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Agilent E4401B, E4402B, E4404B, E4405B, and E4407B

ESA-E Series Spectrum Analyzers

Technical Specifications

These specifications apply to the Agilent Technologies E4401B, E4402B, E4404B, E4405B, and E4407B spectrum analyzers.

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 AUTO ALIGN [ALL] has been run.

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
E4404B		
dc coupled		9 kHz to 6.7 GHz
ac coupled		100 kHz to 6.7 GHz
Band		
0		9 kHz to 3.0 GHz
1		2.85 GHz to 6.7 GHz
E4405B		
dc coupled		9 kHz to 13.2 GHz
ac coupled		100 kHz to 13.2 GHz
Band		N[4]
0	1–	9 kHz to 3.0 GHz
1	1–	2.85 GHz to 6.7 GHz
2	2–	6.2 GHz to 13.2 GHz
E4407B		
internal mixing		9 kHz to 26.5 GHz
external mixing (opt. AYZ)		18 GHz to 325 GHz
Band	N[4]	
0	1–	9 kHz 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

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Frequency reference

		(Opt. 1D5)
Aging	$\pm 2\times10^{-6}$/year	$\pm 1\times10^{-7}$/year
Temperature stability	$\pm 5\times10^{-6}$	$\pm 1\times10^{-8}$
Settability	$\pm 5\times10^{-7}$	$\pm 1\times10^{-8}$

Frequency readout accuracy

(Start, Stop, Center, Marker) ±(frequency indication x frequency reference error[1] + span accuracy +15% of RBW + 10 Hz + 1 Hz x N^4)

Marker frequency counter[2]

Accuracy [3] ±(marker frequency × frequency reference error[1] + 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 Four digits or 2 Hz × N^4 whichever is greater

Accuracy (8192 sweep points) ±0.5% of span

Frequency sweep time

Range 1 ms to 4000 s

Span = 0 Hz (Opt. AYX) 5 µs to 4000 s

(Opt. B7D) 2.5 µs to 4000 s

Accuracy ±1%

Sweep trigger Free run, Single, Line, Video, External, Delay, Gate (Opt.1D6), and TV (Opt. B7B)

Delay trigger range 1 µs to 400 s

Sweep (trace) point range 101 to 8192

Resolution bandwidth 1 kHz to 5 MHz (–3 dB) in 1-3-10 sequence.

9 kHz and 120 kHz (–6 dB) EMI bandwidths.

Option 1DR Adds 10, 30, 100, and 300 Hz (–3 dB) bandwidths and 200 Hz (–6 dB) EMI bandwidth.

Accuracy

1 kHz to 3 MHz ±15%

5 MHz ±30%

10 Hz to 300 Hz (Opt. 1DR) ±10%

Selectivity (characteristic)

–60 dB/–3 dB

10 Hz to 300 Hz <5:1[6]

1 kHz to 5 MHz <15:1[6]

Video bandwidth range 30 Hz to 3 MHz[6] in 1-3-10 sequence

1 Hz to 3 MHz[6] (Opt. 1DR)

Stability

Noise sidebands (1 kHz RBW, 30 Hz VBW and sample detector)

≥10 kHz offset from CW signal	≤–90 dBc/Hz + 20 Log N^4
≥20 kHz offset from CW signal	≤–98 dBc/Hz + 20 Log N^4
≥30 kHz offset from CW signal	≤–100 dBc/Hz + 20 Log N^4
≥100 kHz offset from CW signal	≤–112 dBc/Hz + 20 Log N^4

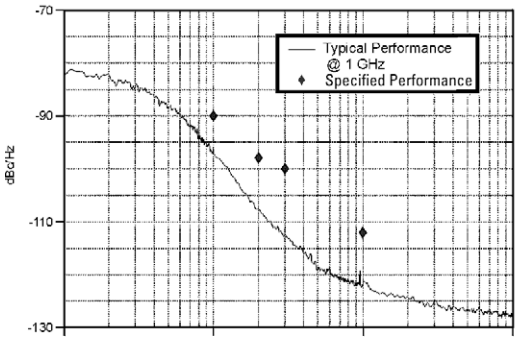

Figure 1. Noise sidebands for E4402B, E4404B, E4405B, and E4407B

Residual FM

1 kHz RBW, 1 kHz VBW	≤150×N^4 Hz pk-pk in 100 ms
Option 1D5	≤100×N^4 Hz pk-pk in 100 ms
Option 1DR	≤10×N^4 Hz[6] pk-pk in 20 ms
Option 1DR and 1D5	≤2×N^4 Hz pk-pk in 20 ms

System-related sidebands

≥30 kHz offset from CW signal ≤–65 dBc + 20 Log N^4

Amplitude specifications

Amplitude range

Measurement range Displayed average noise level (DANL) 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)
	(input attenuator ≥5 dB)
E4402B/04B/05B/07B	+30 dBm (1 W)

Peak pulse power

	(input attenuator ≥30 dB)
E4401B	+30 dBm (1 W)
E4401B (75 Ω Opt. 1DP)	+75 dBmV (0.4 W)
E4402B/04B/05B/07B	+50 dBm (100 W)

dc

E4401B, E4402B	100 Vdc
E4401B (75 Ω Opt. 1DP)	100 Vdc
E4404B, E4405B	0 Vdc (dc coupled) 50 V (ac coupled)
E4407B	0 Vdc

1 dB gain compression (total power at input mixer[5])

50 MHz to 6.7 GHz	0 dBm
6.7 GHz to 13.2 GHz	–3 dBm
13.2 GHz to 26.5 GHz	–5 dBm

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Displayed Average Noise Level (DANL) (dBm)

(Input terminated, 0 dB attenuation, sample detector)
1 kHz RBW; 30 Hz VBW
10 Hz RBW; 1 Hz VBW

	1 kHz RBW	10 Hz RBW (Opt. 1DR)	1 kHz RBW (w/preamp Opt. 1DS)	10 Hz RBW (w/preamp Opt. 1DR Opt. 1DS)
E4401B				
400kHz-1MHz	≤–115	≤–134	≤–131	≤–149
1MHz-500MHz	≤–119	≤–138	≤–135	≤–153
500MHz-1GHz	≤–117	≤–136	≤–133	≤–151
1GHz-1.5GHz	≤–113	≤–132	≤–129	≤–147
E4402B				
1MHz-10MHz[6]	≤–117	≤–136	≤–132	≤–150
10MHz-1GHz	≤–117	≤–136	≤–132	≤–150
1GHz-2GHz	≤–116	≤–135	≤–131	≤–149
2GHz-3GHz	≤–114	≤–133	≤–129	≤–147
E4404/05/07B				
1MHz-10MHz[6]	≤–116	≤–134	≤–131	≤–149
10MHz-1GHz	≤–116	≤–135	≤–131	≤–149
1GHz-2GHz	≤–115	≤–134	≤–129	≤–147
2GHz-3GHz	≤–112	≤–131	≤–127	≤–145
3GHz-6GHz	≤–112	≤–131	na	na
6GHz-12GHz	≤–110	≤–129	na	na
12GHz-22GHz	≤–107	≤–126	na	na
22GHz-26.5GHz	≤–101	≤–120	na	na
E4407B (Opt. AYZ)				
External mixer[6]	≤–134+ external mixer conversion loss	≤–153+ external mixer conversion loss	na	na

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 ≥1 kHz	0 to -85 dB from reference level is calibrated
RBW ≤300 Hz (Opt. 1DR)	0 to -120[13] dB from reference level is calibrated
Linear scale	10 divisions
Scale units	dBm, dBmV, dBµV, volts, watts, and Hz (Opt. BAA)

Marker readout resolution

Log scale	
0 to –85 dB	0.04 dB
0 to –120 dB (Opt. 1DR)	0.04 dB
Linear scale	0.01% of reference level

Fast sweep times for zero span (Option AYX)

Log scale	
0 to –85 dB	0.3 dB
Linear	0.3% of reference level

Frequency response (10 dB input attenuation)

	Absolute[7]	Relative flatness[8]
9 kHz to 3.0 GHz	±0.5 dB	±0.5 dB
3.0 GHz to 6.7 GHz	±1.5 dB	±1.3 dB
6.7 GHz to 26.5 GHz	±2.0 dB	±1.8 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)

Absolute amplitude accuracy

At reference settings[15]	±0.34 dB
Preamp on[16] (Opt. 1DS)	±0.5 dB
External mixer (Opt. AYZ)	IF INPUT absolute amplitude accuracy + external mixer conversion loss accuracy[17]
Overall amplitude accuracy[9]	±(0.54 dB + absolute frequency response)

RF input VSWR[6] (at tuned frequency, ≥10 dB attenuation)

E4401B	
1 MHz to 1.1 GHz	1.35:1
1.1 GHz to 1.5 GHz	2:1
E4402B	
9 kHz to 100 kHz	2:1
100 kHz to 3 GHz	1.4:1
E4404B/05B	
9 kHz to 100 kHz	2:1
100 kHz to 6.7 GHz	1.3:1
6.7 GHz to 13.2 GHz	1.5:1
E4407B	
9 kHz to 6.7 GHz	1.3:1
6.7 GHz to 13.2 GHz	1.5:1
13.2 GHz to 22 GHz	2:1
22 GHz to 26.5 GHz	2.2:1

Resolution bandwidth switching uncertainty

(Referenced to 1 kHz RBW, at reference level)

10 Hz to 3 MHz RBW	±0.3 dB
5 MHz RBW	±0.6 dB

Reference level

Range	same as amplitude range
Resolution	
Log scale	±0.1 dB
Linear scale	±0.12% of reference level
Accuracy (reference level – attenuator setting + preamp gain)	±0.3 dB @–10 dBm to –60 dBm ±0.5 dB @–60 dBm to –85 dBm ±0.7 dB @–85 dBm to –90 dBm

Display scale fidelity

Log maximum cumulative	
0 dB to –85 dB level)	±(0.3 dB + 0.01 x dB from reference
Log incremental accuracy	
0 dB to –80 dB	±0.4dB/4dB from reference level
Linear accuracy	±2% of reference level

Linear-to-log switching

±0.15 dB at reference level

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Spurious responses

Second harmonic distortion

E4401B	
2 MHz to 750 MHz	<–75 dBc for –40 dBm tone at input mixer[5].
E4402/04/05/07B	
10 MHz to 500 MHz	<–65 dBc for –30 dBm tone at input mixer[5].
500 MHz to 1.5 GHz	<–75 dBc for –30 dBm tone at input mixer[2].
1.5 GHz to 2.0 GHz	<–85 dBc for –10 dBm tone at input mixer[2].
>2.0 GHz	<–100 dBc for –10 dBm tone at input mixer[5] (or below displayed average noise level).

Third-order intermodulation distortion

E4401B	
10 MHz to 1.5 GHz	<–80 dBc for two –30 dBm tones at input mixer[5] and >50kHz separation.
E4402B/04B/05B/07B	
100 MHz to 6.7 GHz	<–82 dBc for two –30 dBm tones at input mixer[5] and >50kHz separation.
> 6.7 GHz	<–75 dBc for two –30 dBm tones at input mixer[5] and >50kHz separation.

Other input-related spurious

>30 kHz offset	<–65 dBc for –20 dBm tone at input mixer[5].

Residual responses (input terminated and 0 dB attenuation)

150 kHz to 6.7 GHz <–90 dBm

Amplitude reference output

E4402B/04B/05B/07B –20 dBm (nominal)

General specifications

Temperature range

Operating	0 °C to + 55 °C
Storage	–40 °C to + 75 °C

EMI compatibility

Conducted and radiated interference is in compliance with CISPR Pub. 11/1990 Group 1 Class A

Audible noise

<40 dBa pressure and <4.6 bels power (ISODP7779)

Military specification

Type tested to the environmental specifications of MIL-PRF-28800F class 3.

Power requirements

ON (line 1)	90 to 132 V rms, 47 to 440 Hz 195 to 250 V rms, 47 to 66 Hz Power consumption <300 W
Standby (line 0)	Power consumption <5 W
DC operation	
Voltage	12 to 20 Vdc
Power consumption	<200 W

Data storage (nominal)

Internal	200 traces or states
External (floppy)	200 traces or states

Weight[6] (without options)

E4401B	13.2 kg	(29.1 lbs.)
E4402B	15.5 kg	(34.2 lbs.)
E4404B/05B/07B	17.1 kg	(37.7 lbs.)

Dimensions

w/o handle	222mm(H) x 409mm(D) x 373mm(W)
w/handle (max.)	222mm(H) x 516mm(D) x 408mm(W)

Measurement speed

	E4401B	E4402B	E4404B,E4405B E4407B
Local measurement rate[10]	≥50/sec	≥45/sec	≥40/sec
Remote measurement and GPIB transfer rate[11]	≥45/sec	≥45/sec	≥40/sec
RF center frequency tuning time [18]	≤75 ms	≤75 ms	≤75 ms

Inputs/outputs

Front panel connectors

INPUT	50 Ω Type N (f)
Opt. 1DP	75 Ω BNC (f)
Opt. BAB	50 Ω APC 3.5 (m)
RF OUT	50 Ω Type N (f)
Opt. 1DP	75 Ω BNC (f)
PROBE POWER	+15 Vdc, –12.6 Vdc at 150 mA max. characteristic
EXT KEYBOARD	6-pin mini-DIN, PC keyboards
Speaker	front-panel knob controls volume
Headphone	3.5mm (1/8 inch) miniature audio jack
Power output	0.2 W into 4 Ω
AMPTD REF OUT	50 Ω, BNC (f)
IF INPUT (Opt. AYZ)	50 Ω, SMA (f)
LO OUTPUT (Opt. AYZ)	50 Ω, SMA (f)

Rear panel connectors

10 MHz REF OUT	50 Ω, BNC (f), >0 dBm
10 MHz REF IN	50 Ω, BNC (f), –15 to +10 dBm
GATE TRIG/EXT TRIG IN	BNC (f), 5 V TTL
GATE/HI SWP OUT	BNC (f), 5 V TTL
VGA OUTPUT	VGA compatible monitor, 15–pin mini D-SUB, (31.5 kHz horizontal, 60 Hz vertical sync rates, non-interlaced) Analog RGB 640 x 480

Option A4J (IF and sweep ports) or Option AYX

AUX IF OUT	BNC (f), 21.4 MHz, nominal –10 to –70 dBm (uncorrected)
AUX VIDEO OUT	BNC (f), 0 to 1 V (uncorrected)
HI SWP IN	BNC (f), low stops sweep, (5 V TTL)
HI SWP OUT	BNC (f), (5 V TTL)
SWP OUT	BNC (f), 0 to +10 V ramp

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GPIB interface
(Option A4H) IEEE-488 bus connector

Serial interface
(Option 1AX) RS-232, 9-pin D-SUB (m)

Parallel interface
(Option A4H or 1AX) 25-pin D-SUB (f), printer port only

Option specifications

Option 1D6 time-gated spectrum analysis

Gate delay/length

Range	1 µs to 400 s
Resolution	<gate delay(s)/65000; rounded up to nearest µs.
Accuracy	±(500 ns + 0.01% × gate delay readout)

Option 1DN and 1DQ tracking generator

Frequency range

E4401B	
Opt. 1DN, (50 Ω)	9 kHz to 1.5 GHz
Opt. 1DQ, (75 Ω)	1 MHz to 1.5 GHz
E4402B/04B/05B/07B	
Opt. 1DN, (50 Ω)	9 kHz to 3.0 GHz

Output level

Range	
E4401B	
Opt. 1DN	0 to –70 dBm
Opt. 1DQ	+42.76 to –27.24 dBmV
E4402B/04B/05B/07B	
Opt. 1DN	–1 to –66 dBm
Resolution	0.1 dB
Absolute accuracy (@ 50 MHz)	
Opt.1DN	±0.75 dB
Opt.1DQ	±1.5 dB

Vernier

Range	
E4401B	10 dB
E4402B/04B/05B/07B	9 dB
Accuracy	
E4401B	
Opt 1DN	±0.5 dB, 0 to –10 dBm
Opt 1DQ	±0.9 dB, +42.76 to +32.76 dBmV
E4402B/04B/05B/07B	
Opt 1DN	±0.75 dB, 0 to –10 dBm

Output attenuator range

E4401B	0 to 60 dB, 10 dB steps
E4402B/04B/05B/07B	0 to 56 dB, 8 dB steps

Output flatness

E4401B	
Opt. 1DN, (50 Ω)	
9 kHz to 10 MHz	±2.0 dB
10 MHz to 1.5 GHz	±1.5 dB
Opt. 1DQ, (75 Ω)	
1 MHz to 10 MHz	±2.5 dB
1 MHz to 10 MHz	±2.0 dB
E4402B/04B/05B/07B	
9 kHz to 10 MHz	±3.0 dB
10 MHz to 3.0 GHz	±2.0 dB

Effective source match (characteristic)

E4401B	<2.5:1
E4402B/04B/05B/07B	<2.0:1 (0 dB atten.)
	<1.5:1 (≥8 dB atten.)

Spurious output

Harmonic spurs	
E4401B	
(0 dBm output)	
9 kHz to 20 MHz	<–20 dBc
20 MHz to 1.5 GHz	<–25 dBc
E4402B/04B/05B/07B	
(–1 dBm output)	
9 kHz to 3 GHz	<–25 dBc
Non-Harmonic spurs	
E4401B	<–35 dBc
E4402B/04B/05B/07B	
9 kHz to 2 GHz	<–27 dBc
2 GHz to 3 GHz	<–23 dBc

Dynamic range
Maximum output power – displayed average noise level

Power sweep

Range	
E4401B	
Opt. 1DN	(–15 dBm to 0 dBm) – (source attenuator setting)
Opt. 1DQ	(+27.76 dBmV to +42.76 dBmV) – (source attenuator setting)
E4402B/04B/05B/07B	
Opt. 1DN	(–10 dBm to –1 dBm) – (source attenuator setting)
Resolution	0.1 dB

Option 1DS preamp[6]

Gain +20 dB, nominal

Noise Figure

E4401B	4 dB
E4402B/04B/05B/07B	5 dB

Option AYZ external mixing

LO OUTPUT

Frequency range	2.9 to 7.1 GHz
Power	
2.9 to 6.1 GHz	14.5 to 16 dBm at the mixer when connected with an 5061-5458 cable
2.9 to 7.1 GHz	13 to 17.5 dBm
VSWR	<1.9:1

IF INPUT

Frequency range	321.4 MHz ±5 MHz
Maximum safe input level	10 dBm (ac), ±10 V (dc)
VSWR	<1.9:1

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Absolute amplitude accuracy[14]
(reference levels from –10 to –60 dB)

Amplitude corrections	20 °C to 30 °C	0 °C to 55 °C
15 to 30 dB	1.0 dB	1.5 dB
>30 to 50 dB	1.2 dB	1.7 dB
>50 to 60 dB	1.4 dB	1.9 dB

1 dB gain compression level: –20 dBm with –10 dBm reference level and 0 dB amplitude corrections

Mixer bias (IF INPUT)

Voltage
- Maximum range: ±3.3 V
- Linear compliant range: ±2 V

Current (0 Ω load)
- Range: ±10 mA
- Resolution: <20 mA
- Accuracy: ± (3% + resolution)

Output impedence: 490 Ω

Option BAA FM demodulation[6]

Input level: –60 dBm + attenuator setting–preamp gain
Signal level: 0 to –30 dB below reference level

FM deviation (FM gain)
Range: 10 kHz to 1 MHz
Resolution: provides 1 Hz display annotation resolution
FM deviation range

10 kHz to 40 kHz	12 Hz
>40 kHz to 200 kHz	60 Hz
>200 kHz to 1 MHz	300 Hz

Accuracy[12]: <(2% of FM deviation range + 2 × resolution)

FM bandwidth (–3 dB)
FM deviation range

10 kHz to 40 kHz	7.5 × FM deviation range
>40 kHz to 200 kHz	1.3 × FM deviation range
>200 kHz to 1 MHz	0.3 × FM deviation range

Option B7B TV trigger and picture on screen

Amplitude requirements[6]

TV source: SA: Top 50% of linear display

TV source: EXT VIDEO IN: 500 mVp-p to 2 Vp-p

Compatible standards: NTSC-M, NTSC-Japan
PAL-M, PAL-B, D, G, H, I,
PAL-N, PAL-N combination,
SECAM-L

Field selection: Entire frame, even, odd

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Notes

1. Frequency reference error = (aging rate ¥ period of time since adjustment + settability + temperature stability).
2. Not available in RBW <1 kHz (Option 1DR).
3. Marker level to DANL >25 dB, span ≤1.5 GHz, RBW/span ≥0.002.
4. N = LO harmonic mixing mode.
5. Mixer power level (dBm) = input power (dBm)—input attenuation (dB).
6. Characteristic.
7. Referenced to 50 MHz amplitude reference (20 °C to 30 °C).
8. Referenced to midpoint between highest and lowest frequency response deviations (20 °C to 30 °C).
9. For reference levels 0 to –50 dBm; input attenuation 10 dB; 1 kHz RBW; 1 kHz video BW; log scale; log range, 0 to 50 dB; coupled sweep time; sample detector; signal input, 0 to –50 dBm; span ≤20 kHz; internal mixing (20 °C to 30 °C).
10. Characteristic; factory preset, fixed center frequency, sweep points = 101, auto align off, RBW = 1 MHz, stop frequency ≤ 3 GHz., span > 10MHz and ≤ 600 MHz (E4401B, span > 102 MHz and ≤ 400 MHz).
11. Characteristic; factory preset, fixed center frequency, sweep points = 101, auto align off, RBW = 1 MHz, stop frequency ≤ 3 GHz., span ≥ 20 MHz, GPIB interface, display and markers off, fixed center frequency, single sweep.
12. In time-domain sweeps.
13. 0 to –70 dB range when span = 0 Hz, or when auto ranging is off.
14. RBW 1 kHz; VBW 1 kHz; scale linear or log; span 2 kHz; sweep time coupled; sample detector; signal at reference level.
15. Reference level –25 dBm (E4401B) or –20 dBm (E4402B/04B/05B/07B); (75 Ω reference level + 28.75 dBmV); input attenuation 10 dB; center frequency 50 MHz; RBW 1 kHz; VBW 1 kHz; scale linear or log; span 2 kHz; sweep time coupled, sample detector, signal at reference level.
16. Reference level –30 dBm; (75 Ω reference level + 18.75 dBmV); input attenuation 0 dB; center frequency 50 MHz; RBW 1 kHz; VBW 1 kHz; scale linear or log; span 2 kHz; sweep time coupled, signal at reference level.
17. Preselector centered with the Agilent 11974-series mixers.
18. Characteristic; includes center frequency tuning + measurement + GPIB transfer times, stop frequency ≤ 3GHz, sweep points = 101, display and markers off, single sweep.

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