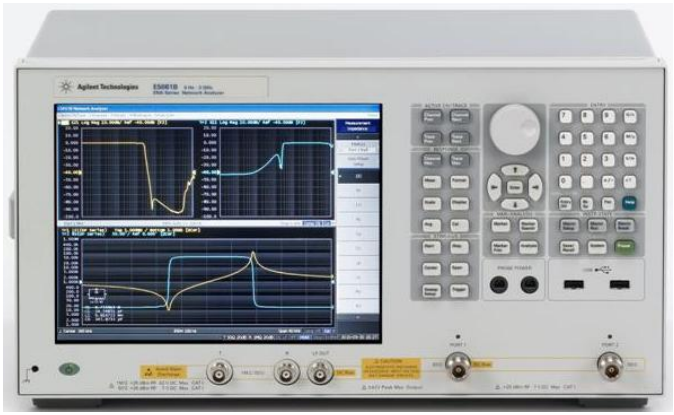
Migrating 419xA / 439x to E5061B LF-RF Network Analyzer with new Impedance Analysis function



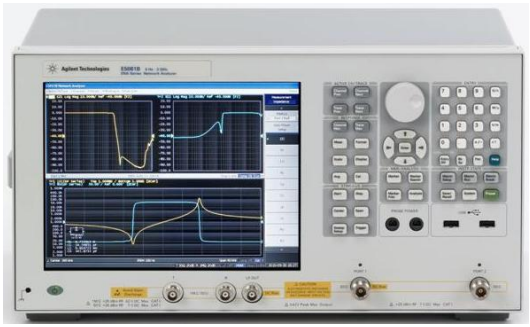
E5061B-3L5/005

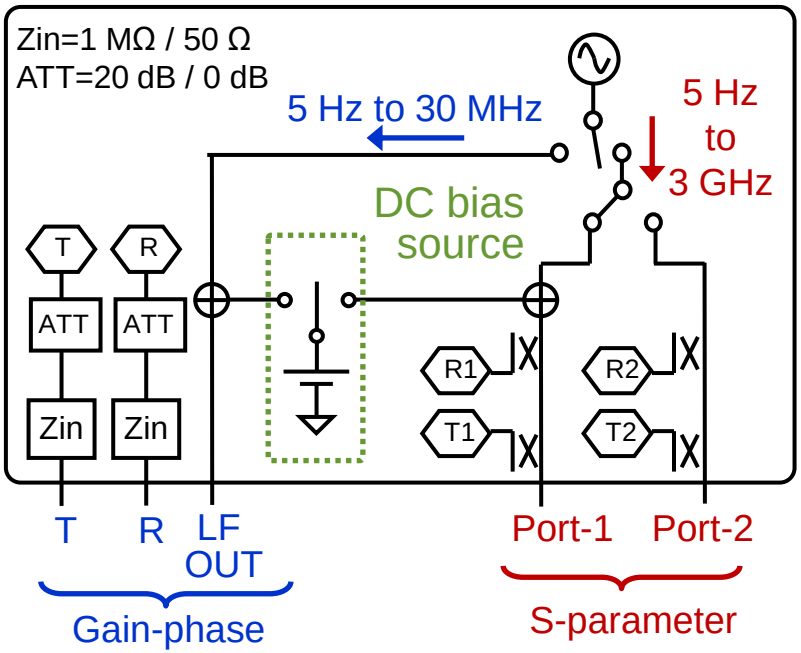
Agilent Technologies
February 2011

Contents

E5061B-3L5 LF-RF network analyzer

Comprehensive NA/ZA solution from 5 Hz to 3 GHz



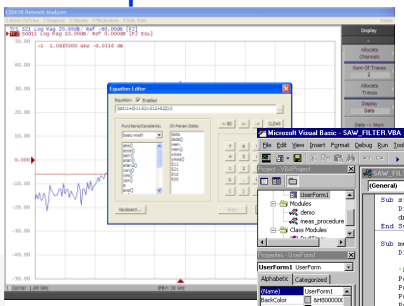


- S-parameter test port (5 Hz to 3 GHz, 50 Ω)
- Gain-phase test port with 1 MΩ input (5 Hz to 30 MHz, Zin=1 MΩ / 50 Ω)
- Wide dynamic range
- Built-in DC bias source (up to ±40 Vdc, max 100 mAdc, sweepable)
- Impedance analysis function (option 005)

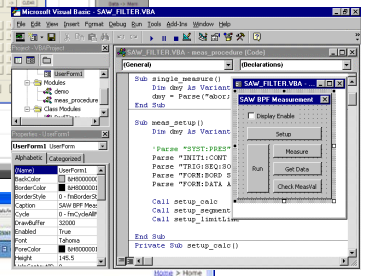
E5061B-3L5 LF-RF network analyzer

Advanced measurement capabilities and usability in a compact box

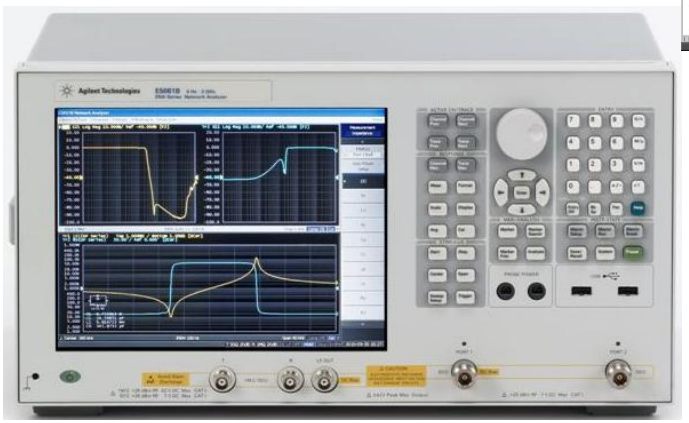
Equation editor

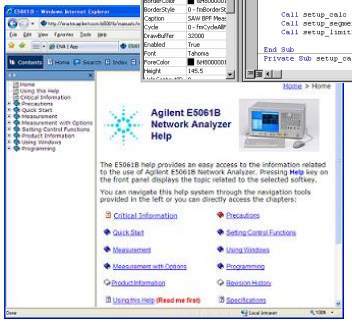


VBA

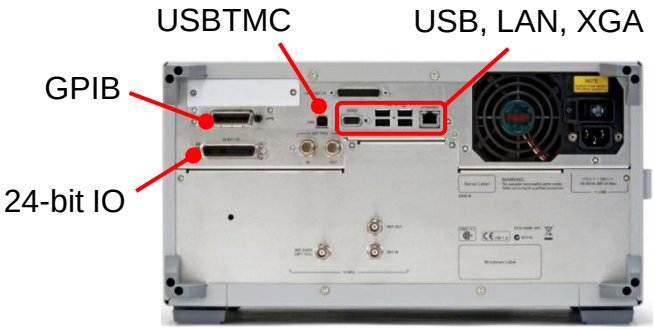


Small footprint





On-line help



Powerful connectivity

Touch screen

E5061B-3L5 options

Model/option	Description
E5061B	Network Analyzer
Test set option:	
E5061B-3L5	LF-RF network analyzer with DC bias, 5 Hz to 3 GHz
Impedance analysis options:	
E5061B-005	Impedance analysis function for LF-RF NA
E5061B-720	Add 50 Ω resistor set
Other options:	
E5061B-1E5	High stability time base
E5061B-010	Time domain/Fault location analysis
E5061B-020	Standard hard disk drive #1
E5061B-810	Add keyboard
E5061B-820	Add mouse
E5061B-1CM	Rack mount kit
E5061B-1CN	Front handle kit
E5061B-1CP	Rack mount & front handle kit
E5061B-1A7	ISO 17025 compliant calibration
E5061B-A6J	ANSI Z540 compliant calibration

NOTE:
#1 Option 020 is the only hard disk option for the E5061B. Must choose this option when ordering the E5061B.

Migrating legacy NA/ZA combo analyzers to E5061B

4192A ZA / Gain-Phase
5 Hz to 13 MHz

4194A ZA / Gain-Phase
100 Hz to 40 MHz (ZA)
10 Hz to 100 MHz (G-P)

4195A NA/ZA/SA
100 k to 500 MHz (ZA)
10 Hz to 500 MHz (NA)

4395A NA/ZA/SA
100 k to 500 M (ZA)
10 Hz to 500 MHz (NA)

4396x NA/ZA/SA
100 k to 1.8 GHz (NA/ZA)

Impedance analysis (ZA)
&
Network analysis (NA)

E5061B-3L5 LF-RF network analyzer with opt.005 impedance analysis function (5 Hz to 3 GHz)

Offers more comfortable measurements.

- *Fully covers NA + ZA capabilities.*
- *Wider freq coverage*
- *More flexibility & easy-to-use*
- *Much smaller footprint*

Comparison of major functions

	4192A	4194A	4195A	4395A-010	E5061B-3L5/005
Meas. function	ZA + Gain-phase	ZA + Gain-phase	NA + ZA + SA	NA + ZA + SA	NA + ZA
Freq. range	5 Hz to 13 MHz	Gain-phase: 10 Hz to 100 MHz ZA: 100 Hz to 40 MHz (100 kHz to 100 MHz with 41941A probe)	NA/SA: 10Hz to 500MHz ZA: 100 kHz to 500 MHz	NA/SA: 10Hz to 500MHz ZA: 100 kHz to 500 MHz (with 43961A)	5 Hz to 3 GHz (S-parameter test port) 5 Hz to 30 MHz (Gain-phase test port)
NA test port	Source/R/T	Source/R/T	Source/R/T, dual	Source/R/A/B	S-parameter test port (5 Hz to 3 GHz) Gain-phase test port (Source/R/T, 5 Hz to 30 MHz)
1 MΩ input	Built-in	Built-in	External 1 MΩ adapter	External 1 MΩ adapter	Built-in
S-param. test set	No	No	No	External (100 k to 500 MHz)	Built-in (5 Hz to 3 GHz)
ZA function	Auto balance bridge (for low to very-high Z)	Auto balance bridge (for low to very high Z, 100 Hz to 40 MHz) (Plus, I-V method with 41941A, 100 k to 100 MHz, for low to high Z)	Reflection method (with 41951A, for low to mid Z)	I-V method (with 43961A, for low to high Z)	Reflection method (for low to mid Z) Series-thru method (for mid to high Z) Shunt-thru method (for very low Z)
DC bias source	AC+DC output (for ZA only)	AC+DC output (for ZA only)	DC output, sweepable	DC output	AC+DC output at Port-1/LF OUT, DC output at LF OUT, sweepable
mΩ measurement at low-freq	No	No	No	No	Yes (Gain-phase shunt-thru method)
Channel / trace	N/A	1-ch / 2-trace	1-ch / 2-trace	2-ch / 1-trace	4-ch / 4-trace
Sweep type	N/A	Linear & log freq, Power, ACV, DC bias, Program sweep Up & Down sweep	Linear & log freq, Power, ACV, DC bias, Program sweep, Partial swp, Up & Down sweep	Linear & log freq, Power, Segment sweep	Linear & log freq, Power, DC bias, Segment sweep
Built-in programming	No	ASP	ASP	IBASIC	VBA
Trace math	No	Yes	Yes	Yes	Yes (Equation editor)
Data storage	No	Internal register	FDD, Internal register	FDD, Flash memory	HDD, USB memory, etc
Interface	GPIB	GPIB, 8-bit I/O	GPIB, 8-bit I/O	GPIB, 8-bit I/O	GPIB, LAN, USBTMC, 24-bit I/O

For spectrum measurements

Migrate to dedicated spectrum analyzers:

- N9000A CSA signal analyzer (9 kHz to 3 GHz / 7.5 GHz)
- N9010A EXA signal analyzer (9 kHz to 3.6 GHz / 7 GHz / 13.6 GHz / 26.5 GHz)
- N9020A MXA signal analyzer (20 Hz to 3.6 GHz / 8.4 GHz / 13.6 GHz / 26.5 GHz)

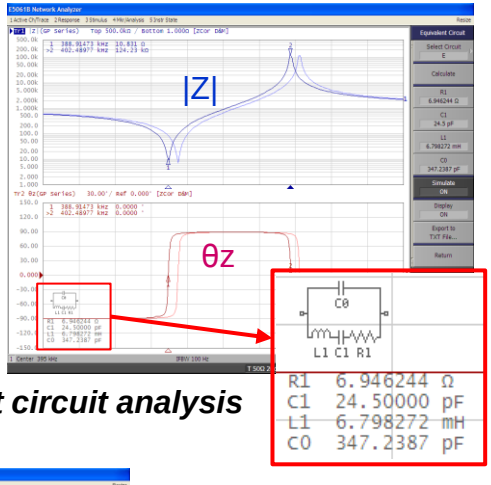
Contents

E5061B-005 Impedance Analysis option

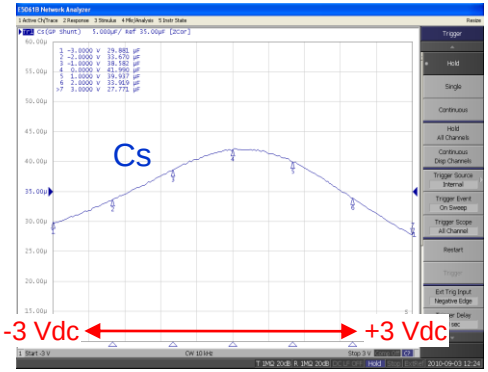
Impedance analysis firmware option for E5061B-3L5 LF-RF NA

NEW

- Fully support basic ZA functions
  - Display Z parameters (|Z|, θz, |Y|, θy, Cp, Cs, Lp, Ls, Rp, Rs, D, Q, R, X, G, B)
  - Open/Short/Load (+ Low-loss-C) calibration
  - Fixture compensation (Open/Short/Load + Electrical length)
  - Equivalent circuit analysis
- Covers various Z measurements with multiple measurement methods
  (Reflection, Series-thru, and Shunt-thru)
- DC biased Z measurement
  (0 to ±40 Vdc, max 100 mAdc)



Equivalent circuit analysis



DC bias sweep for ceramic capacitor

For more details, refer to "E5061B-3L5 LF-RF network analyzer with Option 005 Impedance Analysis Function, Data Sheet" (5990-7033EN)

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Typical migration paths for Z measurements

4195A+41951A
(100 k to 500 MHz)

4395A/96x+43961A
(100k to 500 M/1.8 GHz)

Typical DUTs:
Inductors, transformers, large capacitors,
RFID, antenna coils, crystal resonators,
RF passive components, etc

4194A
(ZA: 100 Hz to 40 MHz)

4192A
(5 Hz to 13 MHz)

Typical DUTs:
Ceramic resonators, piezo sensors,
crystal resonators,
small capacitors, large inductors, etc

Main migration path

Measure high-Z.

Need higher freq.
Measure low Z.

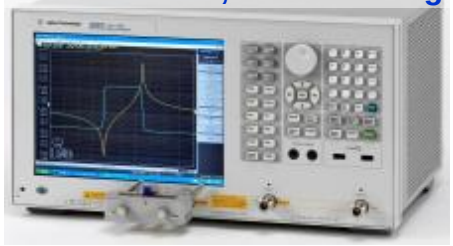
Main migration path

Measure milliohm Z of
large capacitors & DC-DC conv.

Measure high-Q or low-D (tan-delta)

E5061B-3L5/005
Reflection method
5 Hz to 3 GHz, for low to mid Z

E5061B-3L5/005
Gain-phase series-thru method
5 Hz to 30 MHz, for mid to high Z

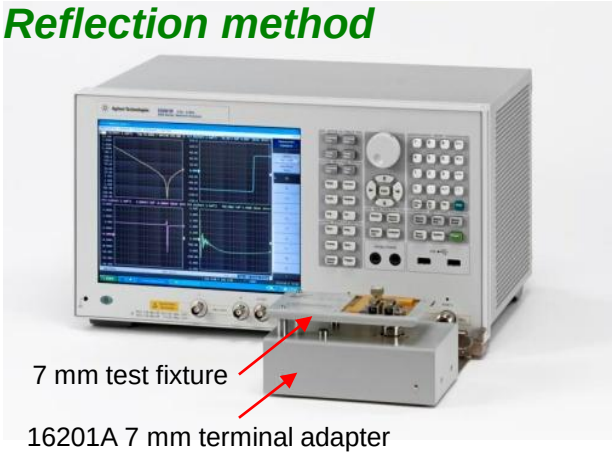


E5061B-3L5/005
Shunt-thru methods

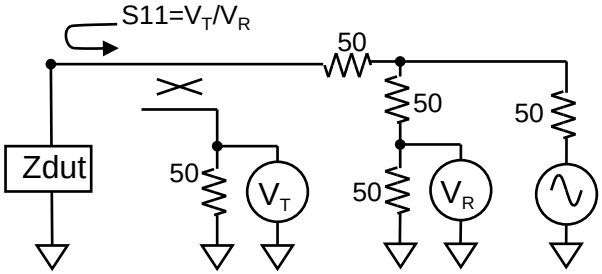
4294A / E4991A Z-analyzers

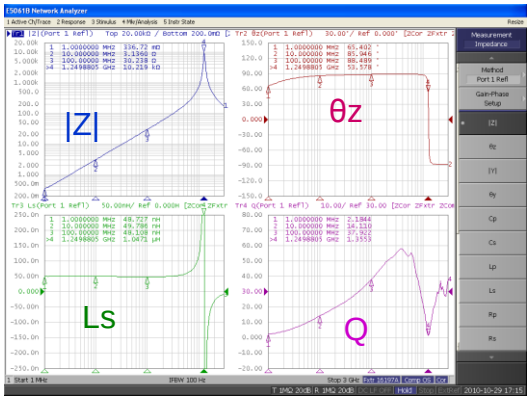
To migrate most of your Z measurements

Reflection method



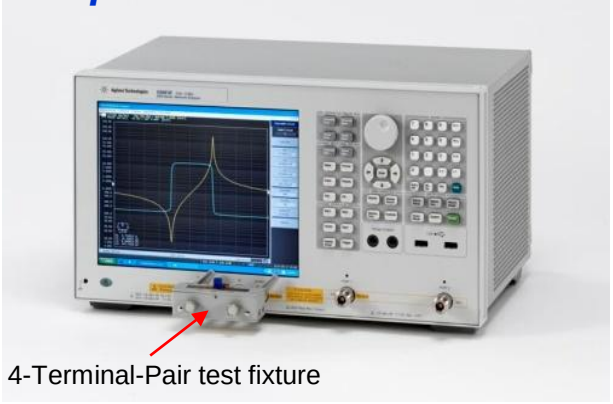
- 5 Hz to 3 GHz [#1]
- For low to middle Z (10% accuracy range: 1 Ω ~ 2 kΩ)
- 7 mm test fixtures can be used.



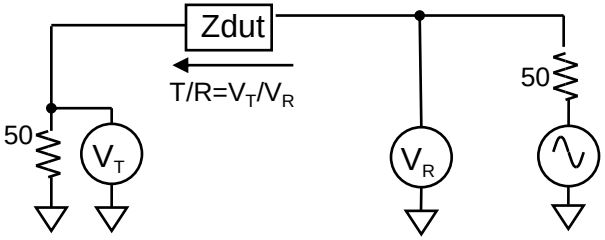


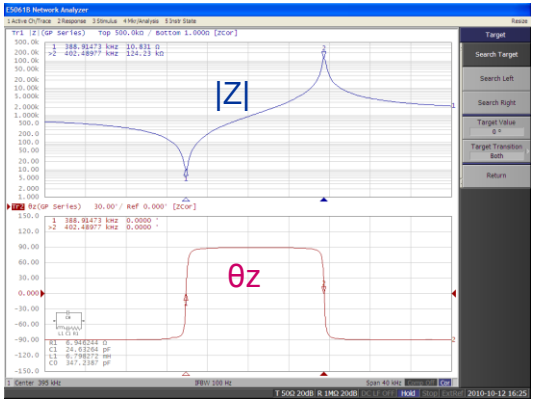
Note #1: Max freq depends on test fixture.

Gain-phase series-thru method



- 5 Hz to 30 MHz (at Gain-phase test port)
- For middle to high Z (10% accuracy range: 5 Ω ~ 20 kΩ)
- 4TP test fixtures can be used.





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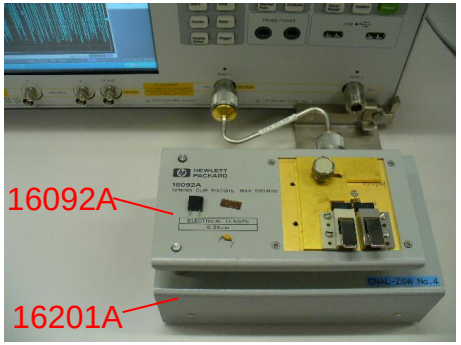
Options & accessories configuration example

Reflection method



Mainframe

E5061B	network analyzer
E5061B-3L5	LF-RF NA with DC bias
E5061B-005	ZA firmware for LF-RF NA

Adapter for connecting fixtures

16201A	7 mm terminal adapter kit
16201A-001	7 mm terminal adapter kit for E5061B

7 mm cal kit

16195B (open/short/load + optional low-loss-capacitor), or
85031B (open/short/load)

7 mm component test fixtures

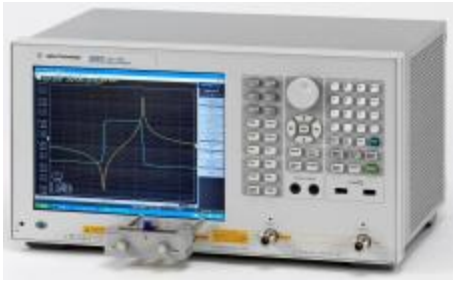
16092A (SMD & leaded-DUT, 500 MHz), 16192A (SMD, 2 GHz),
16197A (SMD, 3 GHz), 16196x (SMD, 3 GHz)

NOTES:

- 7 mm open/short/load calibration devices included in the 41951A/43961A Z test kit can be used instead of the 16195B (for open/short/load calibration up to 1.8 GHz).
- The 41951A/43961A Z test kits cannot be used instead of the 16201A.

Options & accessories configuration example

Gain-phase series-thru method

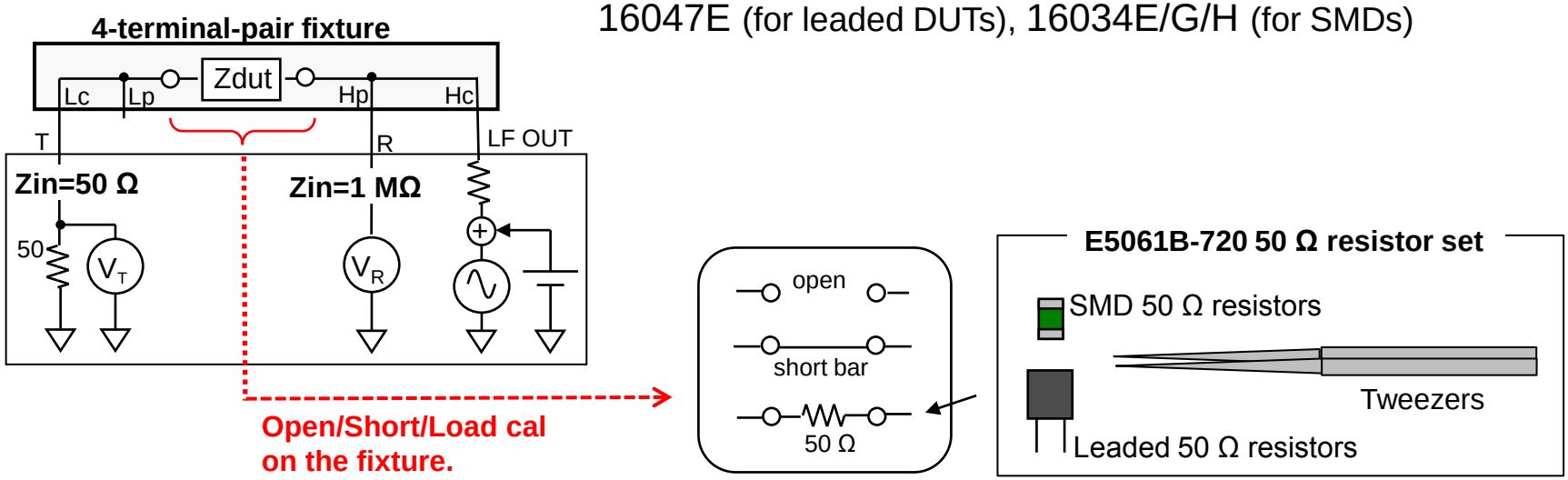


Mainframe

E5061B	network analyzer
E5061B-3L5	LF-RF NA with DC bias
E5061B-005	ZA firmware for LF-RF NA
E5061B-720	50 Ω resistor set

4TP component test fixtures

16047E (for leaded DUTs), 16034E/G/H (for SMDs)



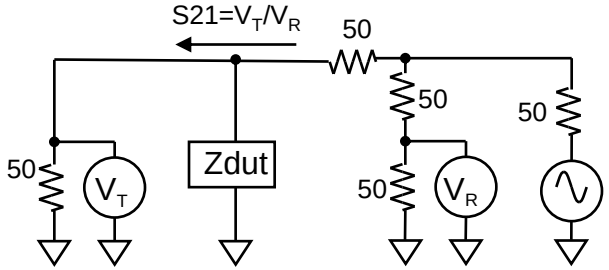
NOTE:

• The 16047A/D test fixtures are not recommended for use with the E5061B, because it is difficult to perform the load calibration stably using the leaded load device. Use the 16047E which can hold the leaded devices more tightly.

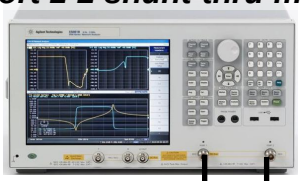
To measure lower impedance

Shunt-thru method

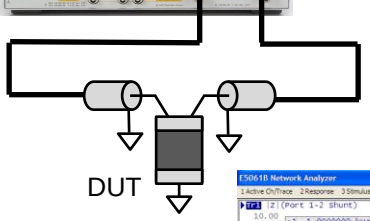
- 5 Hz to 3 GHz (Port 1-2), 5 Hz to 30 MHz (Gain-phase port)
- For very low Z (10% accuracy range: <1 mΩ to 5 Ω)
- Accurate milliohm measurement at LF (Gain-phase port)

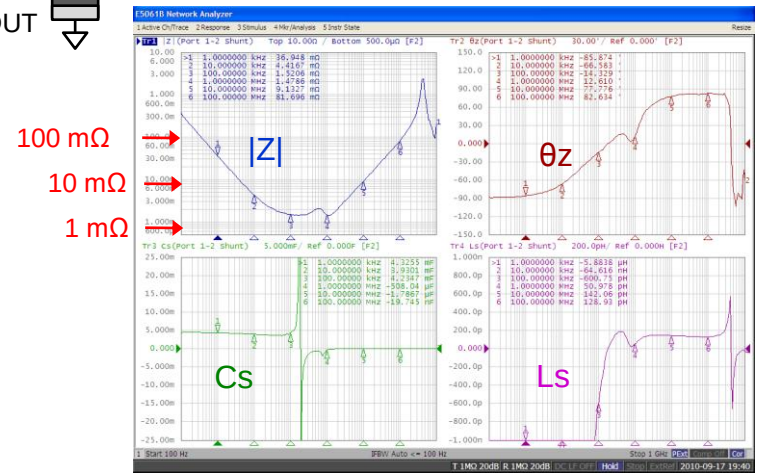


Port 1-2 shunt-thru method



For low Z measurement at middle to high freq range

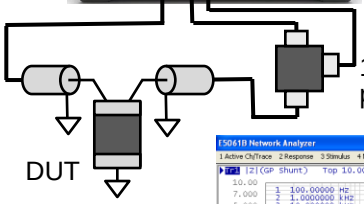


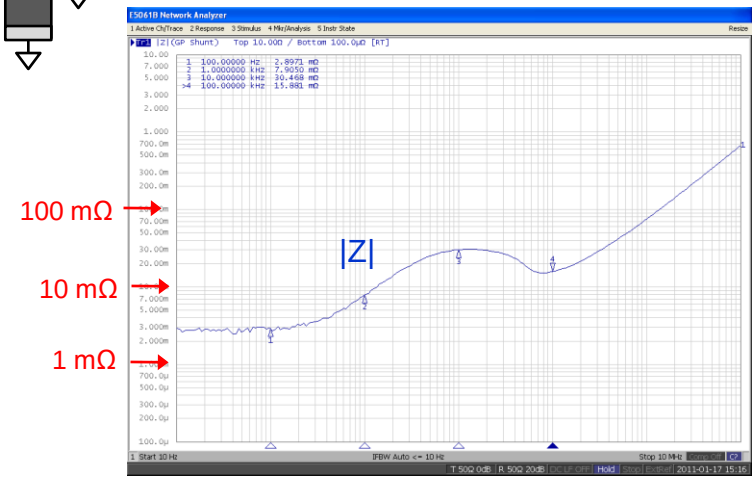


PDN Z measurement *(100 Hz to 1 GHz)*

Gain-phase shunt-thru method

For very low Z measurement at low to middle freq range.

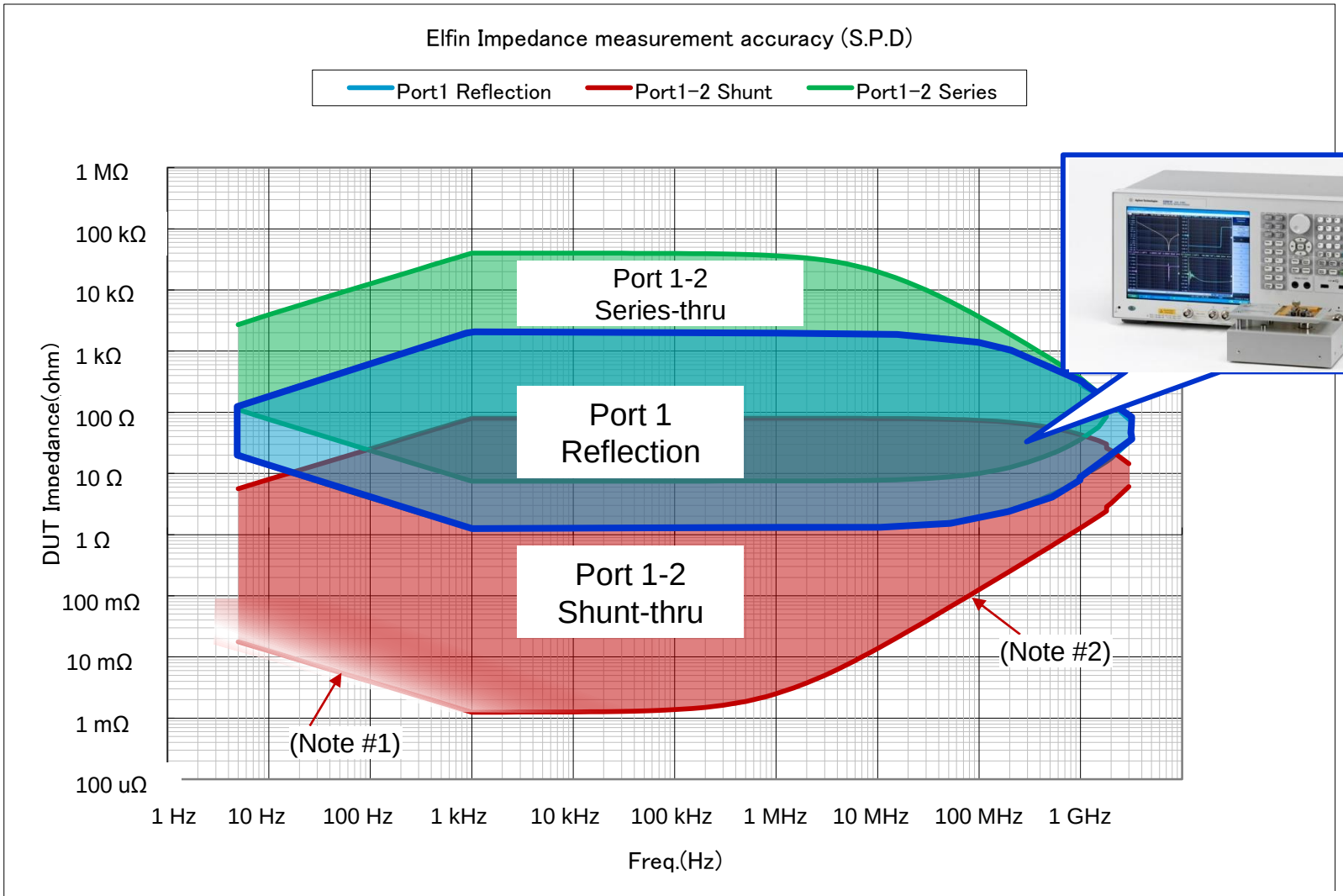




DC-DC conv. output-Z measurement *(10 Hz to 10 MHz)*

E5061B-3L5/005 Z meas accuracy at S-parameter test port

(10% accuracy range, Supplemental Performance Data)



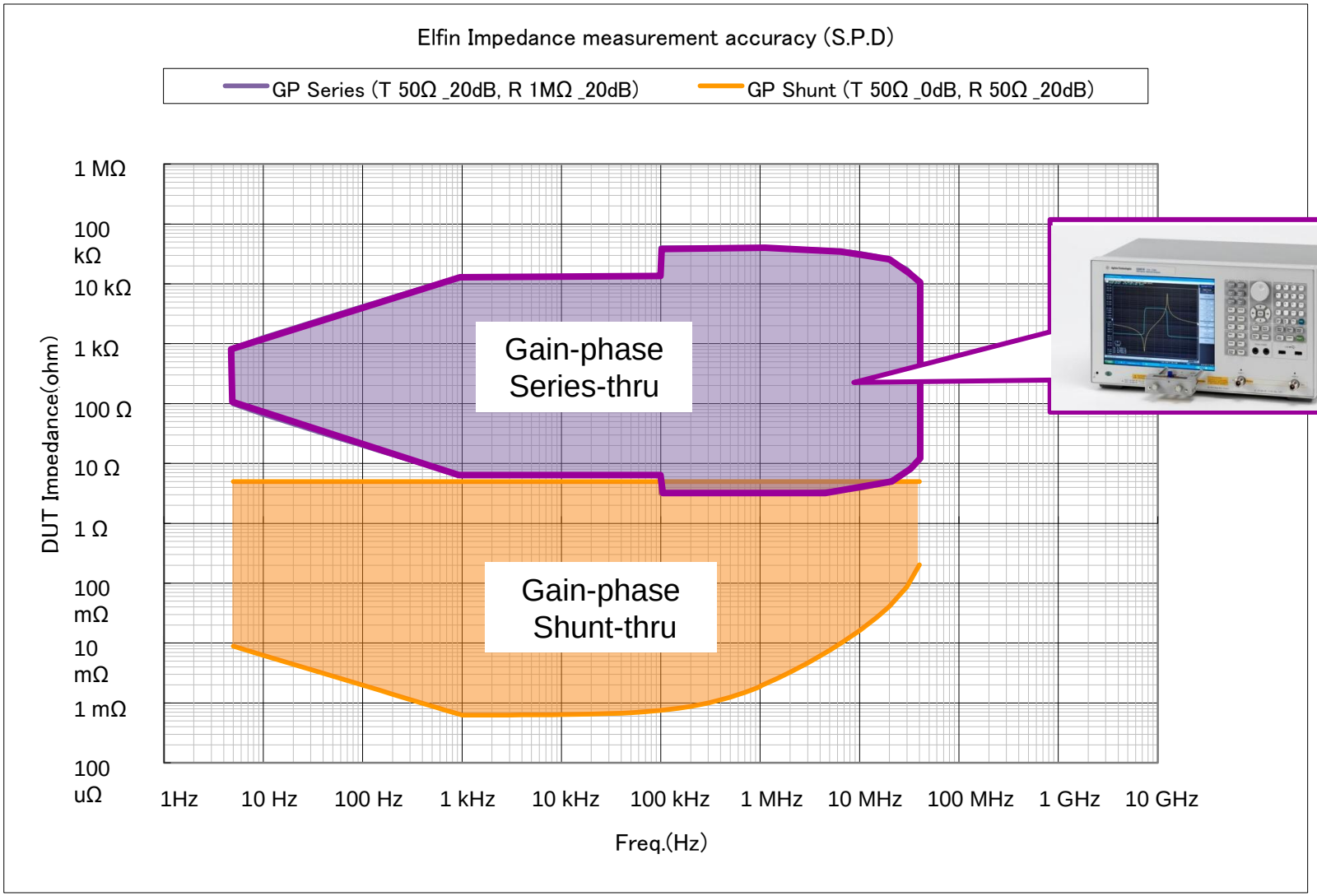
NOTES:

#1 Need external magnetic cores to measure below 10 mΩ in the low freq range (to eliminate GND loop errors).

#2 Case of 20 pH short residual impedance. Possible to measure lower Z range by further reducing the short residual impedance.

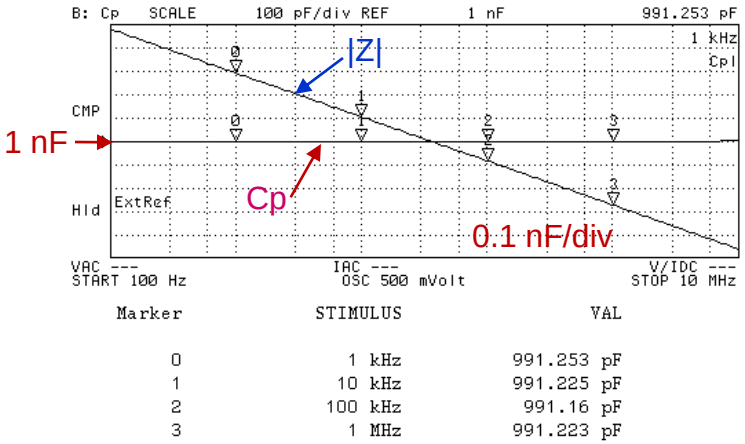
E5061B-3L5/005 Z meas accuracy at Gain-phase test port

(10% accuracy range, Supplemental Performance Data)



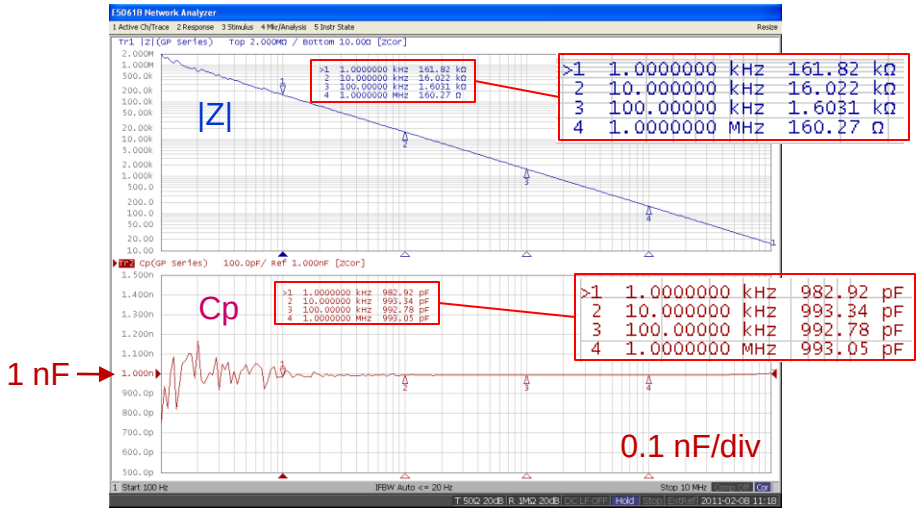
Measurement examples

1 nF capacitor measurement



Marker	STIMULUS	VAL
0	1 kHz	991.253 pF
1	10 kHz	991.225 pF
2	100 kHz	991.16 pF
3	1 MHz	991.223 pF

4294A Z-analyzer + 16034G fixture
Freq=100 Hz to 10 MHz,
Bandwidth=3, Source level=500 mVrms,
Open/short compensation

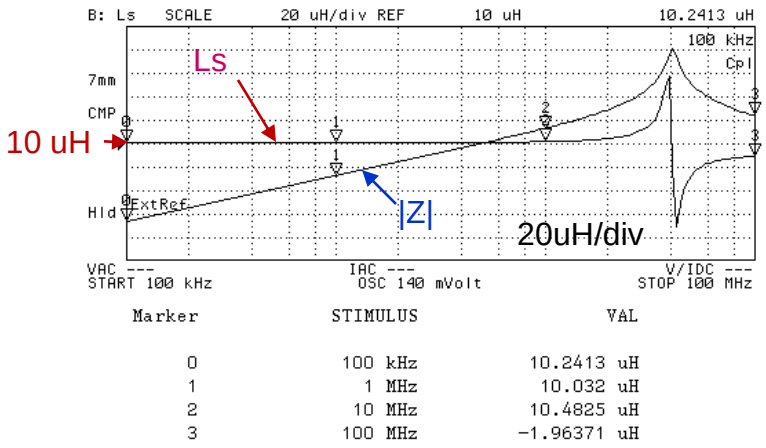


E5061B-3L5/005 + 16034G fixture
Gain-phase series-thru method
Freq=100 Hz to 10 MHz,
IFBW=Auto / 20 Hz limit, Source level=0 dBm,
Open/short/load calibration

- Stable measurement up to 100 kΩ.
- Good data correlation with 4294A Z-analyzer in capacitance measurements.
- Not suitable for measuring low D of capacitors.

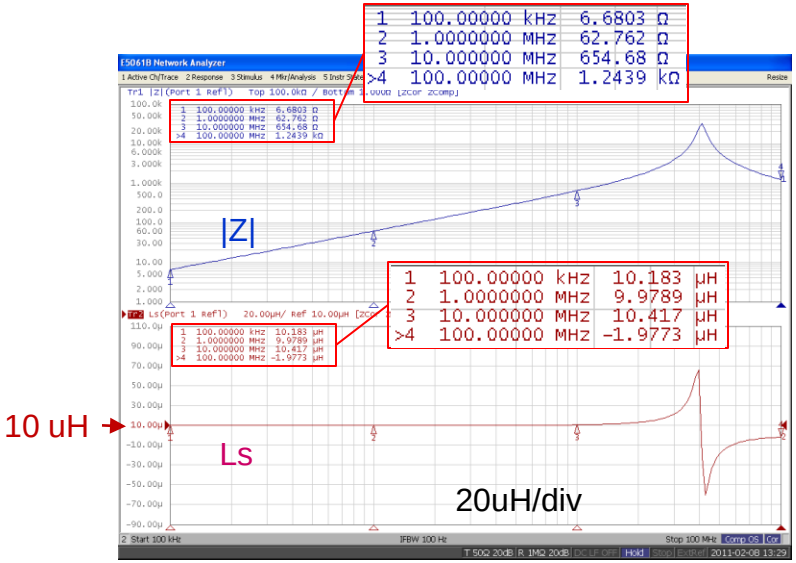
Measurement examples

10uH inductor measurement



Marker	STIMULUS	VAL
0	100 kHz	10.2413 uH
1	1 MHz	10.032 uH
2	10 MHz	10.4825 uH
3	100 MHz	-1.96371 uH

4294A Z-analyzer + 42942A 7 mm adapter + 16092A fixture
Freq=100 kHz to 100 MHz,
Bandwidth=3, Source level=140 mVrms,
Open/short compensation



E5061B-3L5/005 + 16201A 7 mm adapter + 16092A fixture
Reflection method
Freq=100 kHz to 100 MHz,
IFBW=100 Hz, Source level=-10 dBm,
Open/short/load calibration + Open/short compensation

- Stable measurement up to kΩ range.
- Good data correlation with 4294A Z-analyzer in inductance measurements.
- Not suitable for measuring high Q of inductors.

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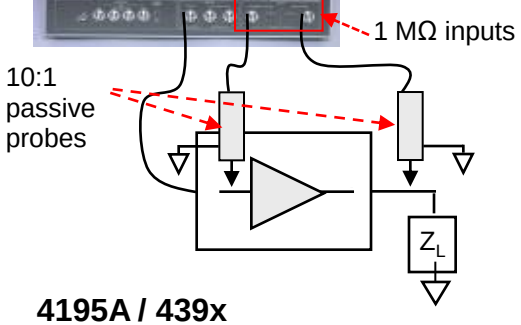
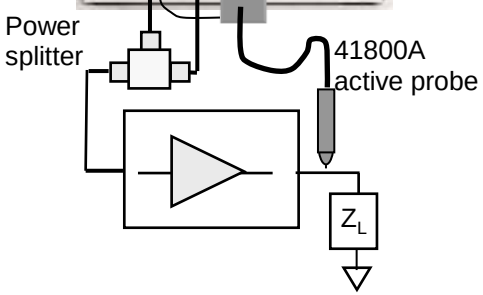
Contents

Amplifier measurement with high-Z probing

4194A / 4192A



4195A / 439x

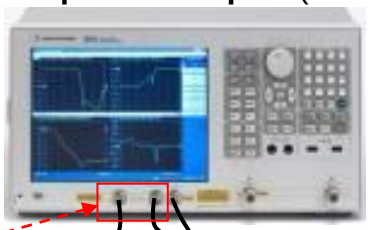


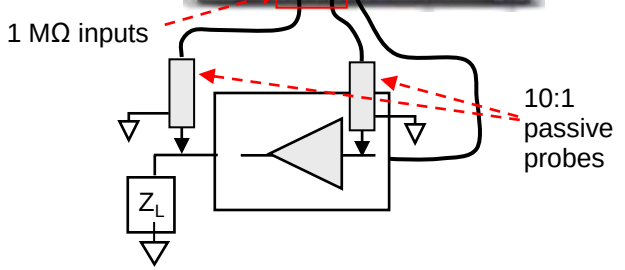
Main migration path

Need higher freq.

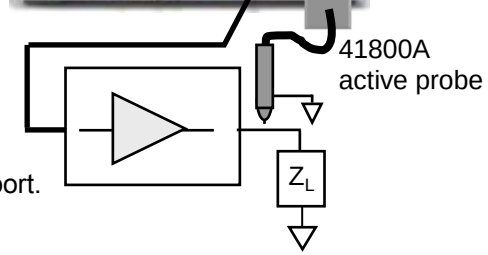
Main migration path

E5061B-3L5
Gain-phase test port (5 Hz to 30 MHz)





E5061B-3L5 + 41800A (5 Hz to 500 MHz)

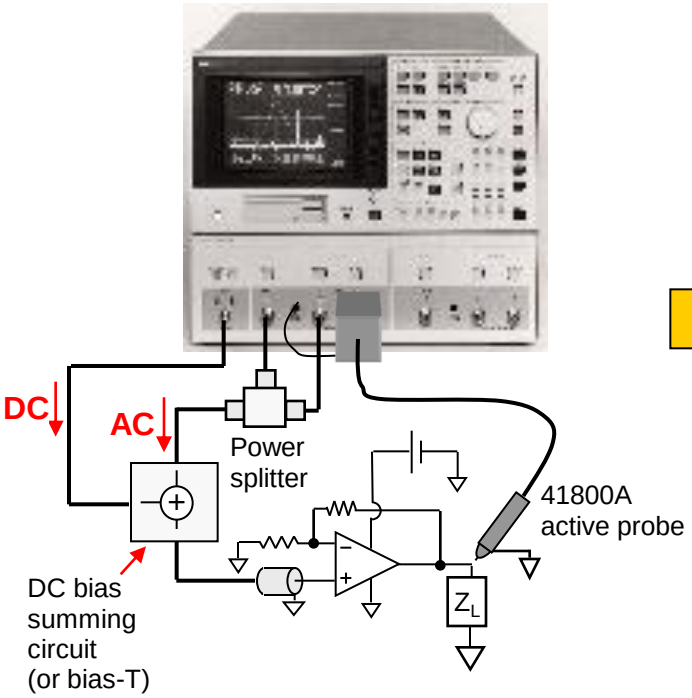


NOTE:
Response thru cal should be performed by probing DUT's input port.

For more details, refer to application note "Measuring freq response with E5061B", (5990-5578EN)

Amplifier measurement with DC bias

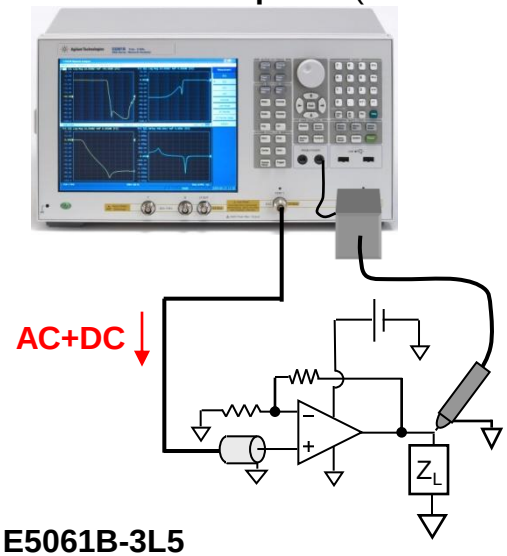
4195A / 439x



DC biased measurement for single-supply amplifier

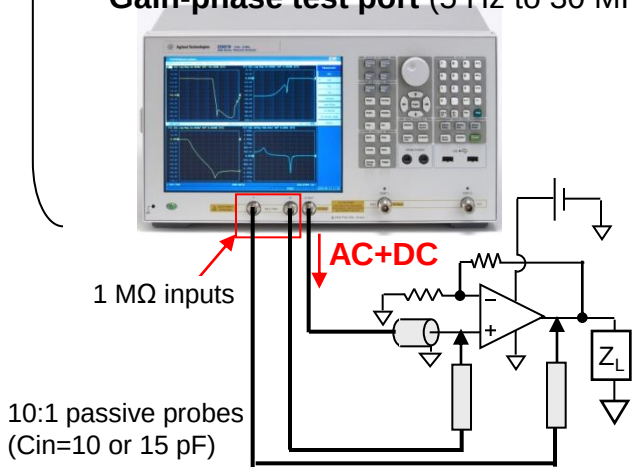
- Need external DC bias summing circuit.
- Lower-end frequency range may be limited by DC bias summing circuit.

E5061B-3L5 +
41800A active probe (5 Hz to 500 MHz)



DC bias can be internally superimposed to AC source signal from 5 Hz.

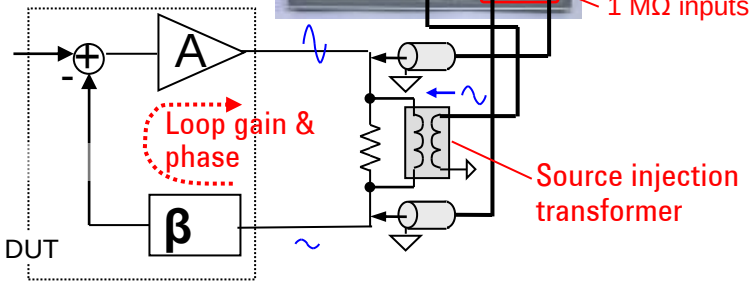
E5061B-3L5
Gain-phase test port (5 Hz to 30 MHz)



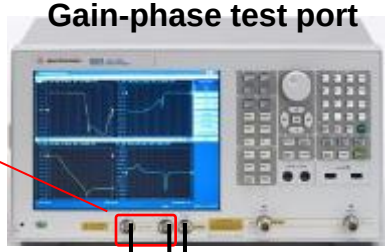
DC-DC converter / SMPS loop gain measurement

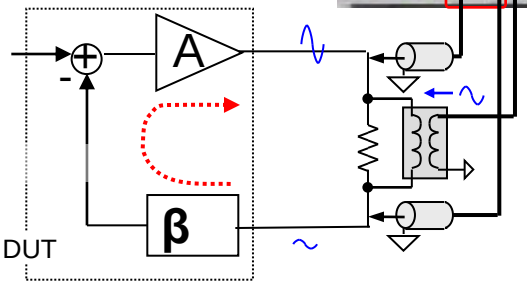
4194A, or

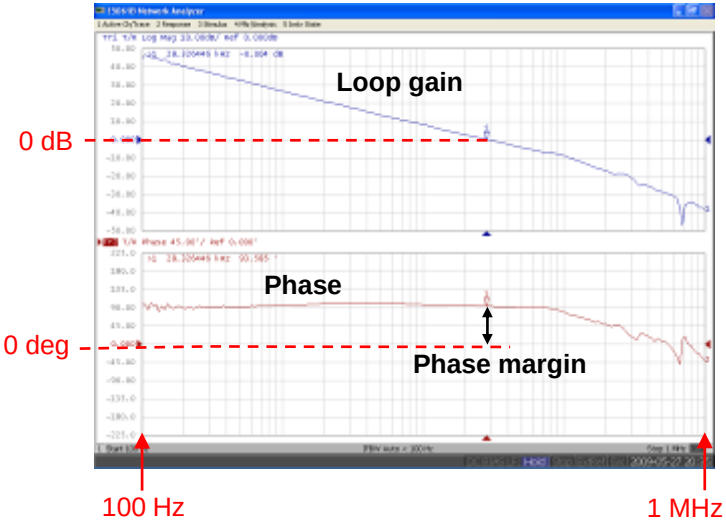
4395A with 41802A
1 MΩ adapters



E5061B-3L5
Gain-phase test port





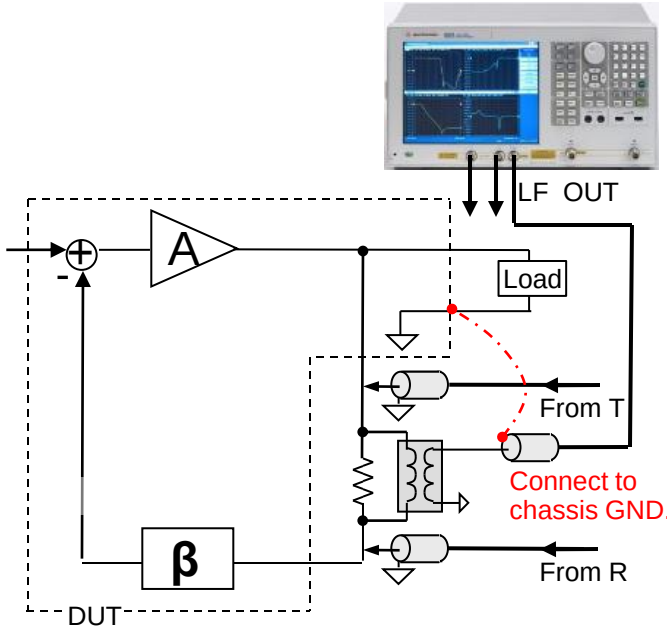


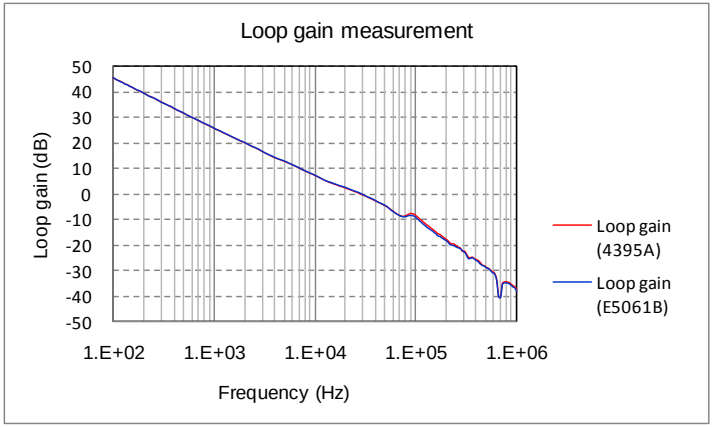
For more details, refer to application note “Evaluating DC-DC converters and PDN with E5061B”, (5990-5902EN)

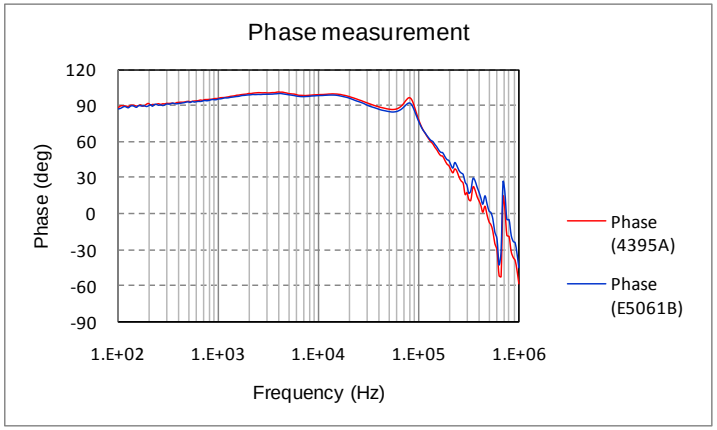
DC-DC converter / SMPS loop gain measurement

For a good data correlation between E5061B and legacy LF NAs;

- Set the source level to the same low level (e.g. less than -15 dBm) so that the loop circuit operates in its linear region.
- Perform the response thru calibration.
- When the measurement with one analyzer is finished , immediately (but quietly) switch the connection to the other analyzer for the next measurement, especially for a drifty DUT.
- Make the sweep time of both instruments to about the same time.
- To connect semi-floating R and T ports of the E5061B to the DUT, it is recommended to use straight coax test cables, rather than passive probes for oscilloscopes which are likely to cause stray couplings to the GND.
- If you use passive probes, it is recommended to connect the E5061B's chassis GND (=outer shield of the LF OUT port) to the DUT's GND.







DC-DC converter loop gain measurement example (E5061B-3L5 vs. 4395A+41802A)

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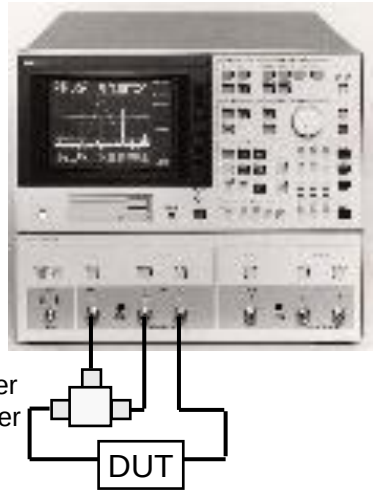
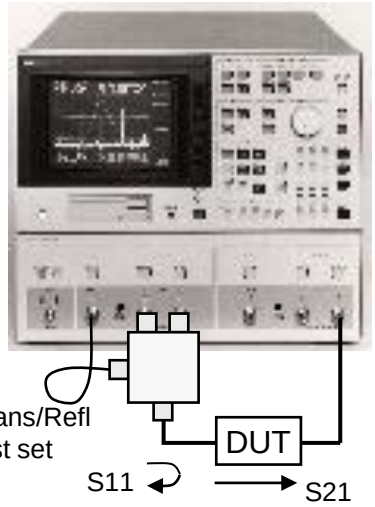
Network analysis for 50 Ω devices (4195A/439x)

- Filters, cables, transformers, amplifiers, etc

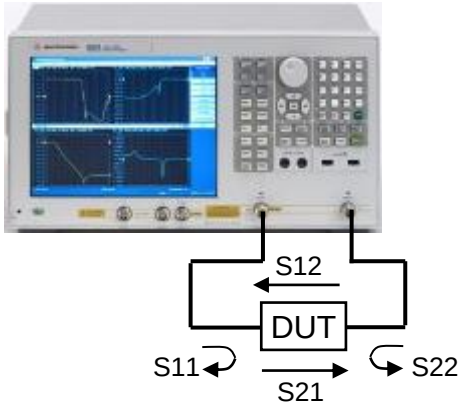


Transmission measurement using power splitter



Transmission/reflection measurement with external test set

E5061B-3L5



- *Wider frequency range (5 Hz to 3 GHz)*
- *No external test set needed*
- *Better dynamic range*
- *Faster speed*

→ e.g. Sweep time in the 100 dB dynamic range setting (@ f>1 MHz):

4195A …… 15 sec

E5061B …. < 50 msec

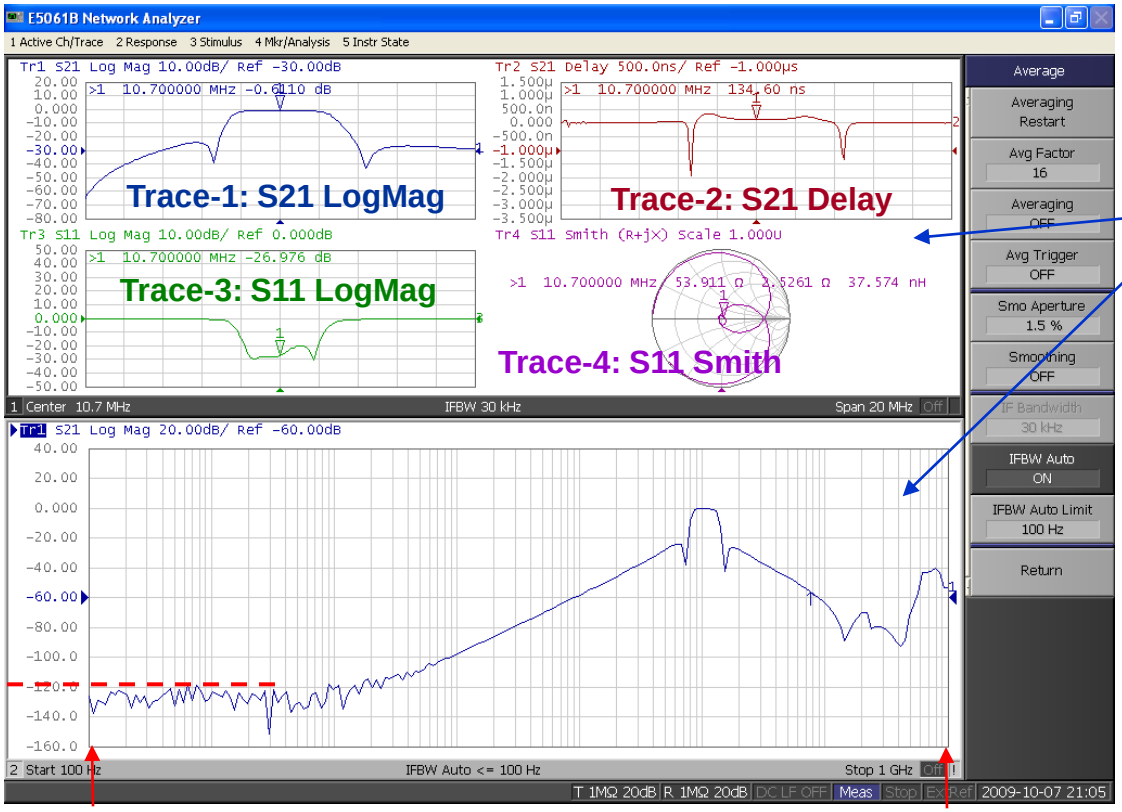
Network analysis for 50 Ω devices

- Filters, cables, transformers, amplifiers, etc

10.7 MHz BPF measurement with E5061B

Ch1:
narrow span
linear sweep

Ch2:
broadband
log sweep



Multi-traces &
Multi-channels
(up to 4-trace x 4-ch)

-120 dB

100 Hz

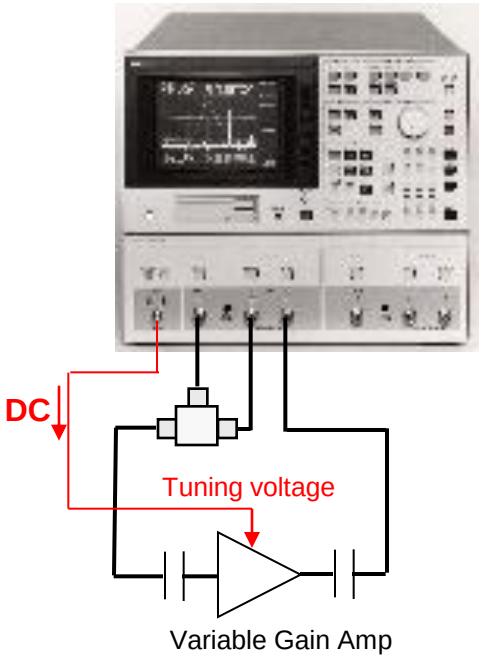
1 GHz

Wider frequency coverage

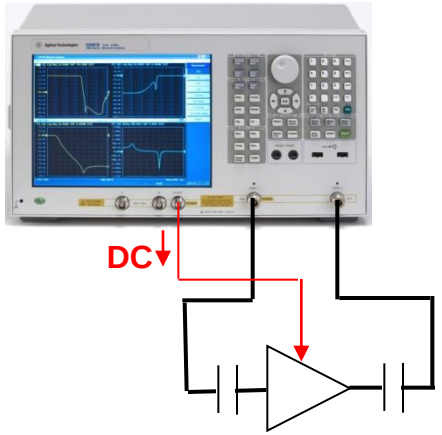
Excellent dynamic range

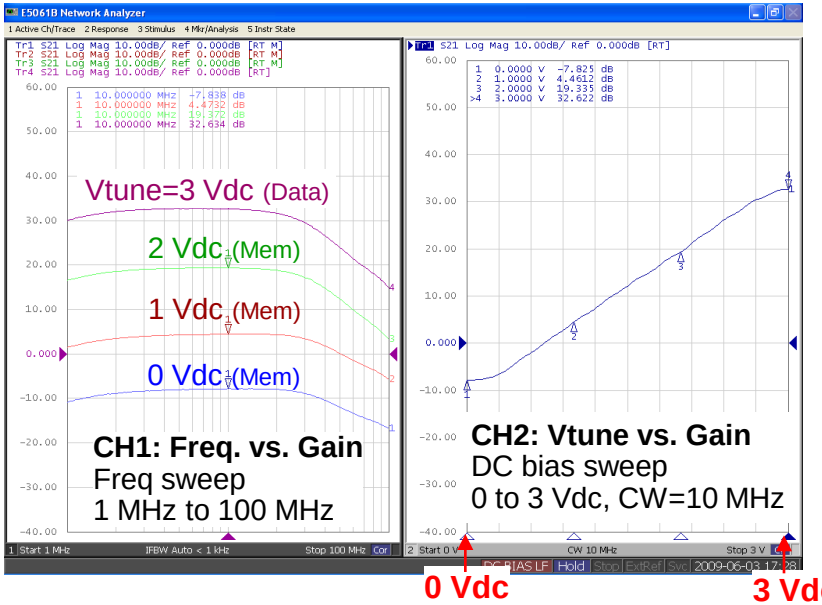
Measuring voltage tunable devices

- Variable Gain Amplifiers, tunable-antennas, MEMS-resonators, etc



Use LF OUT port as sweepable DC source.





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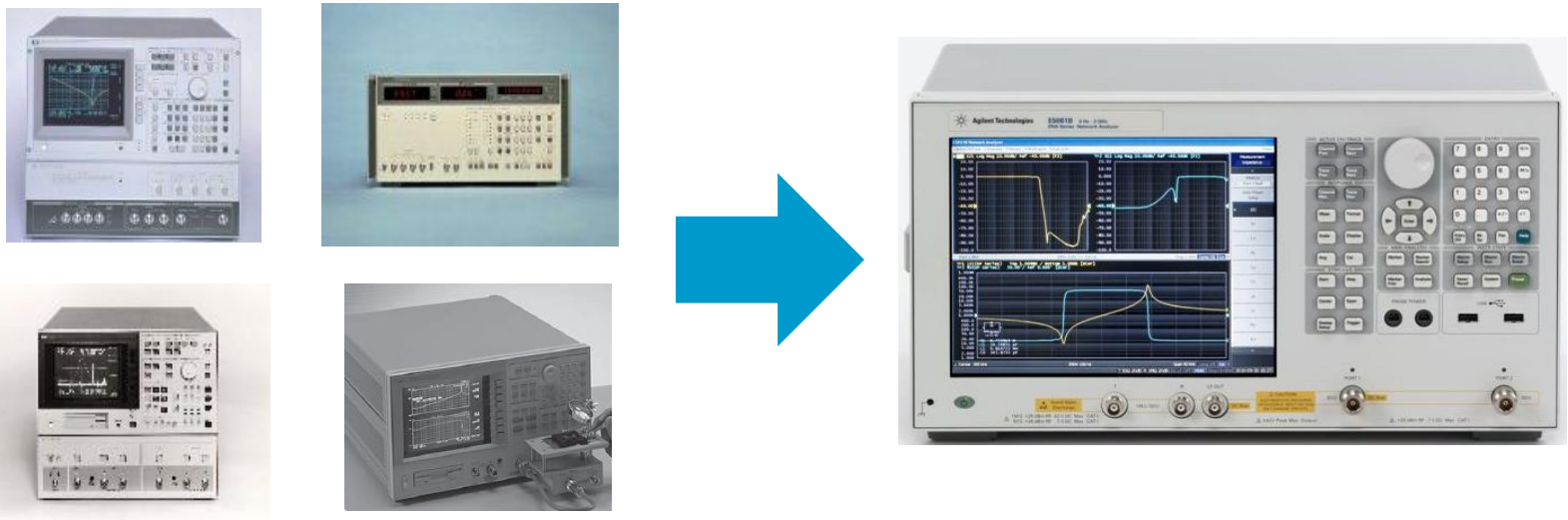
Summary

Migrate your analyzers to E5061B-3L5/005.

- *Fully covers NA + ZA capabilities.*
- *Wider freq coverage*
- *More flexibility & easy-to-use*
- *Much smaller footprint*



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