

## Signal Analyzers

### 176 Mid-Performance Spectrum Analyzers, Portable

E4401B  
E4402B  
E4404B  
E4405B  
E4407B



#### ESA-E Series

#### Specifications

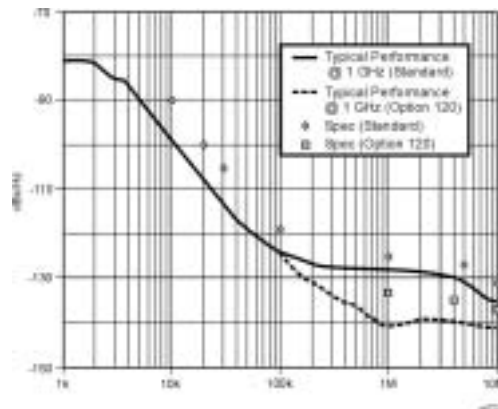
All specifications apply over 0°C to +55°C unless otherwise noted. The analyzer will meet its specifications after 2 hours of storage within the operating temperature range, 5 minutes after the analyzer is turned on, and after ALIGN NOW [RF] has been run.

5

#### Frequency Specifications

Frequency Range		
E4401B	50 Ω	9 kHz to 1.5 GHz
	75 Ω	1 MHz to 1.5 GHz
E4402B		9 kHz to 3.0 GHz
	Option UKB	100 Hz to 3.0 GHz
E4404B	Band	
	0	9 kHz to 3.0 GHz (dc coupled)
	Option UKB	100 Hz to 3.0 GHz
	0	100 kHz to 3.0 GHz (ac coupled)
	1	2.85 GHz to 6.7 GHz
E4405B	Band	LO harmonic = N
	0	1- 9 kHz to 3.0 GHz (dc coupled)
	Option UKB	100 Hz to 3.0 GHz
	0	1- 100 kHz to 3.0 GHz (ac coupled)
	1	1- 2.85 GHz to 6.7 GHz
	2	2- 6.2 GHz to 13.2 GHz
E4407B	Band	LO harmonic = N
	0	1- 9 kHz to 3.0 GHz
	Option UKB	100 Hz to 3.0 GHz
	1	1- 2.85 GHz to 6.7 GHz
	2	2- 6.2 GHz to 13.2 GHz
	3	4- 12.8 GHz to 19.2 GHz
	4	4- 18.7 GHz to 26.5 GHz
External Mixing (Opt AYZ)		18 GHz to 325 GHz
Frequency Reference		(Opt. 1D5)
Aging	±2 x 10 <sup>-6</sup> /year	±1 x 10 <sup>-7</sup> /year
Temperature Stability	±5 x 10 <sup>-6</sup>	±5 x 10 <sup>-8</sup>
Stability	±5 x 10 <sup>-7</sup>	±1 x 10 <sup>-8</sup>
Frequency Readout		
Accuracy (Start, Stop, Center, Marker)	±(frequency indication x frequency reference error <sup>1</sup> + 0.5% of span + 15% of RBW + 10 Hz + span ÷ sweep points - 1)	
Marker Frequency Counter <sup>2</sup>		
Accuracy <sup>3</sup>	±(marker frequency x frequency reference error <sup>1</sup> + counter resolution)	
Counter Resolution		Selectable from 1 Hz to 100 kHz
Frequency Span		
Range	0 Hz (zero span), 100 Hz to the range of the spectrum analyzer	
Resolution		2 Hz x N <sup>4</sup>
Accuracy (8192 sweep points)	±0.5% of span + 2 x span ÷ sweep points - 1	

Frequency Sweep Time		
Range	1 ms to 4000 s	
Span = 0 Hz	10 μs to 4000 s	
(Opt. AYZ)	50 ns to 4000 s (RBW ≥ 1 kHz, 2pts.)	
(Opt. B7D)	25 ns to 4000 s (RBW ≥ 1 kHz, 2pts.)	
Accuracy	±1%	
Sweep Trigger	Free run, Single, Line, Video, External, Offset, Delay, Gate (Opt. 1D6), and TV (Opt. B7B)	
Offset trigger range	±327 ms to ±12.3 μs	
Sweep (trace) point range	Span > 0Hz 101 to 8192	
	Span = 0Hz 2 to 8192	
Resolution Bandwidth (RBW)		
Range	1 kHz to 5 MHz (-3 dB) in 1-3-10 sequence.	
	9 kHz and 120 kHz (-6 dB) EMI bandwidths.	
(Opt. 1DR)	Adds 10, 30, 100, and 300 Hz (-3 dB) bandwidths and 200 Hz (-6 dB) EMI bandwidth.	
(Opt. 1D5 + 1DR)	Adds 1, 3 Hz (-3 dB) bandwidths)	
Accuracy		
1 kHz to 3 MHz RBW	±15%	
5 MHz	±30%	
10 Hz to 300 Hz RBW	±10%	
(Opt. 1DR)		
Selectivity (Characteristic) -60 dB/-3 dB		
10 Hz to 300 Hz (Opt. 1DR)	<5:1	
1 kHz to 5 MHz	<15:1	
Video Bandwidth		
Range	30 Hz to 3 MHz <sup>5</sup> in 1-3-10 sequence	
(Opt. 1DR)	Adds 1, 3, 10 Hz for RBW < 1 kHz	
Stability Noise sidebands (1 kHz RBW, 30 Hz VBW and sample detector)		
≥ 10 kHz offset from CW signal	≤ -90 dBc/Hz + (20 Log N <sup>4</sup> for frequencies > 6.7 GHz)	
≥ 20 kHz offset from CW signal	≤ -100 dBc/Hz + (20 Log N <sup>4</sup> for frequencies > 6.7 GHz)	
≥ 30 kHz offset from CW signal	≤ -104 dBc/Hz + (20 Log N <sup>4</sup> for frequencies > 6.7 GHz)	
≥ 100 kHz offset from CW signal	≤ -113 dBc/Hz + (20 Log N <sup>4</sup> for frequencies > 6.7 GHz)	



Residual FM		
1 kHz RBW, 1 kHz VBW	≤ 150 x N <sup>4</sup> Hz pk-pk in 100 ms	
(Opt. 1D5)	≤ 100 x N <sup>4</sup> Hz pk-pk in 100 ms	
(Opt. 1DR, 1DE)	≤ 2 x N <sup>4</sup> Hz pk-pk in 20 ms	
System-Related Sidebands (offset from CW signal)		
≥ 30 kHz	≤ -65 dBc + (20 Log N <sup>4</sup> for frequencies > 6.7 GHz)	

#### Amplitude Specifications

Amplitude Range		
Measurement Range	Displayed average noise level to maximum safe input level	
Input Attenuator range		
E4401B	0 to 60 dB, in 5 dB steps	
E4402B/04B/05B/07B	0 to 65 dB, in 5 dB steps	

Maximum Safe Input Level	
Average Continuous Power	(input attenuator ≥15 dB)
E4401B	+30 dBm (1 W)
E4401B (75 Ω Opt. 1DP)	+75 dBmV (0.4 W)
E4402B/04B/05B/07B	(input attenuator ≥5 dB)
	+30 dBm (1 W)
Peak Pulse Power	(input attenuator ≥15 dB)
E4401B	+30 dBm (1 W)
E4401B (75 Ω Opt. 1DP)	+75 dBmV (0.4 W)
E4402B/04B/05B/07B	(input attenuator ≥30 dB)
	+50 dBm (100 W)
dc	
E4401B (75 Ω Opt. 1DP)	100 Vdc
E4401B, E4402B	100 Vdc
E4404B, E4405B	0 Vdc (dc coupled)
	50 Vdc (ac coupled)
E4407B	0 Vdc
1 dB Gain Compression (total power at input mixer <sup>5</sup> )	
≥50 MHz	0 dBm
≥6.7 GHz	-3 dBm
≥13.2 GHz	-5 dBm

Displayed Average Noise Level (dBm)  
(Input terminated, 0 dB attenuation, sample-detector, 30/1 Hz VBW)

	1 kHz RBW	10 Hz RBW (Opt. 1DR)	10 Hz RBW w/ preamp (Opt. 1DS) typical	1 Hz RBW (Opt. 1DR, 1D5) typical
<b>E4401B</b>				
400 kHz to 10 MHz	≤-115	≤-134	≤-155	≤-149
10 MHz to 500 MHz	≤-119	≤-138	≤-156	≤-151
500 MHz to 1 GHz	≤-117	≤-136	≤-156	≤-150
1 GHz to 1.5 GHz	≤-114	≤-133	≤-155	≤-148
<b>E4402B</b>				
100 Hz to 9 kHz (Opt. UKB)	—	≤-93	—	≤-103
9 kHz to 100 kHz	—	≤-109	—	≤-119
100 kHz to 1 MHz	—	≤-135	—	≤-145
1 MHz to 10 MHz	≤-120	≤-139	≤-152	≤-149
10 MHz to 1 GHz	≤-117	≤-136	≤-156	≤-150
1 GHz to 2 GHz	≤-116	≤-135	≤-156	≤-150
2 GHz to 3 GHz	≤-114	≤-133	≤-154	≤-150
<b>E4404/05/07B</b>				
100 Hz to 9 kHz (Opt. UKB)	—	≤-93	—	≤-103
9 kHz to 100 kHz	—	≤-109	—	≤-119
100 kHz to 1 MHz	—	≤-135	—	≤-145
1 MHz to 10 MHz	≤-120	≤-139	≤-155	≤-149
10 MHz to 1 GHz	≤-116	≤-135	≤-157	≤-149
1 GHz to 2 GHz	≤-116	≤-135	≤-155	≤-150
2 GHz to 3 GHz	≤-112	≤-131	≤-152	≤-148
3 GHz to 6 GHz	≤-112	≤-131	≤-138	≤-148
6 GHz to 12 GHz	≤-111	≤-130	≤-137	≤-147
12 GHz to 22 GHz	≤-107	≤-126	≤-134	≤-107
22 GHz to 26.5 GHz	-106	-125	-132	-142

### Display Range

Log scale	0.1, 0.2, 0.5 dB/division and 1 to 20 dB/division in 1dB steps; ten divisions displayed
RBW 300 Hz (Opt. 1DR)	0 to -120 dB from reference level is calibrated
RBW 1 kHz	0 to -85 dB from reference level is calibrated
Linear scale	10 divisions
Scale units	dBm, dBmV, dBμV, Volts, Watts, and Hz
Marker Readout Resolution	
Log scale	0.04 dB
Linear scale	0.01% of reference level
Fast sweep times for zero span (Opt. AYX)	
Log scale	
0 to -85 dB from ref. level	0.3 dB
Linear scale	0.3% of reference level
Frequency Response	(10 dB input attenuation)
	Absolute <sup>6</sup> Relative Flatness <sup>5</sup>
20°C to 30°C (30 Hz <sup>7</sup> ) 100 Hz to 3.0 GHz (Opt. UKB)	±0.5 dB      ±0.5 dB

9 kHz to 3.0 GHz	±0.46 dB	±0.5 dB	E4401B
	(±0.14 dB typical)		E4402B
3.0 GHz to 6.7 GHz	±1.5 dB	±1.3 dB	E4404B
6.7 GHz to 26.5 GHz	±2.0 dB	±1.8 dB	E4405B
0°C to 55°C			E4407B
(30 Hz <sup>7</sup> ) 100 Hz to 3.0 GHz (Opt. UKB)	±1.0 dB	±1.0 dB	
9 kHz to 3.0 GHz	±0.76 dB	±1.0 dB	
3.0 GHz to 6.7 GHz	±2.5 dB	±1.5 dB	
6.7 GHz to 26.5 GHz	±3.0 dB	±2.0 dB	
Input Attenuation Switching Uncertainty at 50 MHz			
Attenuation setting			
0 dB to 5 dB	±0.3 dB		
10 dB	Reference		
15 dB	±0.3 dB		
20 to 60 dB (E4401B)	±(0.1 dB + 0.01 x attenuator setting)		
20 to 65 dB	±(0.1 dB + 0.01 x attenuator setting)		
Overall Amplitude Accuracy <sup>8</sup>	±(0.54 dB + Absolute Frequency Response)		
At Reference Settings <sup>8</sup>	±0.34 dB		
RF Input VSWR (at tuned frequency) 10 dB atten.			
100 kHz to 6.7 GHz	1.4:1 <sup>6</sup>		
Resolution Bandwidth Switching Uncertainty (Referenced to 1 kHz RBW, at reference level)			
10 Hz to 3 MHz RBW	±0.3 dB		
5 MHz	±0.6 dB		
Reference Level			
Range	-149.9 dBm to maximum mixer level + attenuator setting		
Resolution	±0.1 dB for log scale, ±0.12% of reference level for linear scale		
Accuracy (reference level attenuator setting)			
-10 dBm to -60 dBm	±0.3 dB		
-60 dBm to -85 dBm	±0.5 dB		
-85 dBm to -90 dBm	±0.7 dB		
Display Scale Fidelity			
Log maximum cumulative			
0 dB to -85 dB	±(0.3 dB + 0.01 x dB from ref. level)		
0 dB to -98 dB (Opt. 1DR)	±(0.3 dB + 0.01 x dB from ref. level)		
98 dB to -120 dB (Opt. 1DR)	±(2 dB + 0.01 x dB from ref. level)		
Log incremental accuracy			
0 dB to -80 dB	±0.4 dB/4 dB from reference		
Linear Accuracy	±2% of reference level		
Linear to Log Switching	±0.15 dB at reference level		
Uncertainty			
Log Scale Switching	No error		
<b>Spurious Responses</b>			
Second Harmonic Distortion			
E4401B			
2 MHz to 750 MHz	<-75 dBc for -40 dBm tone at input mixer. (+35 dBm SHI)		
E4402/04/05/07B			
10 MHz to 500 MHz	<-65 dBc for -30 dBm tone at input mixer. (+35 dBm SHI)		
500 MHz to 1.5 GHz	<-75 dBc for -30 dBm tone at input mixer. (+45 dBm SHI)		
1.5 GHz to 2.0 GHz	<-85 dBc for -10 dBm tone at input mixer. (+75 dBm SHI)		
>2.0 GHz	<-100 dBc for -10 dBm tone at input mixer (or below displayed average noise level). (+90 dBm SHI)		
Third Order Intermodulation Distortion			
E4401B			
10 MHz to 1.5 GHz	<-80 dBc for two -30 dBm tones at input mixer and >50 kHz separation. (+13.5 dBm TOI, +19 dBm typical)		
E4402B/04B/05B/07B			
100 MHz to 6.7 GHz	<-84 dBc for two -30 dBm tones at input mixer and >50 kHz separation. (+11 dBm TOI, +18 dBm typical)		
>6.7 GHz	<-75 dBc for two -30 dBm tones at input mixer and >50 kHz separation. (+7.5 dBm TOI, +11 dBm typical)		
Other Input Related Spurious (in band)			
>offset 30 kHz	<-65 dBc, for -20 dBm tones at input mixer.		
Residual Responses (input terminated and 0 dB attenuation)			
150 kHz to 6.7 GHz	<-90 dBm		