dBc/Hz
10 kHz	170 dBc/Hz
>10 kHz	170 dBc/Hz

Offset frequency	Spurious response
.01 Hz	70 dBc
0.1 Hz	100 dBc
>10 Hz	112 dBc

Carrier frequency: 1.2 GHz to 26.5 GHz

Offset frequency	System noise floor
0.01 Hz	55 dBc/Hz
1.0 Hz	115 dBc/Hz
32 kHz	160 dBc/Hz
>32 kHz	160 dBc/Hz

Offset frequency	Spurious response
0.01 Hz	50 dBc
0.1 Hz	80 dBc
>10 kHz	97 dBc



General specifications

Operating temperature range: +0 °C to +55 °C
Warm-up time: 20 minutes
General considerations:

The 70420A has low susceptibility to RFI and mechanical vibration. Care must be exercised however in making measurements in high RFI or vibration environments as spurious signals may be induced in the module.

Agilent 70421A Specification Summary

RF Input	1.0 GHz to 6.6 GHz	**IF output** **IF output power** **IF gain**	5 MHz to 1.2 GHz 0 to +5 dBm 0 to 45 dB (5 dB steps)
Input power	+15 dBm max 5 dBm min	**Mixing spurious** <6 GHz >6 GHz	(<+15 dBm at mixer) <50 dBc (except below) <70 dBc
Noise figure	15 dB (typical)	**Carrier frequency range (GHz) where a mixing spur will occur <100 MHz from carrier**	**Typical spurious (dBc)**
LO resolution	600 MHz (1.8 GHz to 6.0 GHz)	1.566 – 1.634, 1.166 – 1.234 1.060 – 1.200, 1.274 – 1.303 1.325 – 1.375, 1.420 – 1.460 1.775 – 1.825 1.013 – 1.043, 1.250 – 1.043 1.900 – 1.940, 2.225 – 2.275 1.112 – 1.138, 1.483 – 1.517 1.983 – 2.017, 2.380 – 2.420 2.483 – 2.517, 2.975 – 3.025 3.583 – 3.617 2.556 – 2.586, 2.983 – 3.017 3.071 – 3.101	1 20 30 40 50

Downconverter noise floor

(all oscillators locked)

Input frequency		Offset from carrier (Hz) 1	10	100	1k	10k	100k	1M	10M	100M	Spurious (dBc) <1k	>1k
1.0 to 3.0 GHz	Typical	50	80	97	125	137	143	145	145	145	60	75
	Specification	45	75	92	120	132	138	140	140	140	50	65
3.0 to 6.6 GHz	Typical	44	74	91	119	131	143	145	145	145	50	80
	Specification	39	69	86	114	126	138	140	140	140	44	70

General specifications

Operating temperature range: +0 °C to +55 °C
Warm-up time: 20 minutes
General considerations:

The 70421A has low susceptibility to RFI and mechanical vibration. Care must be exercised however, in making measurements in high RFI or mechanical vibration environments as spurious signals may be induced in the module.

Agilent 70422A specification summary

RF Input	1.0 GHz to 18 GHz (18 GHz to 20 GHz typical overrange)	**IF output** **IF output power** **IF gain**	5 MHz to 1.2 GHz 0 to +5 dBm 0 to 45 dB (5 dB steps)
Input power	+15 dBm max 5 dBm min to 12 GHz 10 dBm min to 18 GHz	**Mixing spurious** <6 GHz >6 GHz	(<+15 dBm at mixer) <50 dBc (except below) <70 dBc
Noise figure	15 dB (typical)	**Carrier frequency range (GHz) where a mixing spur will occur <100 MHz from carrier**	**Typical spurious (dBc)**
LO resolution	600 MHz (1.8 GHz to 18 GHz)	1.566–1.634, 1.166–1.234 1.060–1.200, 1.274–1.303 1.325–1.375, 1.420–1.460 1.775–1.825 1.013–1.043, 1.250–1.043 1.900–1.940, 2.225–2.275 1.112–1.138, 1.483–1.517 1.983–2.017, 2.380–2.420 2.483–2.517, 2.975–3.025 3.583–3.617 2.556–2.586, 2.983–3.017 3.071–3.101	10 20 30 40 50

Downconverter noise floor

(all oscillators locked)

Input frequency		Offset from carrier (Hz) 1	10	100	1k	10k	100k	1M	10M	100M	Spurious (dBc) <1k	>1k
1.0 to 3.0 GHz	Typical	50	80	97	125	137	143	145	145	145	60	75
	Specification	45	75	92	120	132	138	140	140	140	50	65
3.0 to 6.0 GHz	Typical	44	74	91	119	131	143	145	145	145	50	80
	Specification	39	69	86	114	126	138	140	140	140	44	70
6.0 to 12.0 GHz	Typical	38	68	85	113	125	140	140	140	140	50	80
	Specification	33	63	80	108	120	135	135	135	135	40	70
12.0 to 18.0 GHz	Typical	34	64	81	109	121	131	131	131	131	47	70
	Specification	29	59	76	104	116	126	126	126	126	37	60

General specifications

Operating temperature range: +0 °C to +55 °C

Warm-up time: 20 minutes

General considerations:

The 70422A has low susceptibility to RFI and mechanical vibration. Care must be exercised however, in making measurements in high RFI or mechanical vibration environments as spurious signals may be induced in the module.

Agilent 70427A specification summary

RF input	1.5 GHz to 26.5 GHz	**IF output**	5 MHz to 1.2 GHz
		IF output power	0 to +5 dBm (>30 dBm input)
		IF gain	0 to 45 dB (5 dB steps)
Input power	+30 dBm max 30 dBm min	**Mixing spurious** <6 GHz >6 GHz	(<+15 dBm at mixer) <50 dBc (except below) <70 dBc
Noise figure	20 dB (typical)	**Carrier frequency range (GHz) where a mixing spur will occur <100 MHz from carrier**	**Typical spurious (dBc)**
Spectral purity	for input signals <0 dBm, noise at offsets >1 kHz may increase by 1 dB for every dB of input power reduction	1.586 – 1.614 1.790 – 1.81, 1.912 – 1.928 2.392 – 2.408, 2.872 – 2.888 2.990 – 3.000	20 30 30 30
LO resolution	600 MHz (2.4 GHz – 25.8 GHz)	1.708 – 1.720, 1.993 – 2.007	40
O power	0 to +16 dBm (2.4 – 6.6 GHz) 0 to +10 dBm (7.2 – 25.8 GHz)	2.240 – 2.260, 2.493 – 2.507 2.737 – 2.749, 3.592 – 3.600 2.051 – 2.063, 2.095 – 2.100 2.565 – 2.578, 2.793 – 2.807 3.000 – 3.007, 3.080 – 3.092 3.493 – 3.507, 4.108 – 4.120 4.193 – 4.200	40 40 50 50 50 50 50

Downconverter noise floor

(all oscillators locked)

Input frequency		Offset from carrier (Hz) 1	10	100	1k	10k	100k	1M	10M	100M <100	Spurious (dBc) >1k	
1.5 to	Typical	50	80	100	128	138	145	145	145	145	60	80
3.0 GHz	Specification	45	75	95	123	133	140	140	140	140	50	65
3.0 to	Typical	44	74	94	122	134	144	147	147	147	50	80
6.0 GHz	Specification	39	69	89	117	129	139	142	142	142	44	70
6.0 to	Typical	38	68	88	116	128	140	143	143	143	50	80
12.0 GHz	Specification	33	63	83	111	123	135	138	138	138	40	70
12.0 to	Typical	35	65	85	113	125	137	140	140	140	47	70
18.0 GHz	Specification	30	60	80	108	120	132	135	135	135	37	60
18.0 to	Typical	32	62	82	110	122	130	130	130	130	44	65
26.5 GHz	Specification	27	57	77	105	117	125	125	125	125	34	55
mm bands (when adding the 11970 series harmonic mixers)												
26 - 40	Typical	26	56	76	104	116	128	130	131	131	54	80
33 - 50	Typical	26	56	76	104	116	128	130	131	131	44	70
40 - 60	Typical	23	53	73	101	113	125	127	128	128	50	80
50 - 75	Typical	23	53	73	101	113	125	127	128	128	40	70
75 - 110	Typical	20	50	70	97	109	120	122	122	122	47	70

General specifications

Operating temperature range: +0 °C to + 55 °C

Warm-up time: 20 minutes

General considerations:

The 70427A has low susceptibility to RFI and mechanical vibration. Care must be exercised however, in making measurements in high RFI or mechanical vibration environments as spurious signals may be induced in the module.

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

"Our Promise" means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

"Your Advantage" means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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Printed in U.S.A. 10/00
5965-7589E

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