

[Demo Guide]

Amplifier Measurement Wizard for the E5072A ENA Series Network Analyzer



Agilent Technologies
May 2012

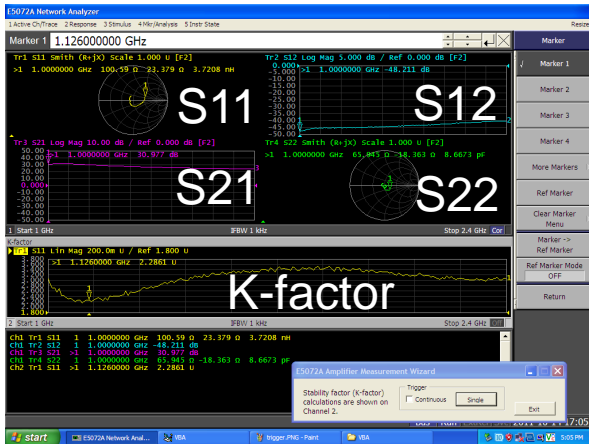
Rev.20120525

E5072A Features

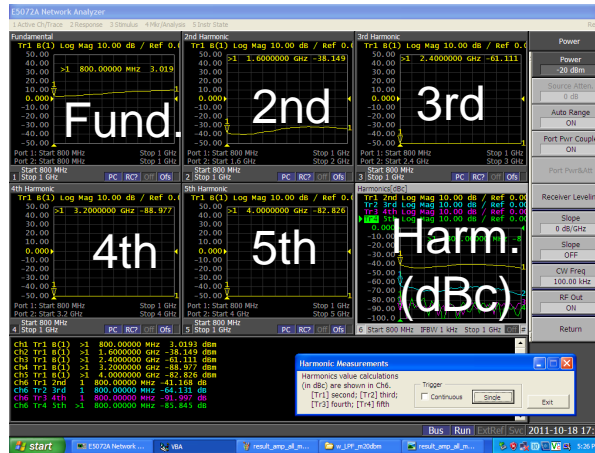
Amplifier Measurement Wizard

- Key parameters of amplifiers: S-parameters (K-factor), harmonics, gain compression (CW or Swept frequency).
- You can view **amplifiers' compression point over frequency** with the easy setup.

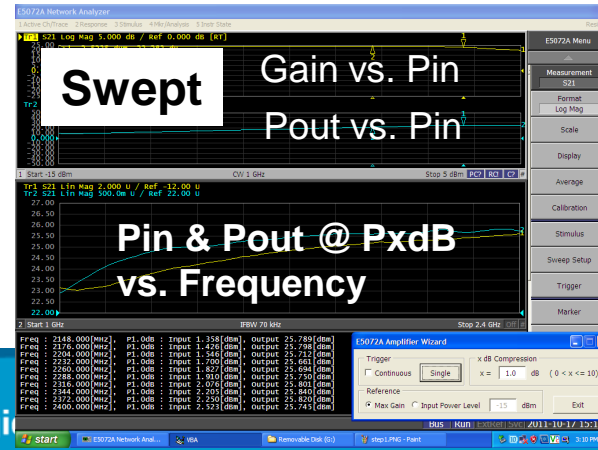
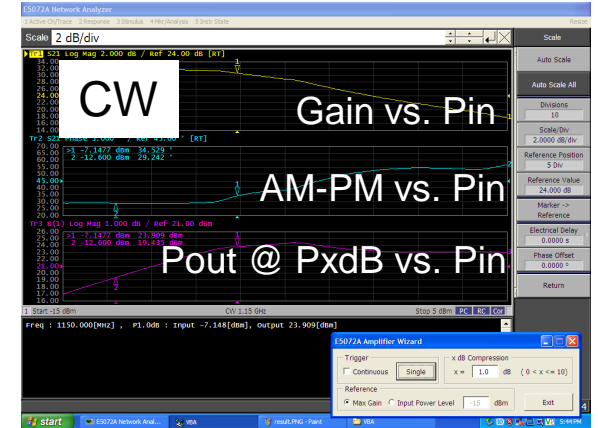
S-parameter & K-factor



Swept Harmonics



Gain Compression (CW or Swept frequency)

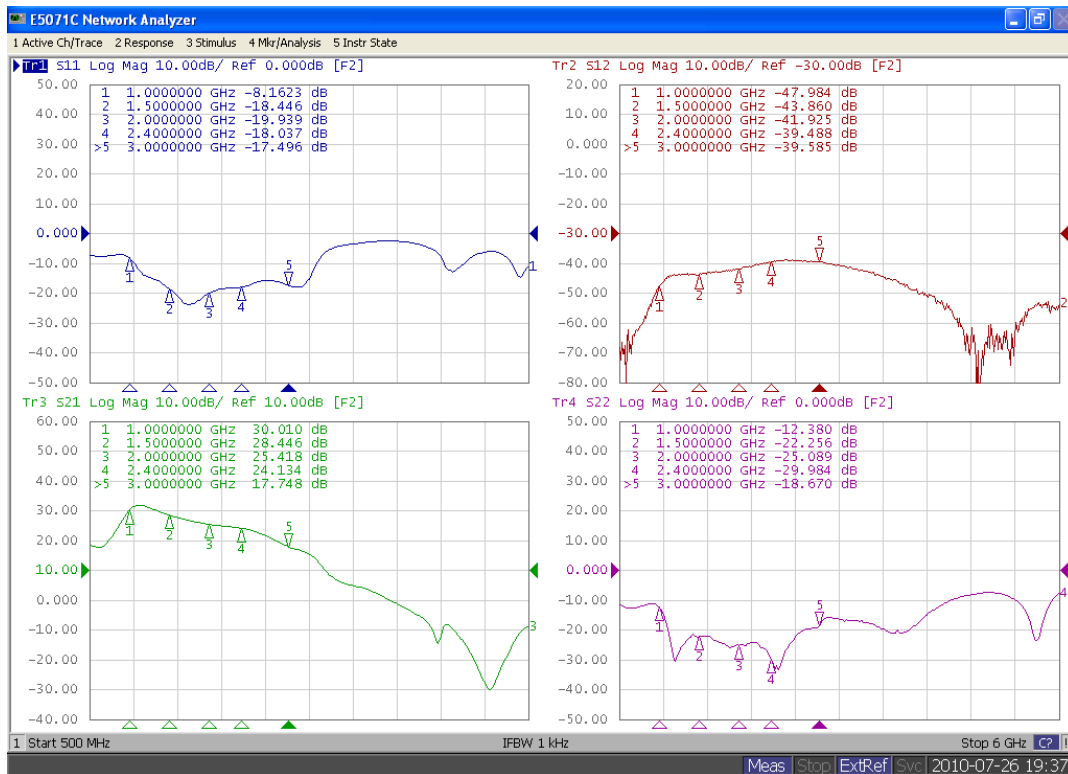


DUT for Demo

- **DUT:** The amplifier included in the E5072A's demo kit is used for measurements.
Mini-Circuits: ZRL-2400LN+ (Agilent P/N: 0955-2330)
*Data sheet is available at: <http://www.minicircuits.com/pdfs/ZRL-2400LN.pdf>

S-parameters:

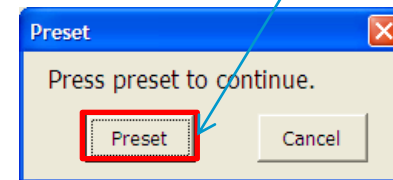
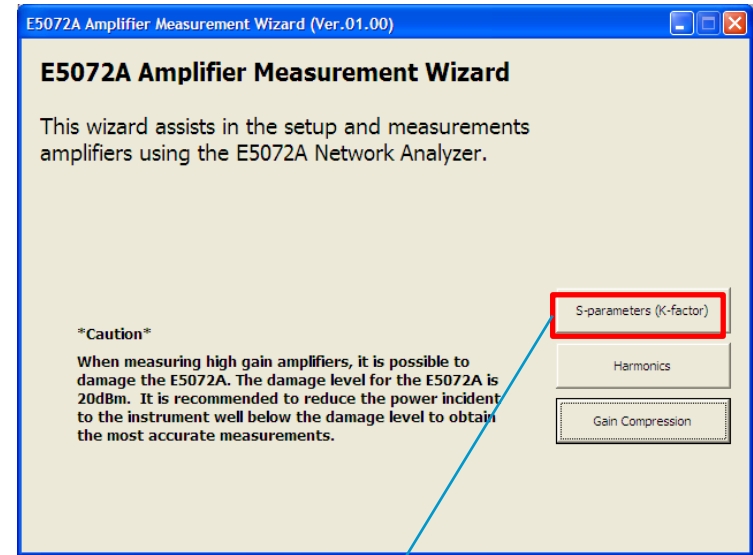
500 M to 6 GHz, IFBW = 1 kHz, Power level = -30 dBm, Full 2-port Cal



Amplifier Measurement Wizard

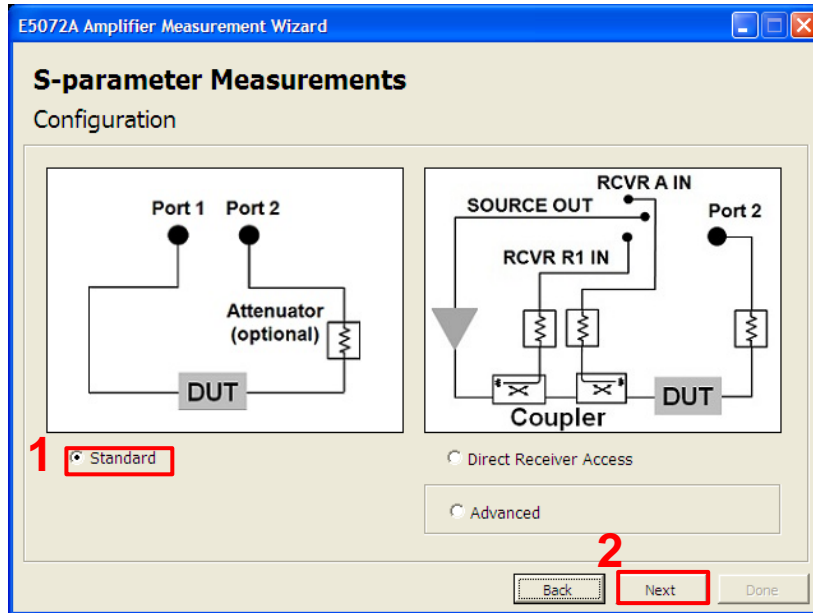
Measurement Procedure

- **Save the wizard program in the E5072A**
Visit: www.agilent.com/find/enavba
Go to [ENA Amplifier Measurement Wizard VBA](#)
Download “E5072AAmplifierWizard_xxxx.zip”
and unzip the file.
Copy “E5072AAmplifierWizard_xxxx.vba” under
“D:/VBA/ “ of the E5072A’s directory.
- **Launch the wizard program**
[Macro Setup] > Load & Run
Select “E5072AAmplifierWizard_xxxx.vba”
* The main window shows up.
- **Select the measurement parameter**
Select the parameter.
 1. **S-parameters (K-factor)**
 2. Harmonics
 3. Gain CompressionPress “Preset” to proceed the setup

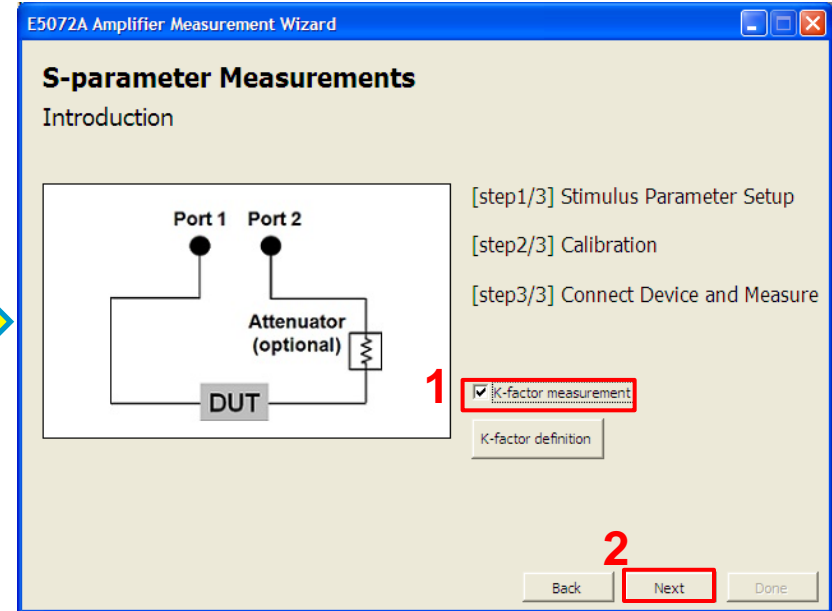


Amplifier Measurement Wizard

Measurement Procedure - S-parameters



1. Select "Standard" (Standard 2-port test)
2. Press "Next"



1. Check "K-factor-measurement"
2. Press "Next"

Amplifier Measurement Wizard

Measurement Procedure - S-parameters

E5072A Amplifier Measurement Wizard
[step1/3] Stimulus Parameter Setup

1 Frequency: Start 1000 MHz, Stop 2400 MHz, Center 1700 MHz, Span 1400 MHz

2 Port Couple: Port Couple

3 Port1 -109 to 20 dBm: -20 dBm; Port2 -109 to 20 dBm: 0 dBm

4 Points: Number of Points 201; IFBW: 1 kHz

5 Next

E5072A Amplifier Measurement Wizard
[step2/3] Calibration

Select the calibration type which you want to apply.

1 Power Calibration

2 2-port / Enhanced Response / Thru Calibration

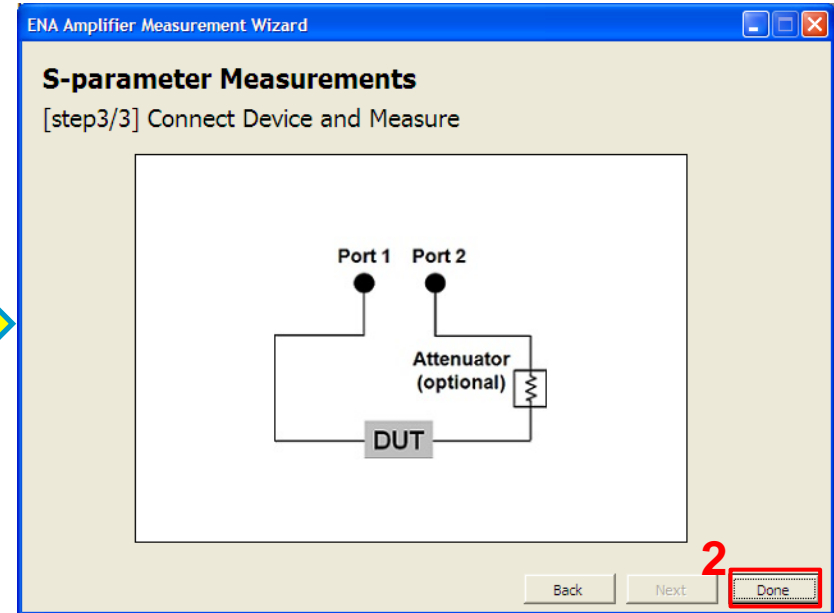
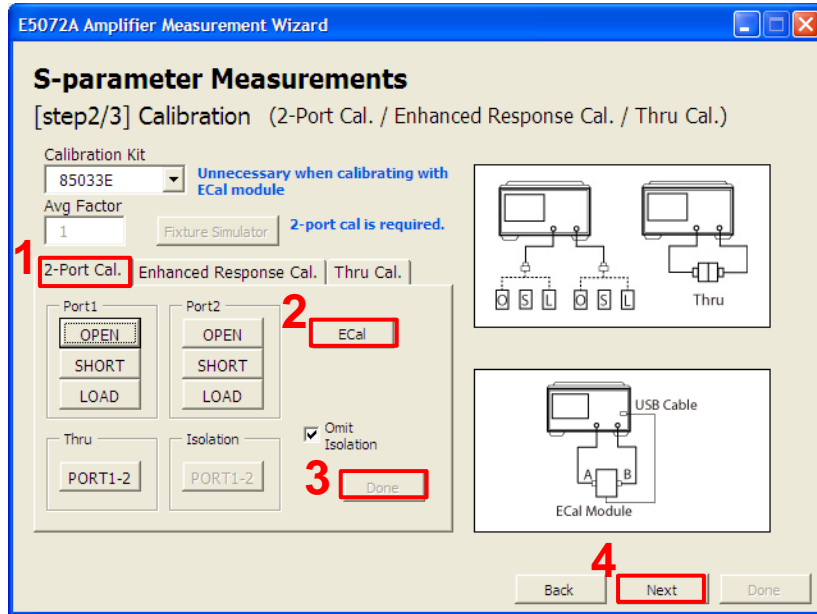
1. Enter Frequency (1000 to 2400 MHz)
2. Uncheck "Port Couple"
3. Enter Power (Port 1: -20 dBm, Port 2: 0 dBm)
4. Enter Points (201) & IFBW (1 kHz)
5. Press "Next"

1. Uncheck "Power Calibration"
2. Press "Next"



Amplifier Measurement Wizard

Measurement Procedure - S-parameters

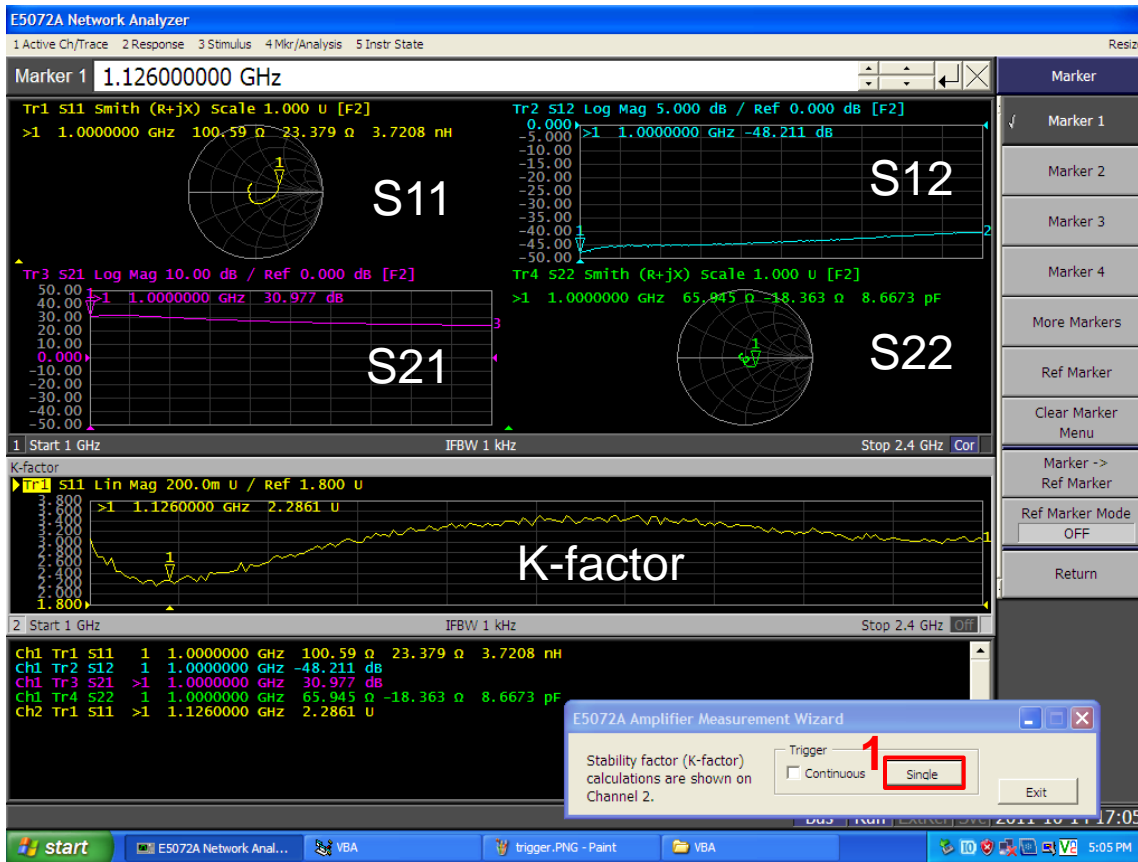


1. Select tab, "2-Port Cal." of full 2-port cal
2. Connect ECal and press "ECal"
3. Press "Done" after calibration
4. Press "Next"

1. Connect DUT
2. Press "Done"

Amplifier Measurement Wizard

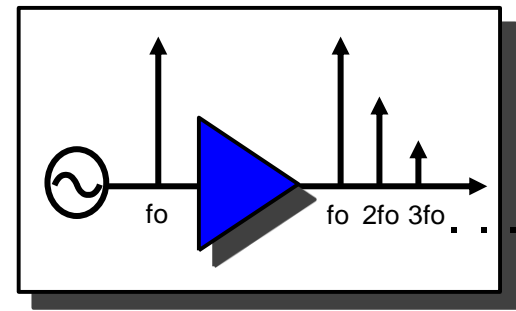
Measurement Procedure - S-parameters



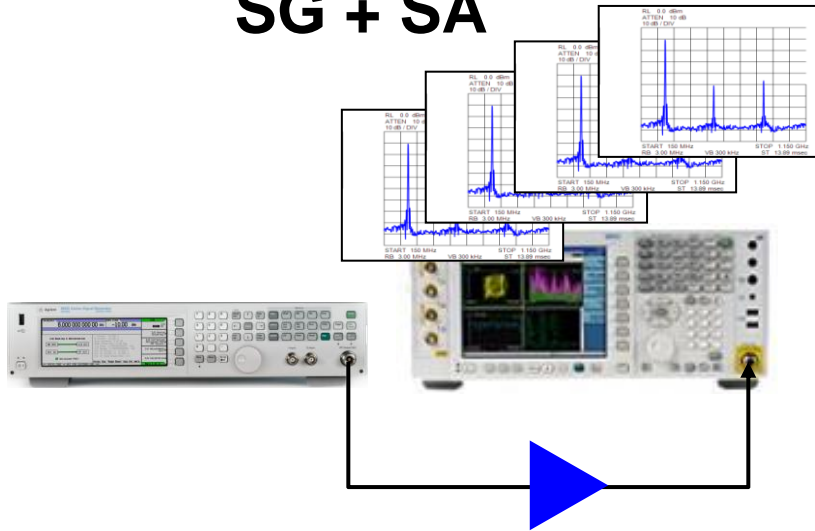
1. Press "Single" to trigger once.

Harmonics Measurement with VNA

Measurement Procedure - Harmonics

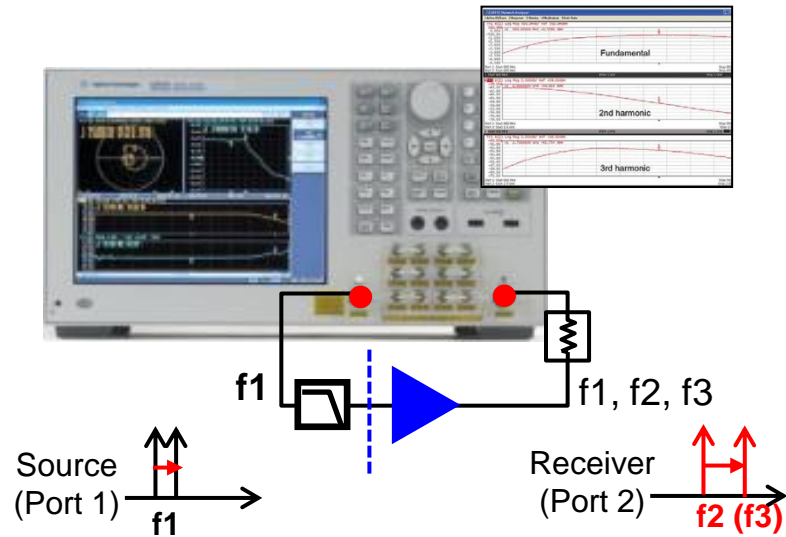


SG + SA



- Using a SG and a SA with CW signals.
- If many frequencies must be tested, test time is increased dramatically.

E5072A

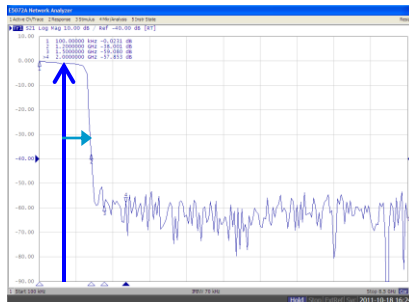
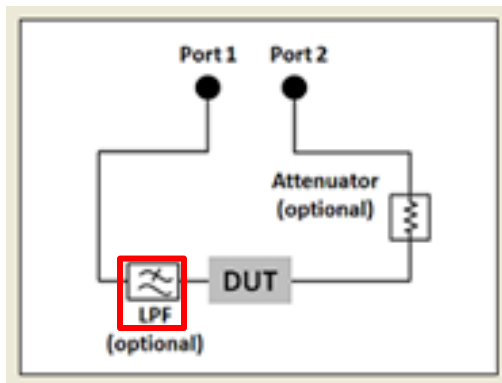


- VNA with **frequency-offset mode (FOM) option** can set different frequencies at the source and receiver.
- **Real-time** swept frequency / power harmonics measurements can be performed.
- Source power calibration and receiver calibration is available with VNA for absolute power measurements.

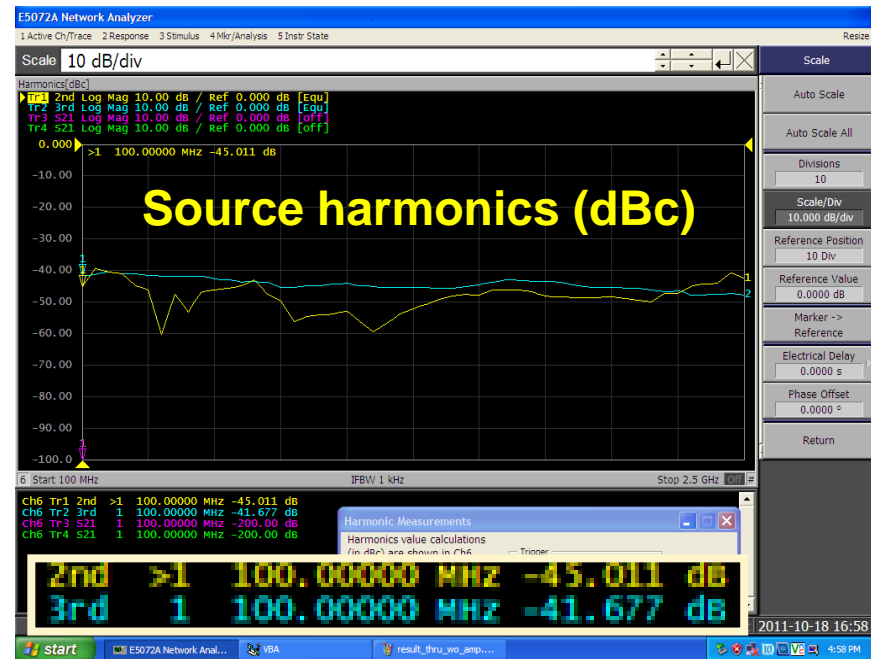
Amplifier Measurement Wizard

Measurement Procedure - Harmonics

- Swept-frequency harmonics measurements with the ENA.
- Option 008 (Frequency offset mode) is necessary for harmonics measurements.
- The external LPF is recommended to suppress the E5072A's source harmonics.



Carrier

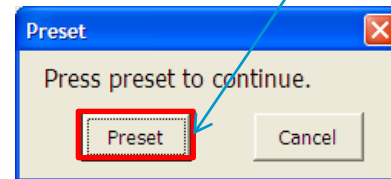
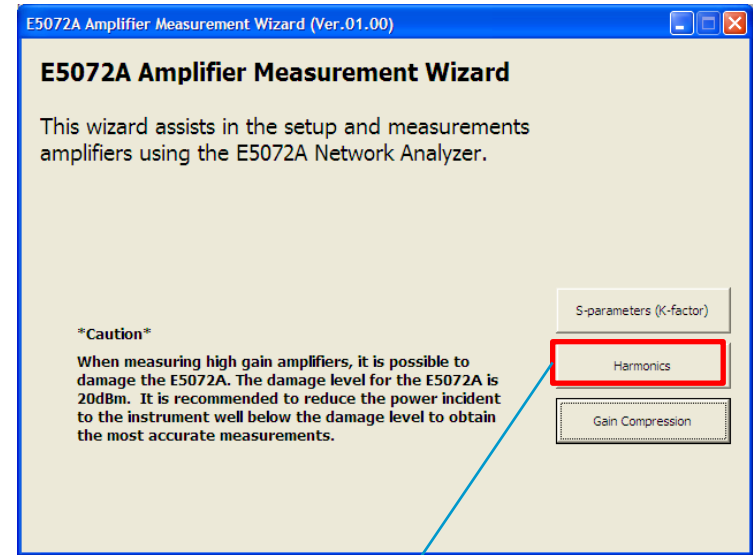


E5072A source harmonics (2nd, 3rd) example:
Carrier = 100 M to 2.5 GHz, Source power = +5 dBm

Amplifier Measurement Wizard

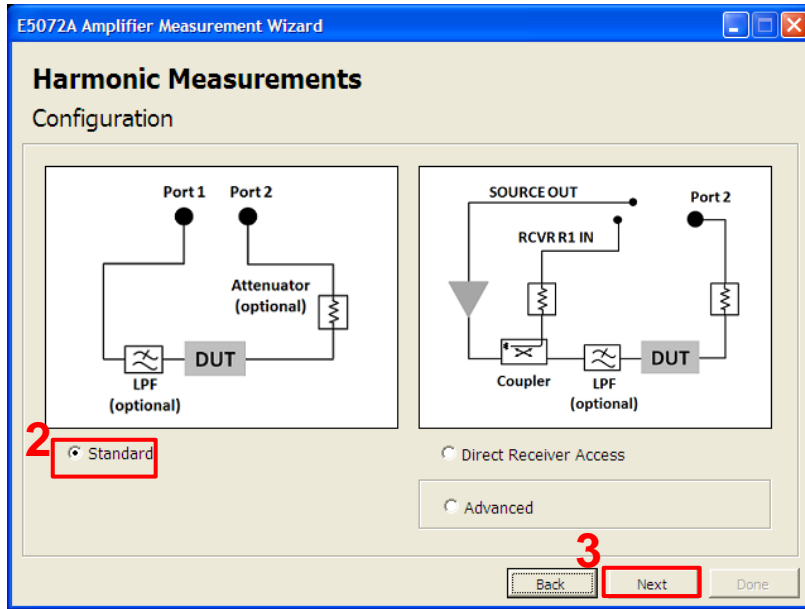
Measurement Procedure - Harmonics

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Copy “E5072AAmplifierWizard_XXXX.vba” under
“D:/VBA/ “ of the E5072A’s directory.
- **Launch the wizard program**
[Macro Setup] > Load & Run
Select “E5072AAmplifierWizard_XXXX.vba”
* The main window shows up.
- **Select the measurement parameter**
Select the parameter.
 1. S-parameters (K-factor)
 - 2. Harmonics**
 3. Gain CompressionPress “Preset” to proceed the setup

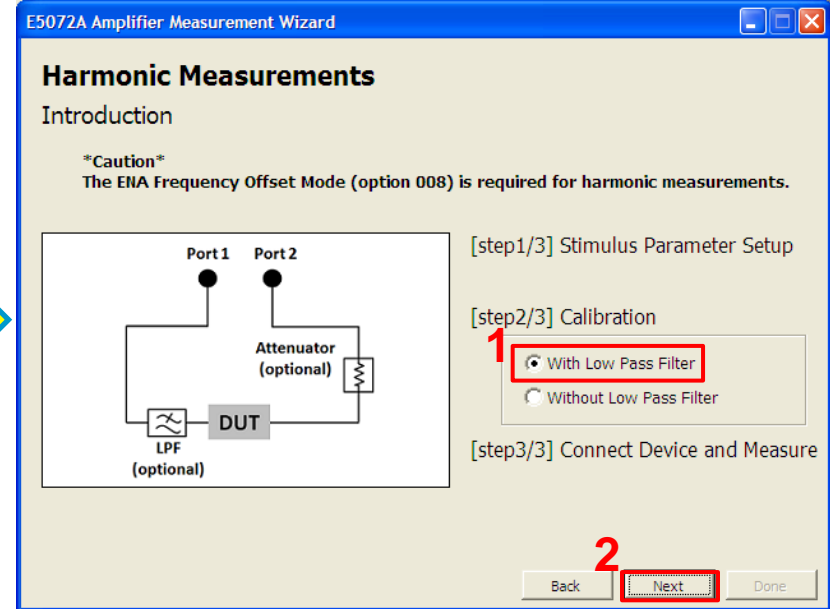


Amplifier Measurement Wizard

Measurement Procedure - Harmonics



1. Connect 20 dB ATT on Port 2
2. Select "Standard" (Standard 2-port test)
3. Press "Next"



1. Check "With Low Pass Filter"
2. Press "Next"

Amplifier Measurement Wizard

Measurement Procedure - Harmonics

Harmonic Measurements
[step1/3] Stimulus Parameter Setup

Fundamental Frequency (f0)

Start: 800 MHz, Stop: 1000 MHz
Center: 900 MHz, Span: 200 MHz

Power: -109 to 20 dBm, -20 dBm

Harmonics

second (2*f0)
 third (3*f0)
 fourth (4*f0)
 fifth (5*f0)

Points

Number of Points: 51
Point : 2 - 1601

Power Limit

Lock
Max Power: 10 dBm

IFBW: 1 kHz

Average: 16

Back Next Done

Harmonic Measurements
[step2/3] Calibration

Select the calibration type which you want to apply.

Power Calibration (for receiver cal)
 Receiver Calibration
 Power Calibration with Filter

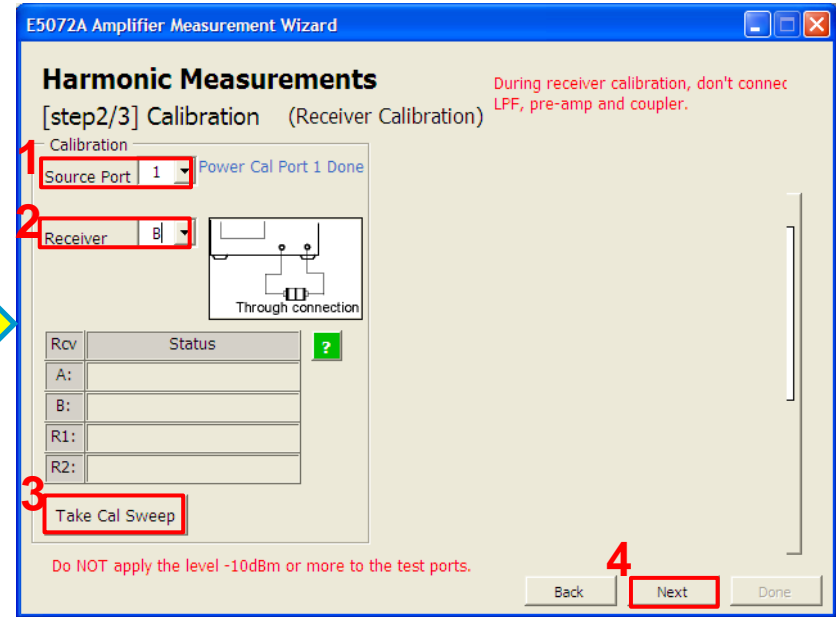
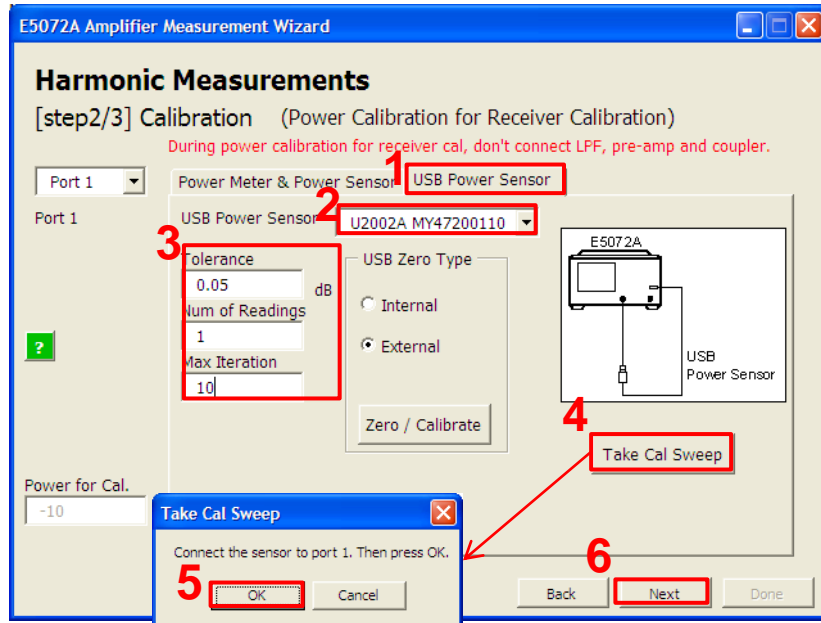
Back Next Done

1. Enter Frequency, Power, Points, IFBW.
2. Check Harmonics “second” and “third”
3. Press “Next”

1. Select all calibrations
2. Press “Next”

Amplifier Measurement Wizard

Measurement Procedure - Harmonics

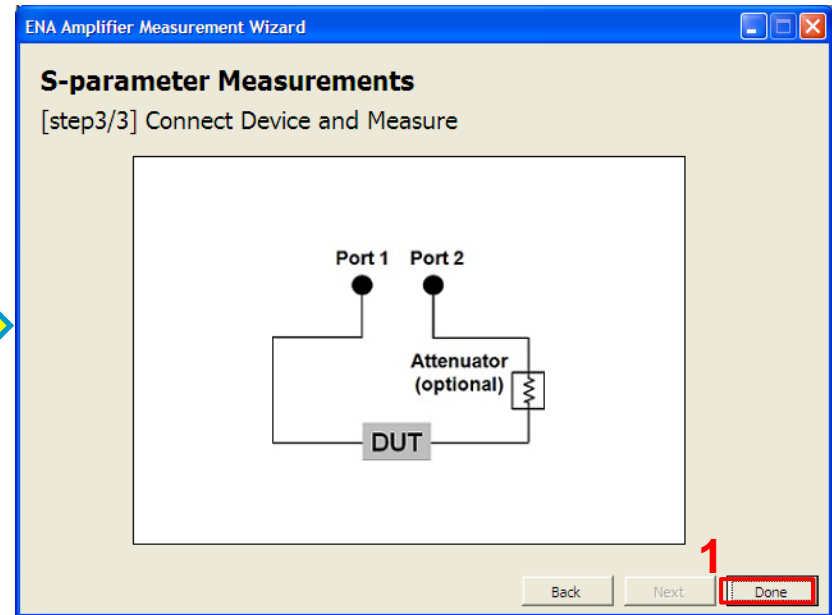
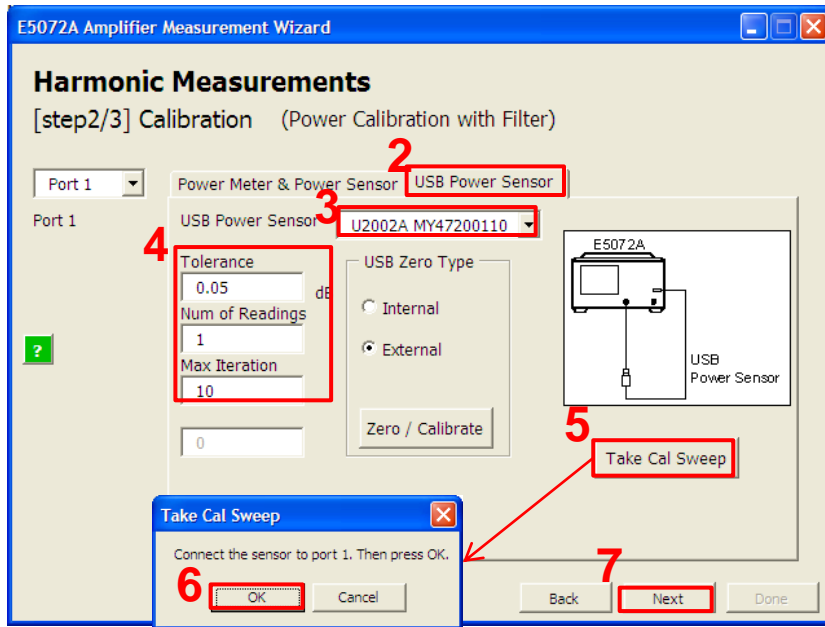


1. Select tab, "USB Power Sensor"
2. Select connected USB power sensor
3. Enter Tolerance, Max Iteration
4. Press Take "Cal Sweep"
5. Connect power sensor and press "OK"
6. Press "Next" after calibration sweep.

1. Select Source Port "1".
2. Select Receiver "B".
3. Press "Take Cal Sweep"
4. Press "Next" after calibration.

Amplifier Measurement Wizard

Measurement Procedure - Harmonics



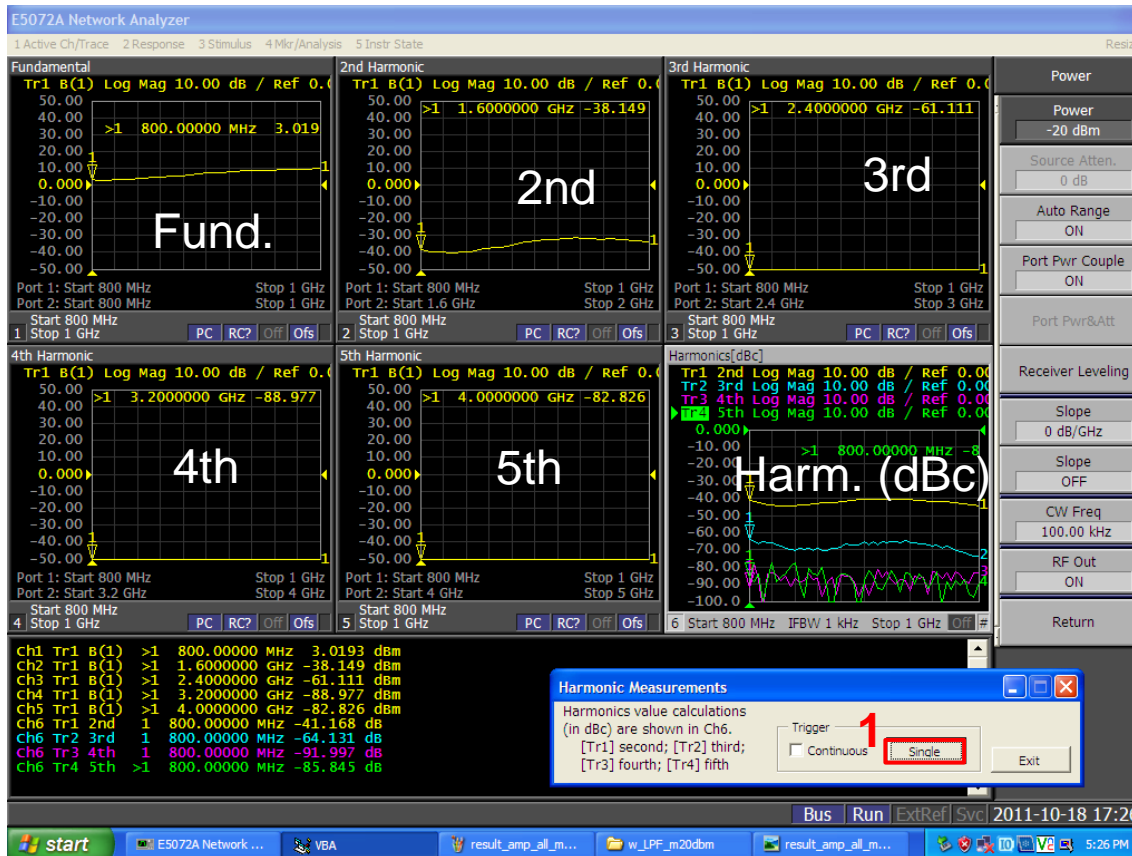
1. Connect LPF on port 1
2. Select tab, "USB Power Sensor"
3. Select connected USB power sensor
4. Enter Tolerance, Max Iteration
5. Press Take "Cal Sweep"
6. Connect power sensor and press "OK"
7. Press "Next" after calibration sweep.

1. Press "Done"

Amplifier Measurement Wizard

Measurement Procedure - Harmonics

- Measurement result



Ch 1 to Ch 5:
Power level of fundamental and harmonics (dBm)

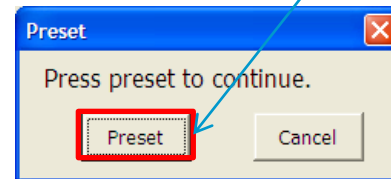
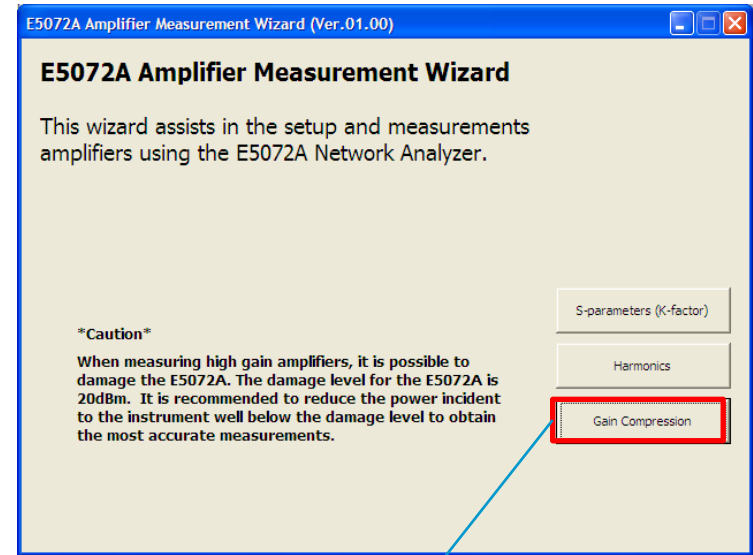
Ch 6:
Harmonics relative to carrier (dBc)

1. Press "Single" to trigger once.

Amplifier Measurement Wizard

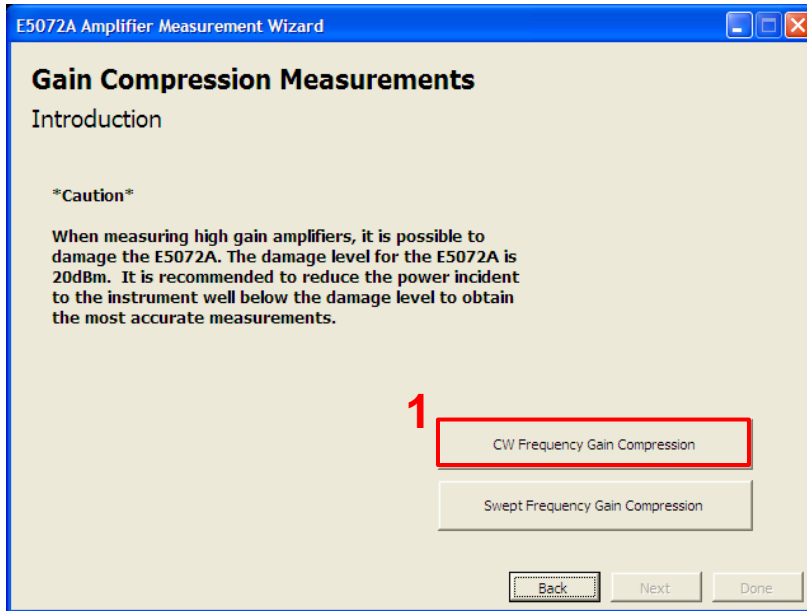
Measurement Procedure - Gain Compression

- **Save the wizard program in the E5072A**
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Go to [ENA Amplifier Measurement Wizard VBA](#)
Download “E5072AAmplifierWizard_xxxx.zip”
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- **Launch the wizard program**
[Macro Setup] > Load & Run
Select “E5072AAmplifierWizard_xxxx.vba”
* The main window shows up.
- **Select the measurement parameter**
Select the parameter.
 1. S-parameters (K-factor)
 2. Harmonics
 - 3. Gain Compression**Press “Preset” to proceed the setup

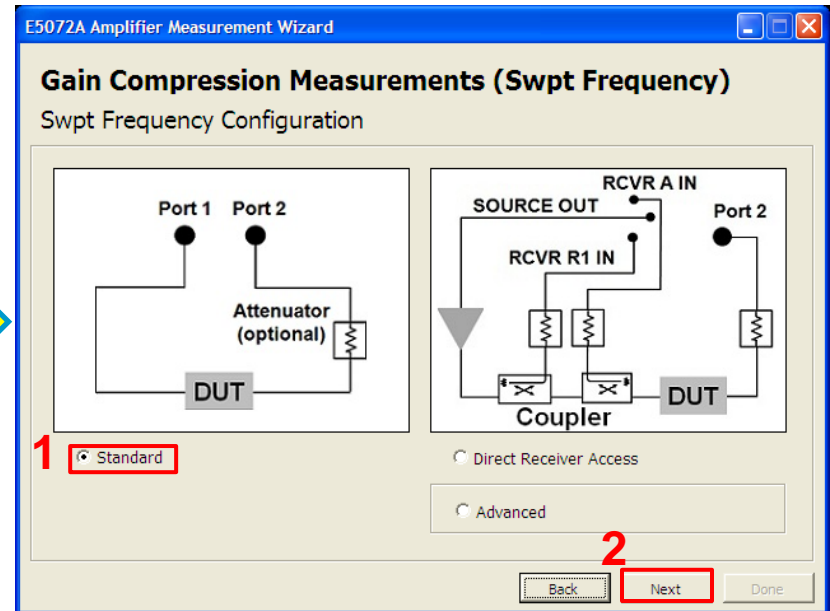


Amplifier Measurement Wizard

Measurement Procedure - CW Gain Compression



1. Press "CW Frequency Gain Compression"

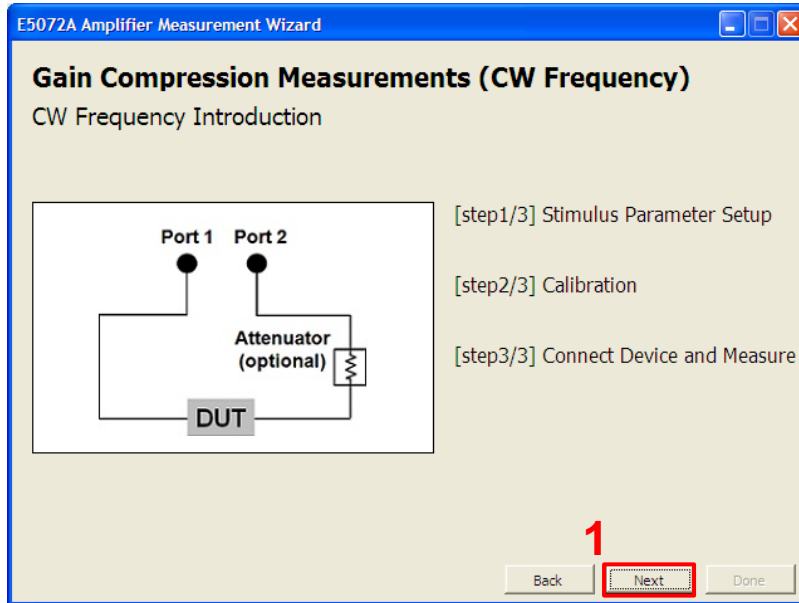


1. Select "Standard" (Standard 2-port test)
2. Press "Next"

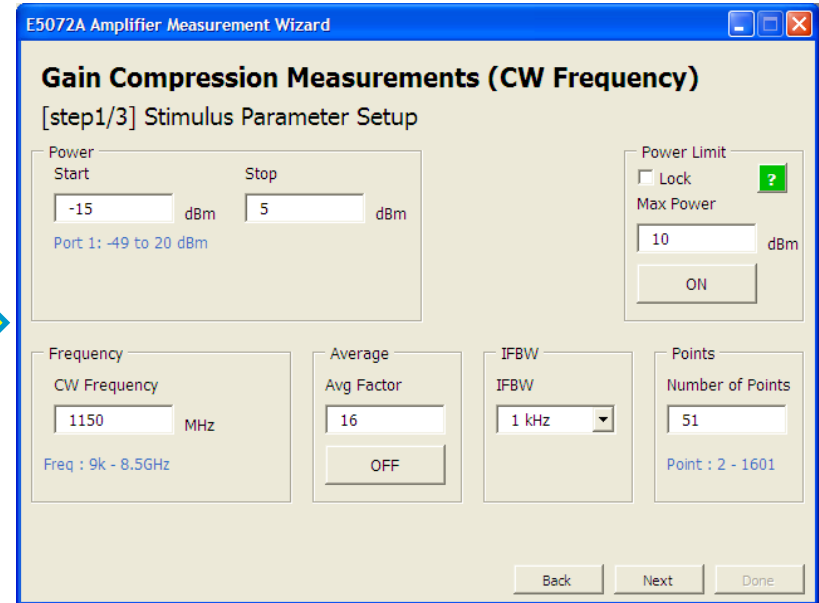


Amplifier Measurement Wizard

Measurement Procedure - CW Gain Compression



1. Press "Next"

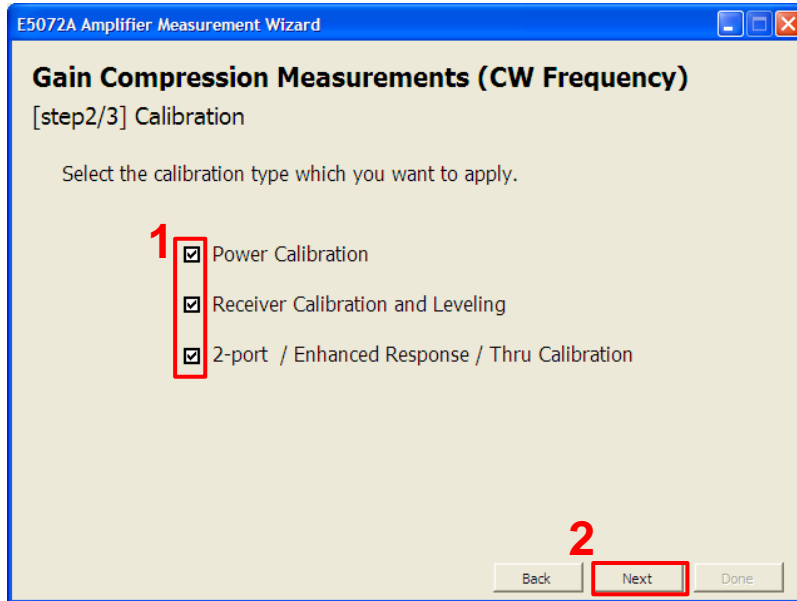


1. Enter stimulus parameters
 - Power (-15 to 5 dBm)
 - CW Frequency (1150 MHz)
 - IFBW (1 kHz)
 - Number of Points (51)

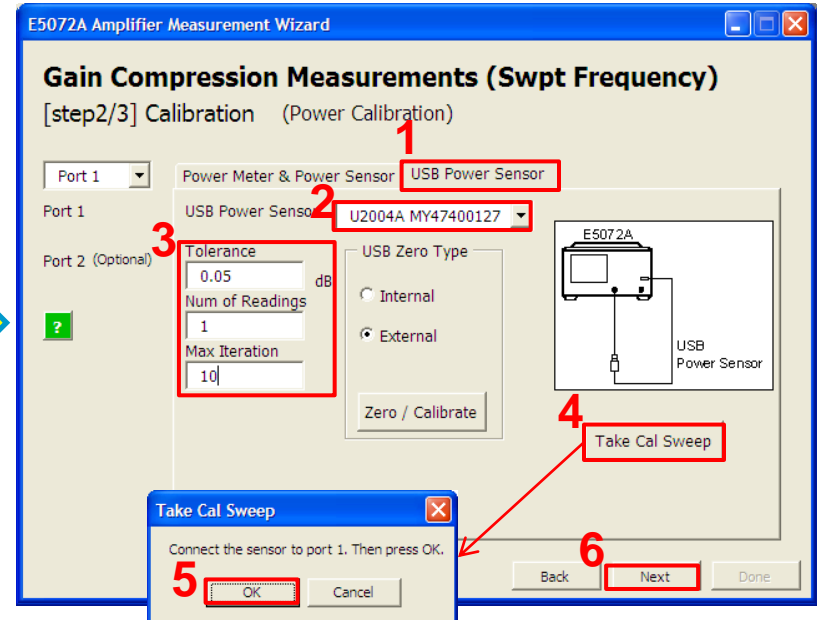


Amplifier Measurement Wizard

Measurement Procedure - CW Gain Compression



1. Select all calibrations
2. Press "Next"



1. Select tab, "USB Power Sensor"
2. Select connected USB power sensor
3. Enter Tolerance, Max Iteration
4. Press Take "Cal Sweep"
5. Connect power sensor and press "OK"
6. Press "Next" after calibration sweep.

Amplifier Measurement Wizard

Measurement Procedure - CW Gain Compression

E5072A Amplifier Measurement Wizard

Gain Compression Measurements (CW Frequency)

[step2/3] Calibration (Receiver Calibration)

Calibration

Source Port: 1 Power Cal Port 1 Done

Receiver: B

Through connection

Rcv	Status
A:	
B:	
R1:	
R2:	

Take Cal Sweep

Do NOT apply the level -10dBm or more to the test ports.

Back Next Done



E5072A Amplifier Measurement Wizard

Gain Compression Measurements (CW Frequency)

[step2/3] Calibration (2-Port Cal / Enhanced Response Cal / Thru Cal.)

Calibration Kit: 85033E Unnecessary when calibrating with ECal module

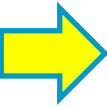
Avg Factor: 1 Fixture Simulator 2-port cal is required.

2-Port Cal. Enhanced Response Cal. Thru Cal.

Thru Isolation Omit Isolation

PORT1-2 PORT1-2 Done

Back Next Done

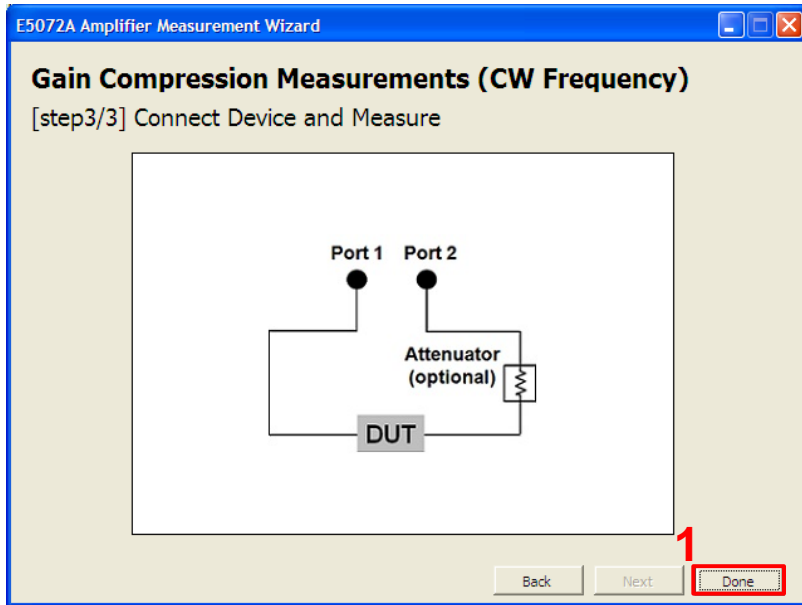


1. Select Source Port "1".
2. Select Receiver "B".
3. Press "Take Cal Sweep"
4. Press "Next" after calibration.

1. Select tab, "Thru Cal."
2. Press Thru "PORT1-2"
3. Press "Done" after calibration sweep
4. Press "Next"

Amplifier Measurement Wizard

Measurement Procedure - CW Gain Compression

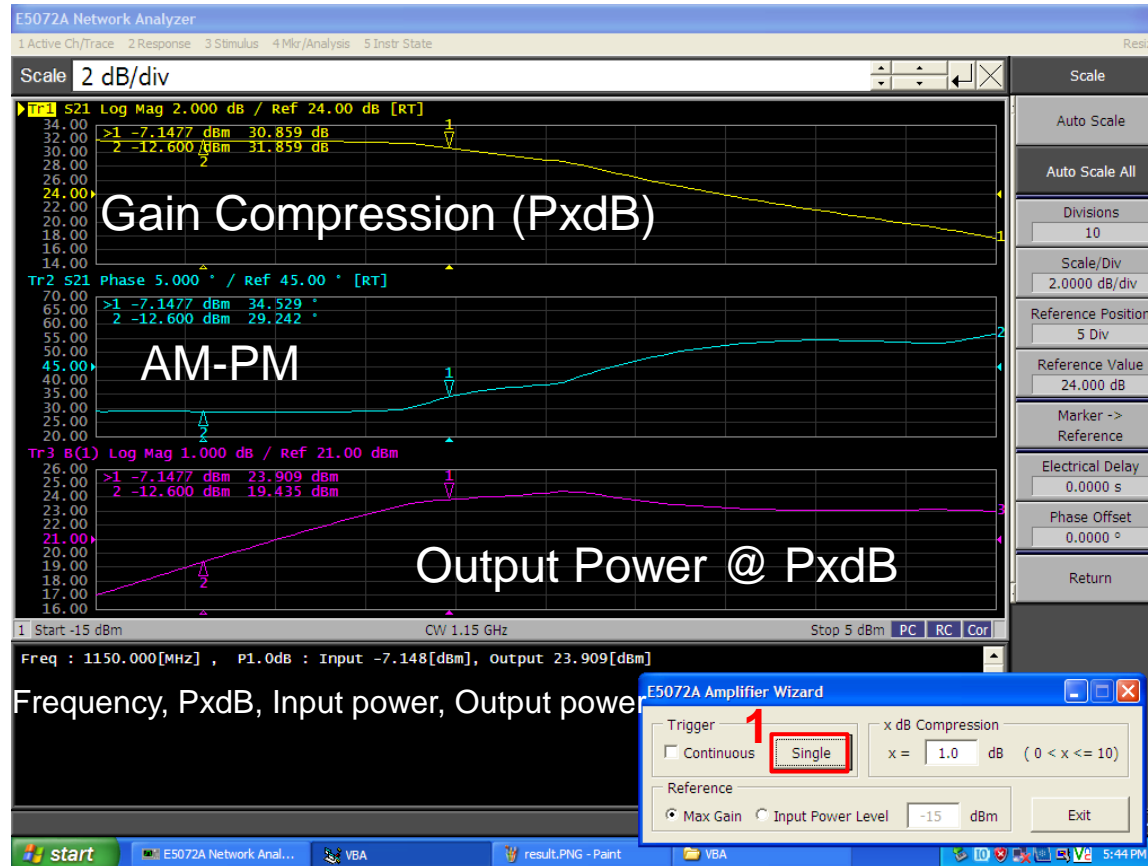


1. Connect DUT and press “Done”

Amplifier Measurement Wizard

Measurement Procedure - CW Gain Compression

- Measurement result



Ch 1 (vs. Input power):
Gain Compression

Ch 2 (vs. Input power):
AM-PM Conversion

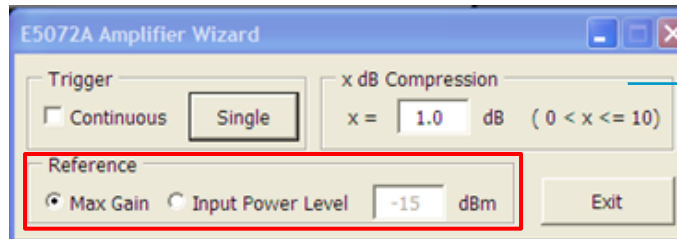
Ch 3 (vs. Input power):
Saturation power @ PxdB

1. Press “Single” to trigger measurement once.

Amplifier Measurement Wizard

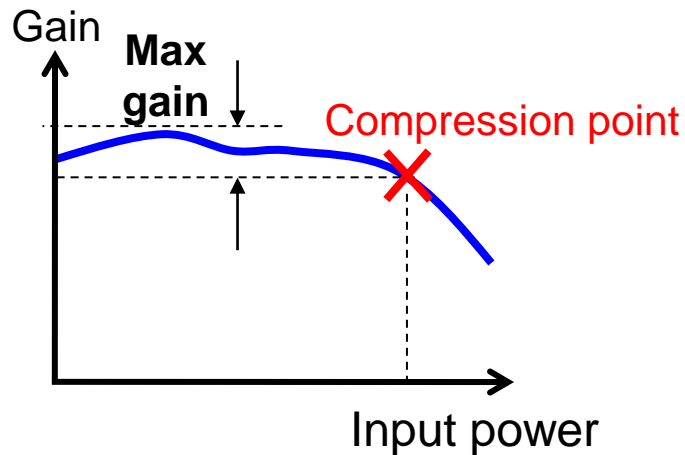
Measurement Procedure - CW / Swept Gain Compression

- Reference for gain compression

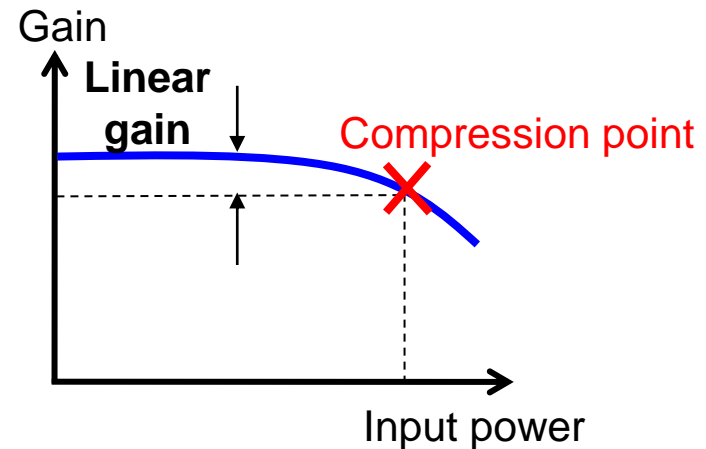


Specified compression level (Px dB)

(1) Max Gain



(2) Input Power Level



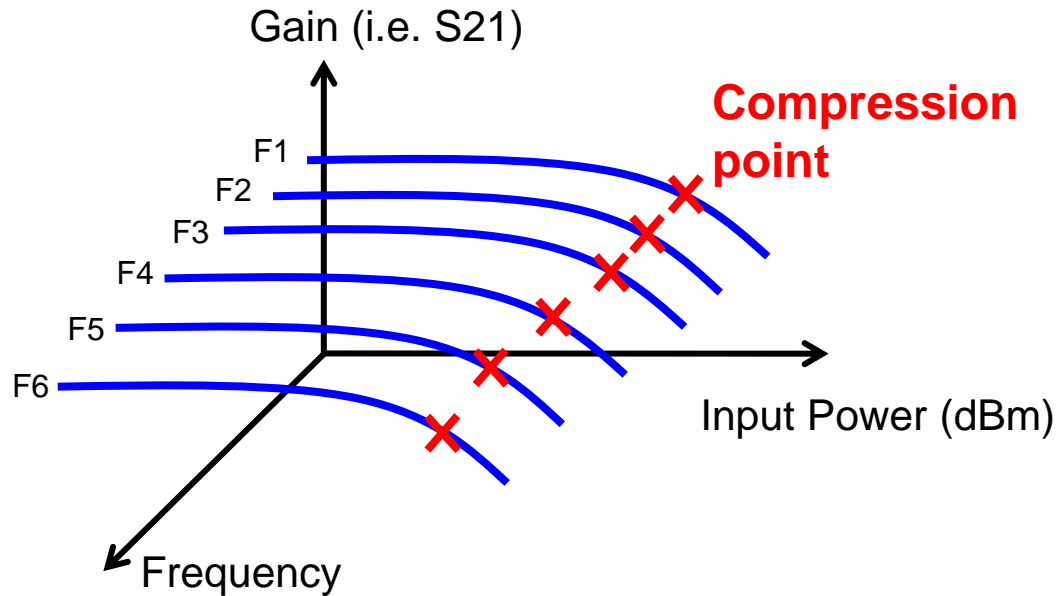
- The highest gain value is used as **the max gain**.
- The compression point is calculated as the max gain minus the specified compression level.

- **The linear gain** is measured using the specified input power level.
- The compression point is calculated as the linear gain minus the specified compression level.

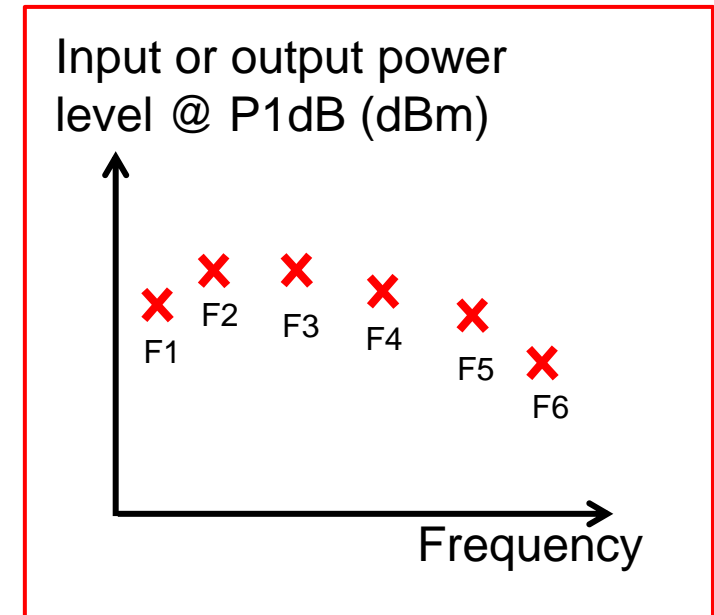


Gain compression over frequency

- Complete device characterization is required with **two-dimensional (2D) sweeps** with sweeping power per frequency.



- A VNA is commonly used by performing power sweeps at multiple CW frequencies (F1, F2,,,) in multiple measurement channels.



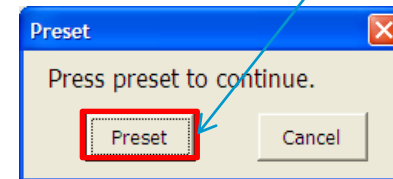
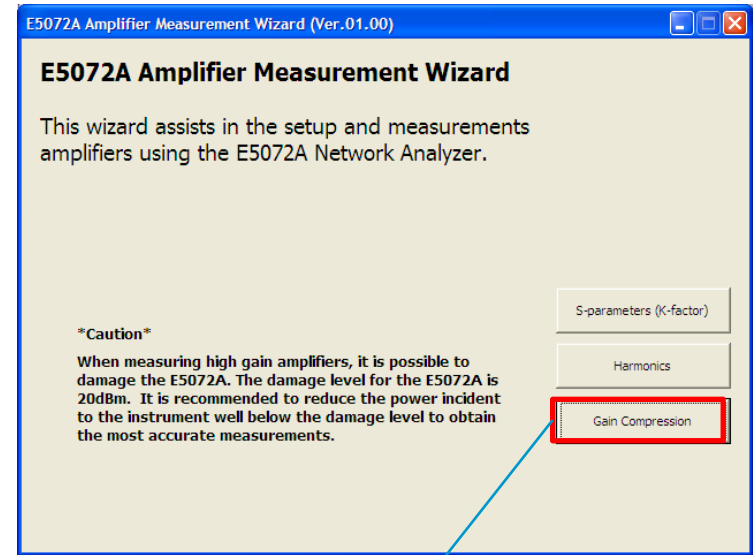
Gain compression over frequency

The intuitive tool for the ENA enables you to perform the measurement easily.

Amplifier Measurement Wizard

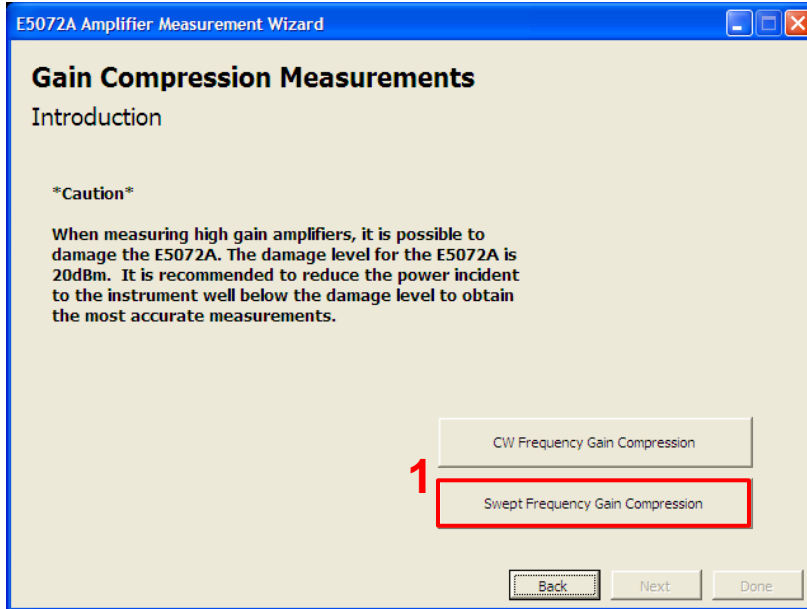
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- **Select the measurement parameter**
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 1. S-parameters (K-factor)
 2. Harmonics
 - 3. Gain Compression**Press “Preset” to proceed the setup

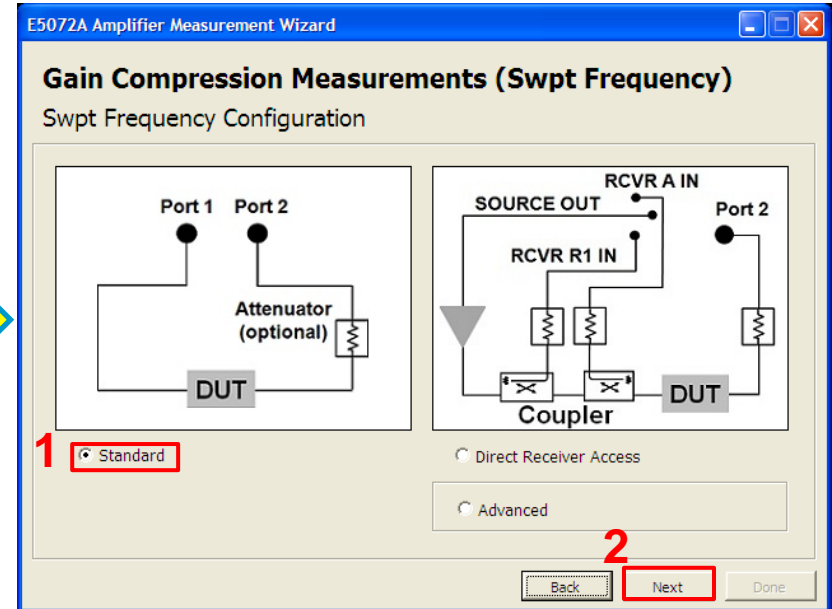


Amplifier Measurement Wizard

Measurement Procedure - Swept Gain Compression



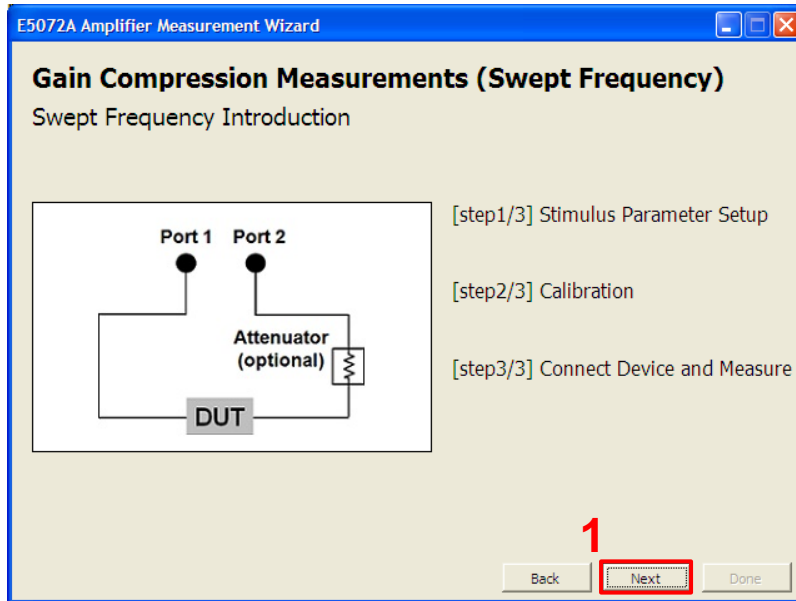
1. Press “Swept Frequency Gain Compression”



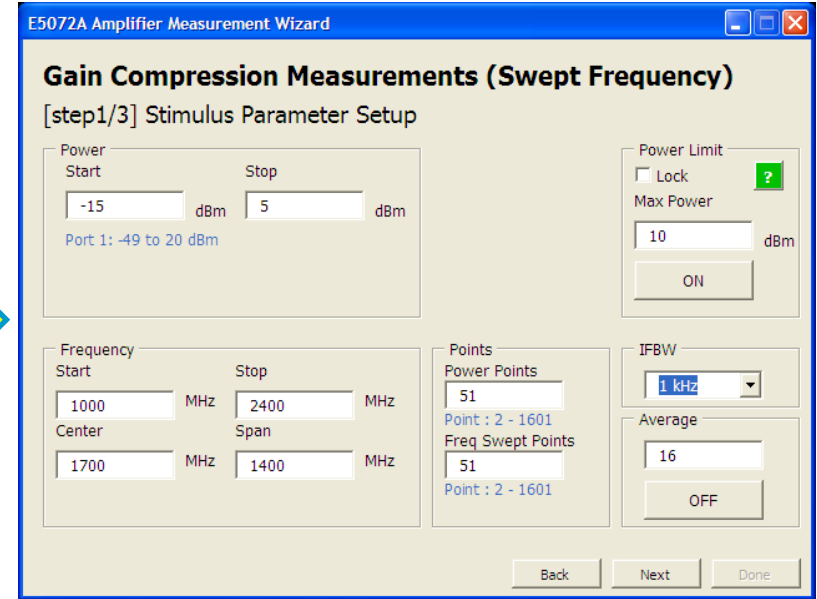
1. Select “Standard” (Standard 2-port test)
2. Press “Next”

Amplifier Measurement Wizard

Measurement Procedure - Swept Gain Compression



1. Press "Next"

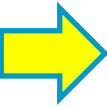
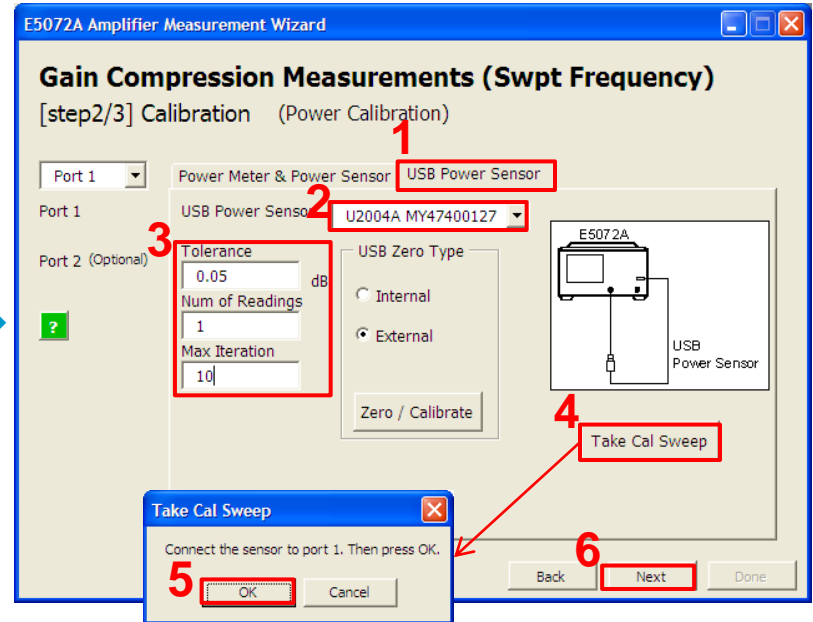
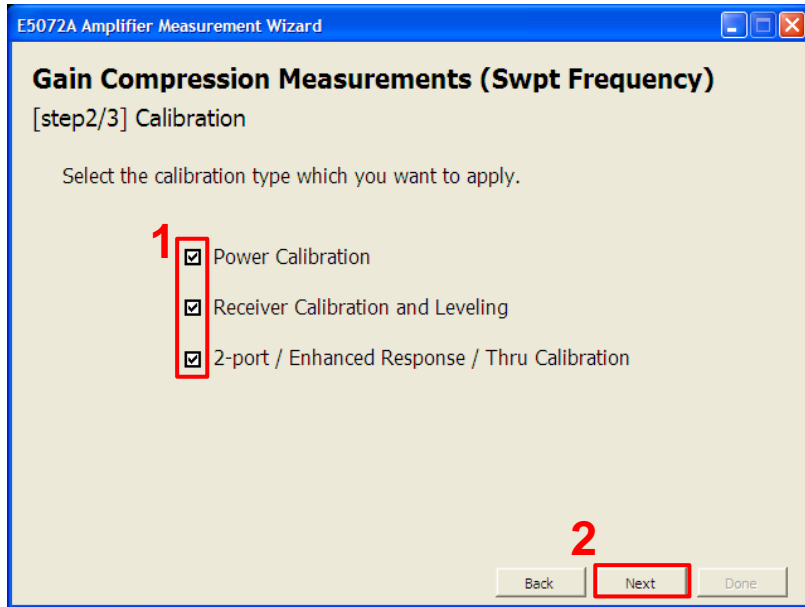


1. Enter stimulus parameters
 - Power (-15 to 5 dBm)
 - Frequency (1000 to 2400 MHz)
 - Points (Power: 51, Freq: 51)
 - IFBW (1 kHz)



Amplifier Measurement Wizard

Measurement Procedure - Swept Gain Compression



1. Select all calibrations
2. Press "Next"

1. Select tab, "USB Power Sensor"
2. Select connected USB power sensor
3. Enter Tolerance, Max Iteration
4. Press Take "Cal Sweep"
5. Connect power sensor and press "OK"
6. Press "Next" after calibration sweep.

Amplifier Measurement Wizard

Measurement Procedure - Swept Gain Compression

E5072A Amplifier Measurement Wizard

Gain Compression Measurements (Swpt Frequency)

[step2/3] Calibration (Receiver Calibration)

Calibration

Source Port: 1

Receiver: B

Through connection

Rcv	Status
A:	
B:	
R1:	
R2:	

Take Cal Sweep

Do NOT apply the level -10dBm or more to the test ports.

Back Next Done

1. Select Source Port "1".
2. Select Receiver "B".
3. Press "Take Cal Sweep"
4. Press "Next" after calibration.

E5072A Amplifier Measurement Wizard

Gain Compression Measurements (Swpt Frequency)

[step2/4] Calibration (2-Port Cal. / Enhanced Response Cal. / Thru Cal.)

Calibration Kit: 85033E

Avg Factor: 1

2-port cal is required.

2-Port Cal. Enhanced Response Cal. Thru Cal.

Thru Isolation

PORT1-2 PORT1-2 Done

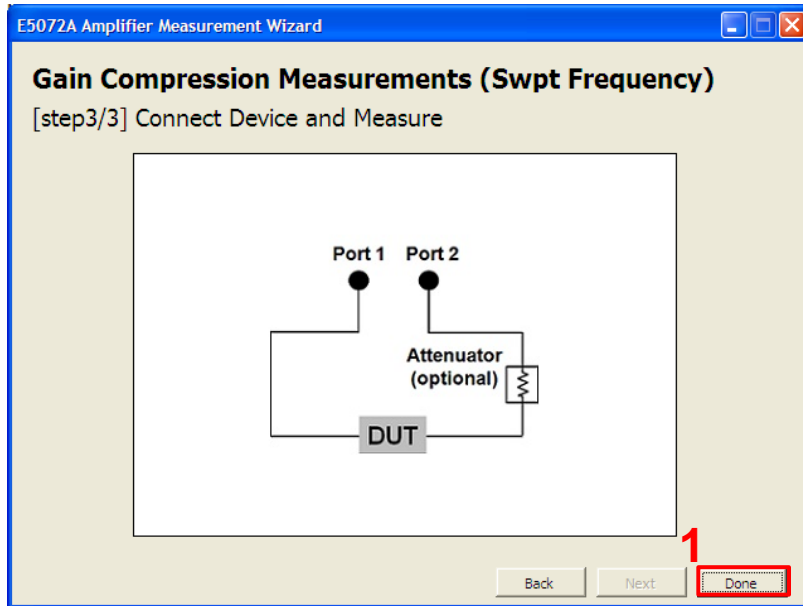
Omit Isolation

Back Next Done

1. Select tab, "Thru Cal."
2. Press Thru "PORT1-2"
3. Press "Done" after calibration sweep
4. Press "Next"

Amplifier Measurement Wizard

Measurement Procedure - Swept Gain Compression

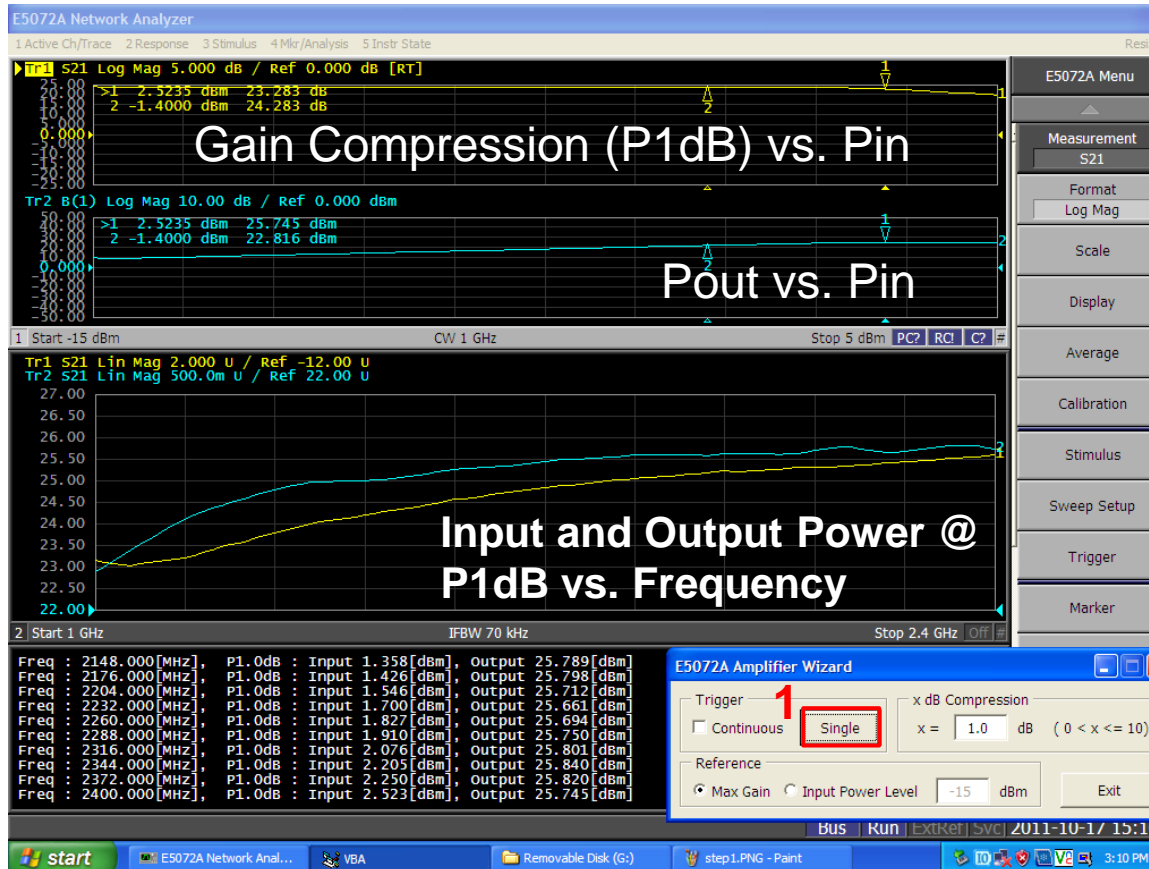


1. Connect DUT and press “Done”

Amplifier Measurement Wizard

Measurement Procedure - Swept Gain Compression

• Measurement result



Ch 1 (vs. Input power):
Tr 1: Gain Comp.
Tr 2: Pout

Ch 2 (vs. Frequency):
Tr 1: Pin @ PxdB vs. Frequency
Tr 2: Pout @ PxdB vs. Frequency

1. Press “Single” to trigger measurement once.

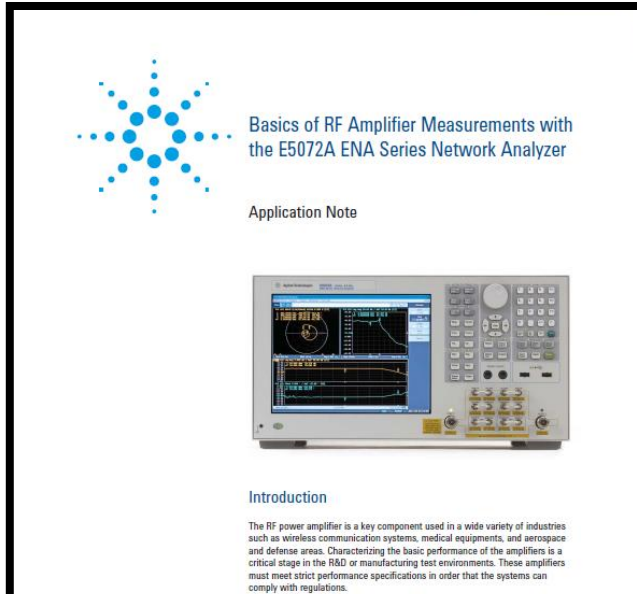
Resources

- Configuration Guide ([5990-8001EN](#))
- Data Sheet ([5990-8002EN](#))
- Quick Fact Sheet ([5990-8003EN](#))
- Technical Overview ([5990-8004EN](#))
- Application Note
 - High-power measurement using the E5072A ([5990-8005EN](#))
 - Basics of RF amplifier measurements with the E5072A ([5990-9974EN](#))
- ENA Series: www.agilent.com/find/ena
- E5072A Product page: www.agilent.com/find/e5072a

Appendix

Application Notes - Available on Agilent Website

Useful application notes with the E5072A are available!



Basics of RF Amplifier
Measurements with the E5072A
(Part Number [5990-9974EN](#))



High-power Measurements with
the E5072A
(Part Number [5990-8005EN](#))

Visit: www.agilent.com/find/e5072a

On-demand Web Seminars

Learn more about the E5072A with on-demand web seminars!

1. Basics of RF Amplifier Test with the VNA

The higher, the better!

Enough margin of source power capability is needed for analyzers.

ex.) Long-distance test

Signal loss associated with Long RF cables, probes, mixers (50-10-75 ohm converters)

Measurement Challenges:
Driving DUT with high power
• Due to loss in the signal path
• compression measurements.

IMD Measurement

Configuration of IMD measurement with VNA

Measurement example (sweep delta)

Power levels of main tones and IM products in swept frequencies can be monitored with the VNA's absolute measurements.

Agilent Technologies

2. Fundamentals of testing amplifiers and high-power devices with RF VNA

Configuration examples

Configuration	Connection	Description
1. Standard 2-port Configuration		• Simple setup without a booster amp
2. Measurement using a booster amplifier		• Booster amp is located on the source path. • High power level beyond network analyzer's capability
3. Direct Receiver Access with a booster amplifier		• Accurate S_{11} & S_{21} measurement for high input & output power DUT. • Eliminates the temperature drift of a booster amp.
4. Full 2-port Correction for High-power DUT		• The most accurate measurements for high input & output power DUT. • All S-parameters (S_{11} to S_{22}) of 2-port DUT can be obtained.

Application Examples Antenna

Measurement requirements:

- DUT: Antenna for broadcasting system
- S_{11} return loss measurement in the field

Test Configuration

Incoming noise (interference signals)

Need to drive measurement signals for improving S/N ratio.

Agilent Technologies

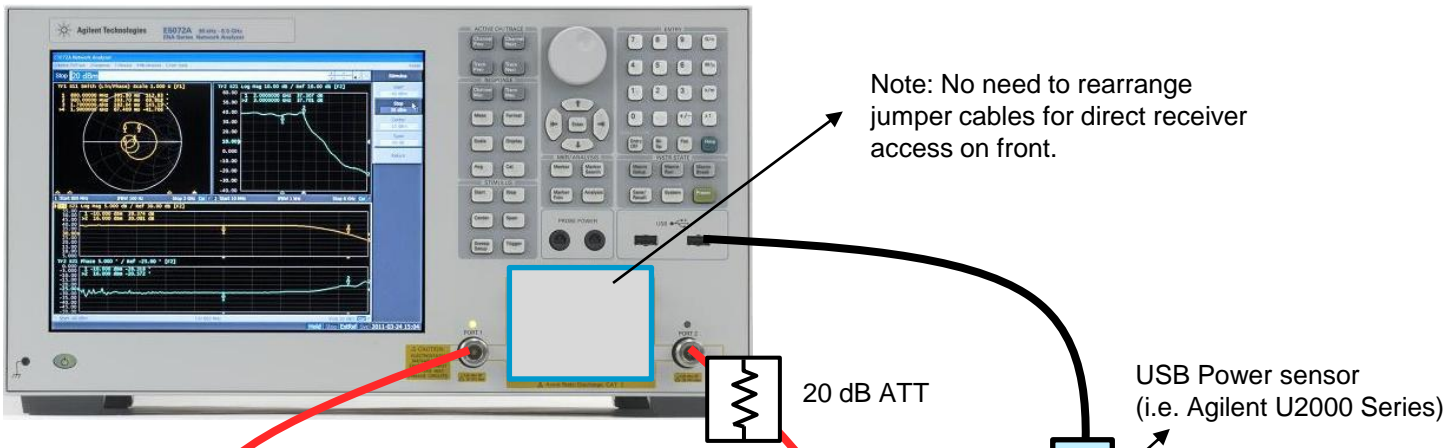
Available at:

<http://www.home.agilent.com/agilent/eventDetail.jsp?c=c=AE&lc=eng&ckey=2089984&nid=-48293.3977412.08&id=2089984>

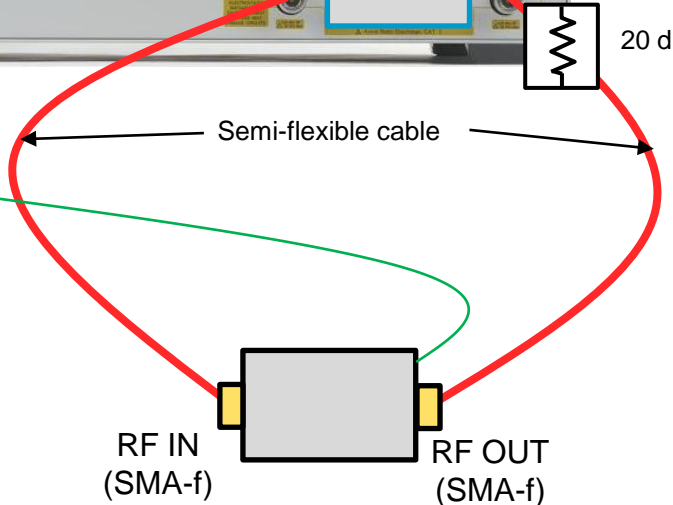
Available at:

<http://www.home.agilent.com/agilent/eventDetail.jsp?cc=US&c=eng&ckey=2087011&nid=-536902639.980173.08&id=2087011&cmpid=1-4103098739>

Test Configuration



Note: **+12 VDC**, **GND** pins of the DUT is connected to power supply (+12 V / 0 V).



DUT:
Mini-Circuits: ZRL-2400LN+
(Agilent P/N: 0955-2330)

E5072A Block Diagram

