



## Signal Analyzers

### 176 Mid-Performance Spectrum Analyzers, Portable

E4401B  
E4402B  
E4404B  
E4405B  
E4407B



### ESA-E Series

#### Specifications

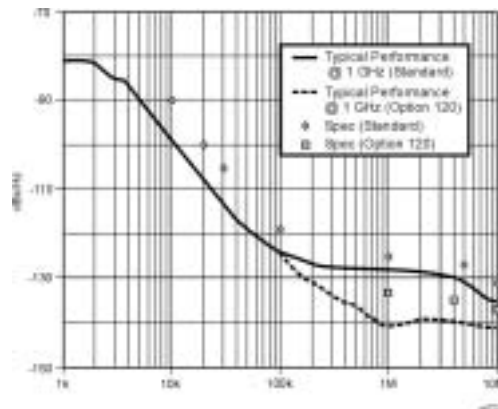
All specifications apply over 0°C to +55°C unless otherwise noted. The analyzer will meet its specifications after 2 hours of storage within the operating temperature range, 5 minutes after the analyzer is turned on, and after ALIGN NOW [RF] has been run.

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#### Frequency Specifications

|   |  |                                    |
|---|--|------------------------------------|
| Frequency Range   |  |                                    |
| E4401B  | 50 Ω   | 9 kHz to 1.5 GHz                   |
|   | 75 Ω   | 1 MHz to 1.5 GHz                   |
| E4402B  | Option UKB   | 9 kHz 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   | 1 ms to 4000 s   |  |
| Range  | 10 μs to 4000 s  |  |
| Span = 0 Hz  | 50 ns to 4000 s (RBW ≥ 1 kHz, 2pts.)   |  |
| (Opt. AYZ)   | 25 ns to 4000 s (RBW ≥ 1 kHz, 2pts.)   |  |
| (Opt. B7D)   | ±1%  |  |
| Accuracy   | Free run, Single, Line, Video, External, Offset, Delay, Gate (Opt. 1D6), and TV (Opt. B7B) |  |
| Sweep Trigger  | ±327 ms to ±12.3 μs  |  |
| Offset trigger range   | Span > 0Hz 101 to 8192   |  |
| Sweep (trace) point range  | 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        | Displayed average noise level to maximum safe input level |  |
| Measurement Range      |   |  |
| 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<br>RBW | 10 Hz RBW<br>(Opt. 1DR) | 10 Hz RBW w/<br>preamp (Opt. 1DS)<br>typical | 1 Hz RBW<br>(Opt. 1DR, 1DS)<br>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<br>(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<br>(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<br>(30 Hz <sup>7</sup> ) 100 Hz to 3.0 GHz<br>(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<br>(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<br>(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   |         |        |