

# Calibrating Solid State Noise Sources

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*Innovation in Noise Figure*

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**Agilent Technologies**

# Agenda

- Introducing the N2002A Noise Source Test Set
- Configuration of the Noise Source Calibration System
- ENR measurement
- Automating the system
- Demonstration
- Programming the new SNS noise source
- Questions



# Introducing The N2002A Noise Source Test Set

## EXAMPLE 1

ENR Uncertainty =  $\pm 0.2$  dB

Noise source Match = 1.15

DUT Noise Figure = 3 dB

DUT Gain = 20 dB

DUT input match = 1.5

DUT output match = 1.5

Instrument noise fig uncertainty =  $\pm 0.05$  dB

Gain Uncertainty =  $\pm 0.2$  dB

Instrument noise figure = 6 dB

Instrument match = 1.6

**RSS Noise Figure Measurement**

**Uncertainty =  $\pm 0.238$  dB**

## EXAMPLE 2

ENR Uncertainty =  $\pm 0.4$  dB

Noise source Match = 1.15

DUT Noise Figure = 3 dB

DUT Gain = 20 dB

DUT input match = 1.5

DUT output match = 1.5

Instrument noise fig uncertainty =  $\pm 0.05$  dB

Gain Uncertainty =  $\pm 0.2$  dB

Instrument noise figure = 6 dB

Instrument match = 1.6

**RSS Noise Figure Measurement**

**Uncertainty =  $\pm 0.418$  dB**



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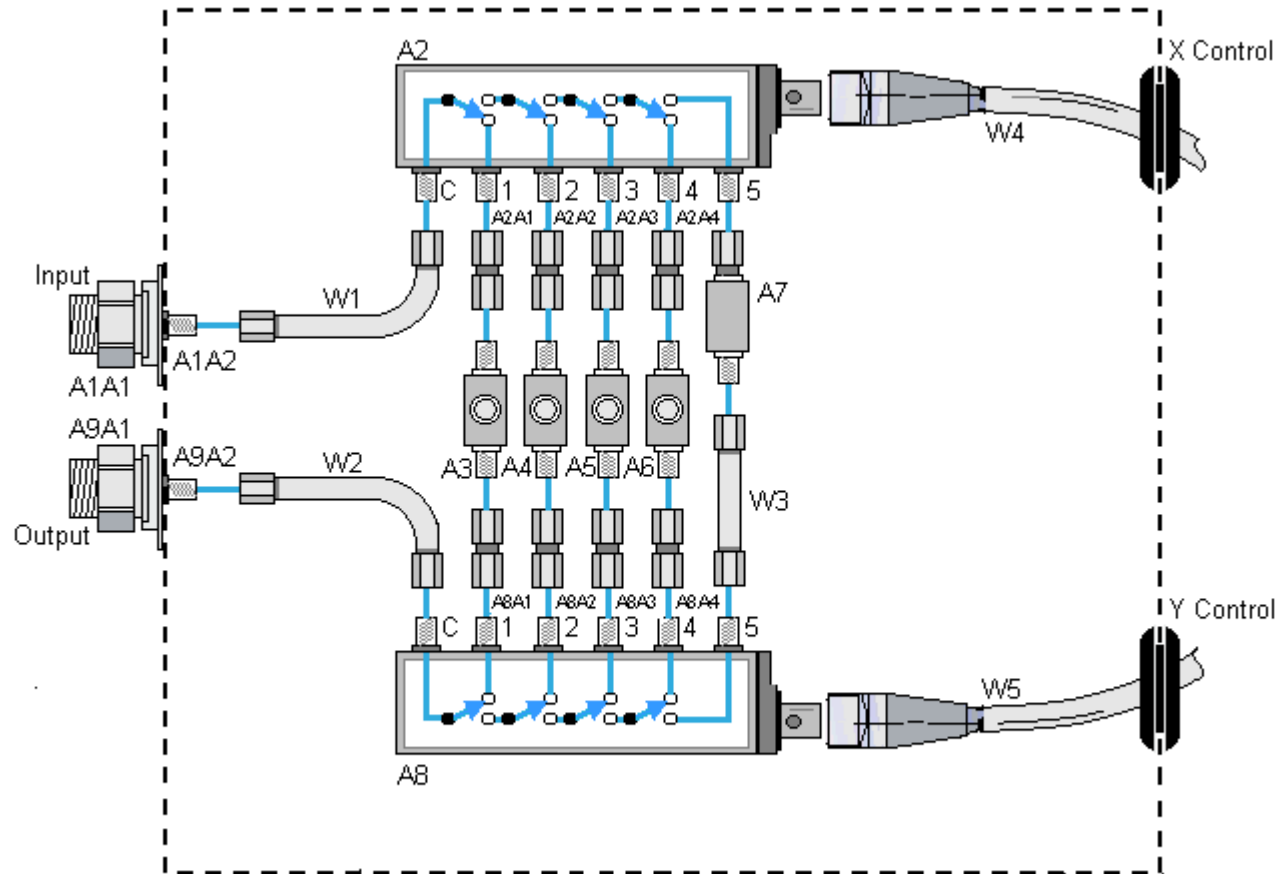
# Introducing the N2002A Noise Source Test Set

- Provides a high level of Isolation
- Reduces measurement uncertainty
- Ensures accurate and repeatable results
- Used in a noise source test system
- Automated or manual capability
- Frequency 10MHz to 26.5 GHz



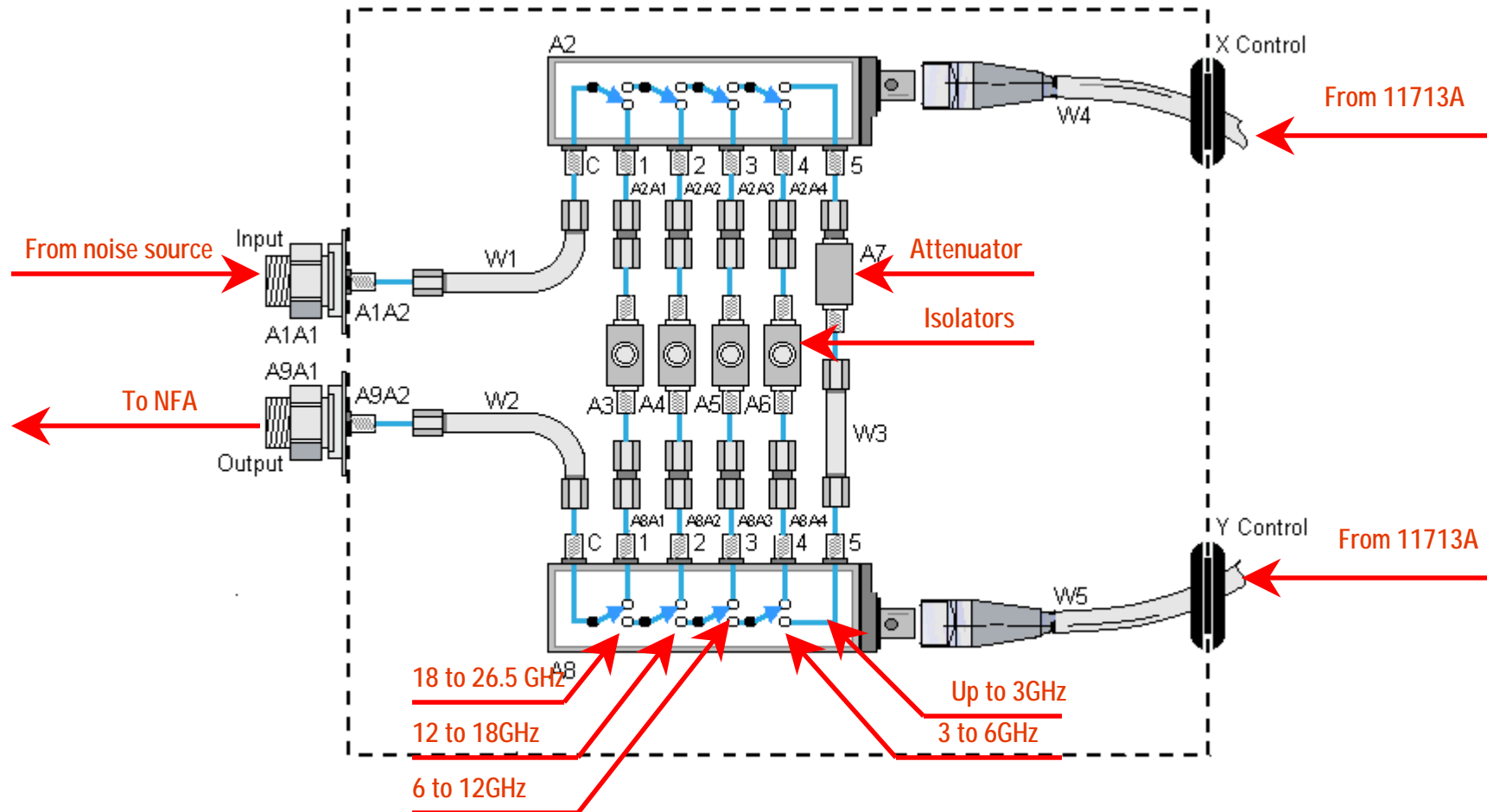
# Introducing The N2002A Noise Source Test Set

*What does the NSTS comprise of ?*



# Introducing The N2002A Noise Source Test Set

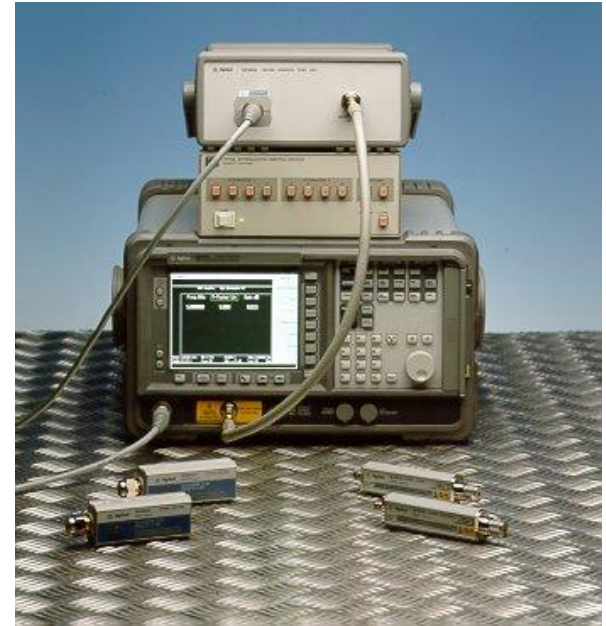
*What does the NSTS comprise of ?*



# Calibration System Configuration

*A noise source calibration system requires -*

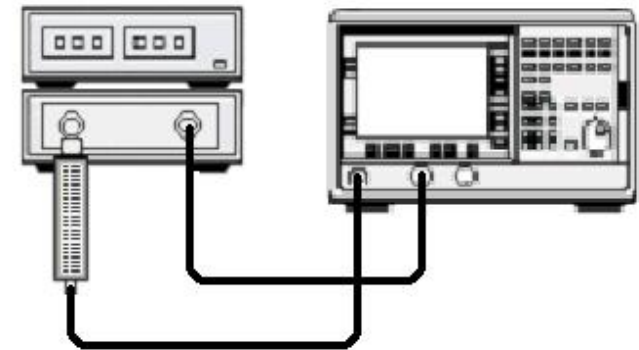
- N2002A 001 noise source test set and software, with options to include required cables & adapters
- N8975A 1D5 (26.5 GHz NFA)
- Reference standard noise source(s) of choice. See special options for Agilent noise sources
- 11713A switch attenuator



# ENR Measurement - Hardware

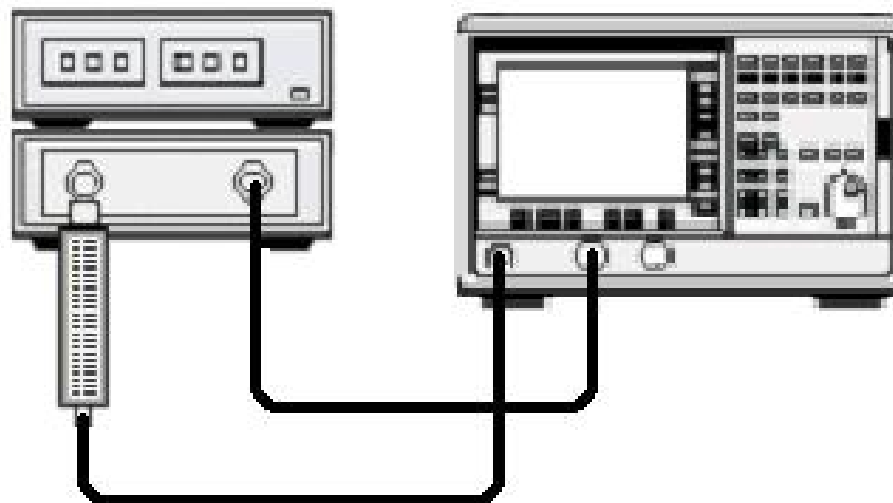
The ENR measurement requires the following equipment:

- N8975A noise figure analyzer
- N2002A noise source test set
- 11713A attenuator/switch driver
- Reference standard noise source





# ENR Measurement – Manual Procedure



# ENR Measurement - Calculation

Then calculate DUT ENR values (ENR<sub>2</sub>) :-

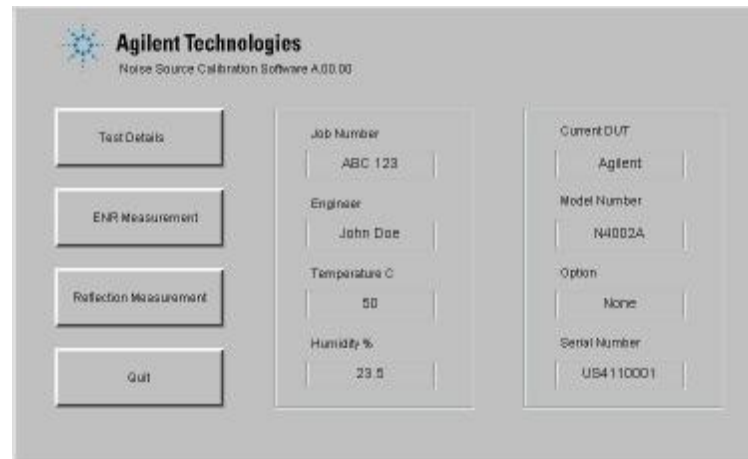
- ENR<sub>1</sub> = excess noise ratio value for reference standard at a selected frequency point
- Y<sub>1</sub> = linear Y-factor measured for reference standard at a selected frequency point
- Y<sub>2</sub> = linear Y-factor measured for DUT at a selected frequency point
- T<sub>0</sub> = 290 kelvin

$$ENR_2 = 10 \times \text{Log}_{10} \left[ \frac{(Y_2 - 1) \times \left( T_0 \times \frac{10^{\frac{ENR_1}{10}}}{(Y_1 - 1)} \right)}{T_0} \right]$$

	Golden Noise Source ENR Value	Golden Noise Source Y-Factor Reading	DUT Y-Factor Reading	RESULT
Frequency 1 10 MHz	15.1	5.1	5.3	
Frequency 2 100 MHz				
Frequency 3 1 GHz				
Frequency...				

# Automating the Calibration Process

- Demonstration software is supplied with the N2002A
- This automates all aspects of the calibration process
- The software is written in Agilent VEE Pro 6.0
- Available as a VEE Pro file or as VEE Pro run time file



Agilent Technologies  
Noise Source Calibration Software A.00.00

Test Details	Job Number ABC 123	Current DUT Agilent
ENR Measurement	Engineer John Doe	Model Number N4002A
Reflection Measurement	Temperature C 50	Option None
Quit	Humidity % 23.5	Serial Number US4110001



# Programming Data into the Agilent SNS N4000 Series of Noise Sources

## Equipment Required:

- NFA (any model)
- 11730A noise source cable
- PC with 3.5 inch floppy disk



# Programming Data into the Agilent N4000 Series of Noise Sources

## Procedure:

- Collect the measurement data
- Correctly format the data
- Copy data to NFA
- Program data file to noise source



Filetype ENR]

[Version 1.1]

[Serialnumber US41140199]

[Model N4001A\_001]

[Caldate 20010921]

[Trackingnum 0]

[Temperature 23.000000]

[Humidity 30.000000]

[Current 1734]

10000000, 14.6830, 0.1100, 0.0300, -70.0000, 0.0500, -35.0000, 0.0000, 0.0000, 0.0000, 0.0000

100000000, 14.5690, 0.1050, 0.0090, -59.2300, 0.0380, -21.9000, 0.0000, 0.0000, 0.0000, 0.0000

1000000000, 14.5700, 0.1010, 0.0200, 82.6800, 0.0250, -169.8500, 0.0000, 0.0000, 0.0000, 0.0000

2000000000, 14.6700, 0.1060, 0.0330, -76.7600, 0.0190, 14.6100, 0.0000, 0.0000, 0.0000, 0.0000

3000000000, 14.7430, 0.1150, 0.0390, 175.8200, 0.0440, -129.9100, 0.0000, 0.0000, 0.0000, 0.0000

4000000000, 14.7770, 0.1250, 0.0160, 95.2300, 0.0500, 126.9300, 0.0000, 0.0000, 0.0000, 0.0000

5000000000, 14.7360, 0.1280, 0.0250, 160.5800, 0.0130, 24.4500, 0.0000, 0.0000, 0.0000, 0.0000

6000000000, 14.6450, 0.1100, 0.0450, 83.0600, 0.0350, 130.8200, 0.0000, 0.0000, 0.0000, 0.0000

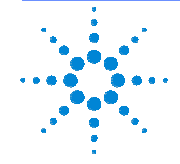


Filetype ENR]  
 [Version 1.1]  
 [Serialnumber US41140199]  
 [Model N4001A\_001]  
 [Caldate 20010921]

# ENR Data Correctly Formatted For SNS

	Freq in Hz	ENR Uncertainty	Ref Mag Off	Ref Phase Off	Ref Mag Off Uncertainty	Ref Phase Off Uncertainty
[Trackingnum 0]						
[Temperature 23.000000]						
[Humidity 30.000000]						
[Current 1734]						
100000000	14.6830	0.1100	0.0300	-70.0000	0.0500	-35.0000
100000000	14.5690	0.1050	0.0090	-59.2300	0.0380	-21.9000
100000000	14.5700	0.1010	0.0200	82.6800	0.0250	-169.8500
200000000	14.6700	0.1060	0.0330	-76.7600	0.0190	14.6100
300000000	14.7430	0.1150	0.0390	175.8200	0.0440	-129.9100
400000000	14.7770	0.1250	0.0160	95.2300	0.0500	126.9300
500000000	14.7360	0.1280	0.0250	160.5800	0.0130	24.4500
600000000	14.6450	0.1100	0.0450	83.0600	0.0350	130.8200

ENR      Ref Mag On      Ref Phase Off      Ref Mag On Uncertainty      Ref Phase On Uncertainty



# Information on Noise Figure products and literature

- Agilent Noise Figure Web Page

<http://www.agilent.com/find/nf>

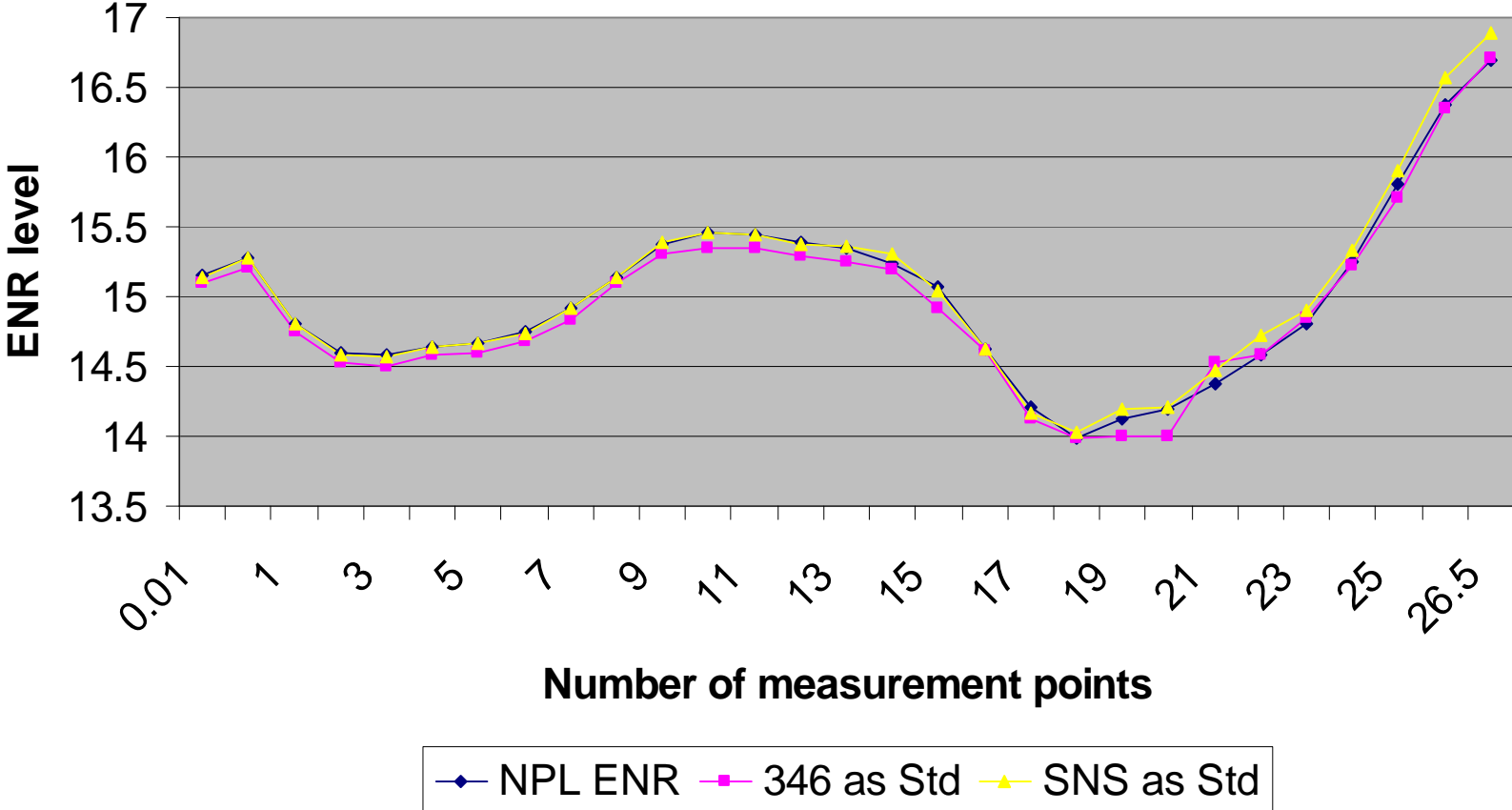
Agilent Noise Source Test Set Web Page

<http://www.agilent.com/find/nsts>

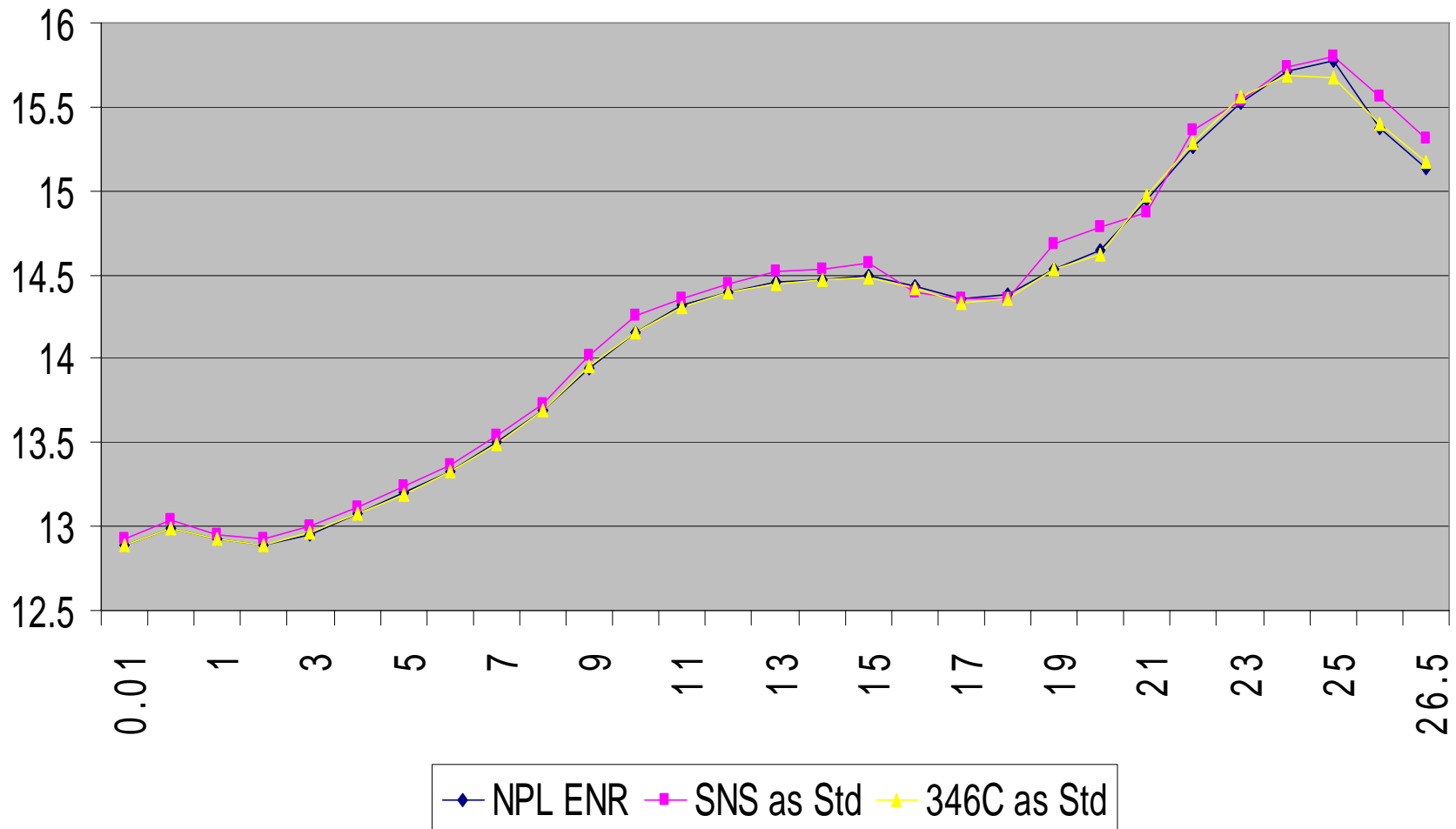




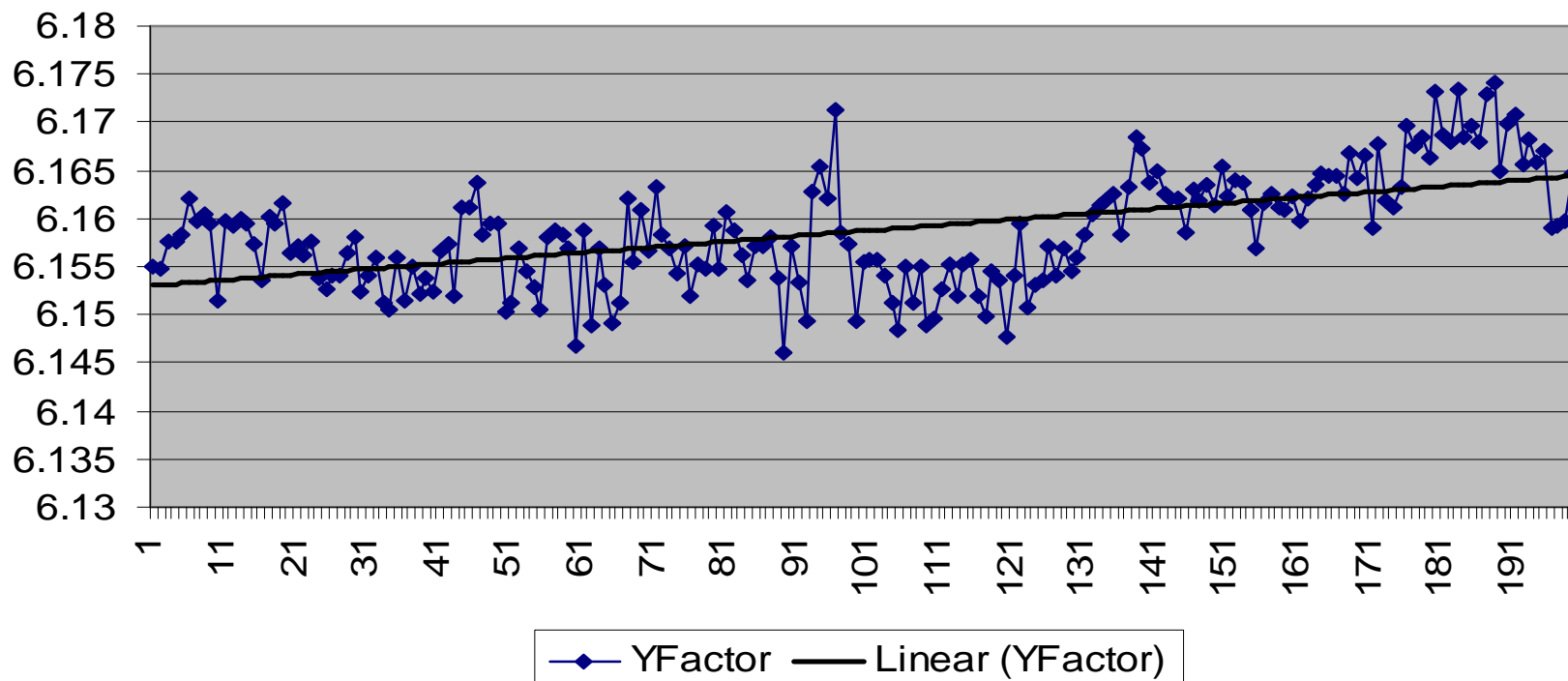
# N4002A Measurement Results



# 346C Measurement Results



## SNS YFactor Measurements



# 346C YFactor Measurements

