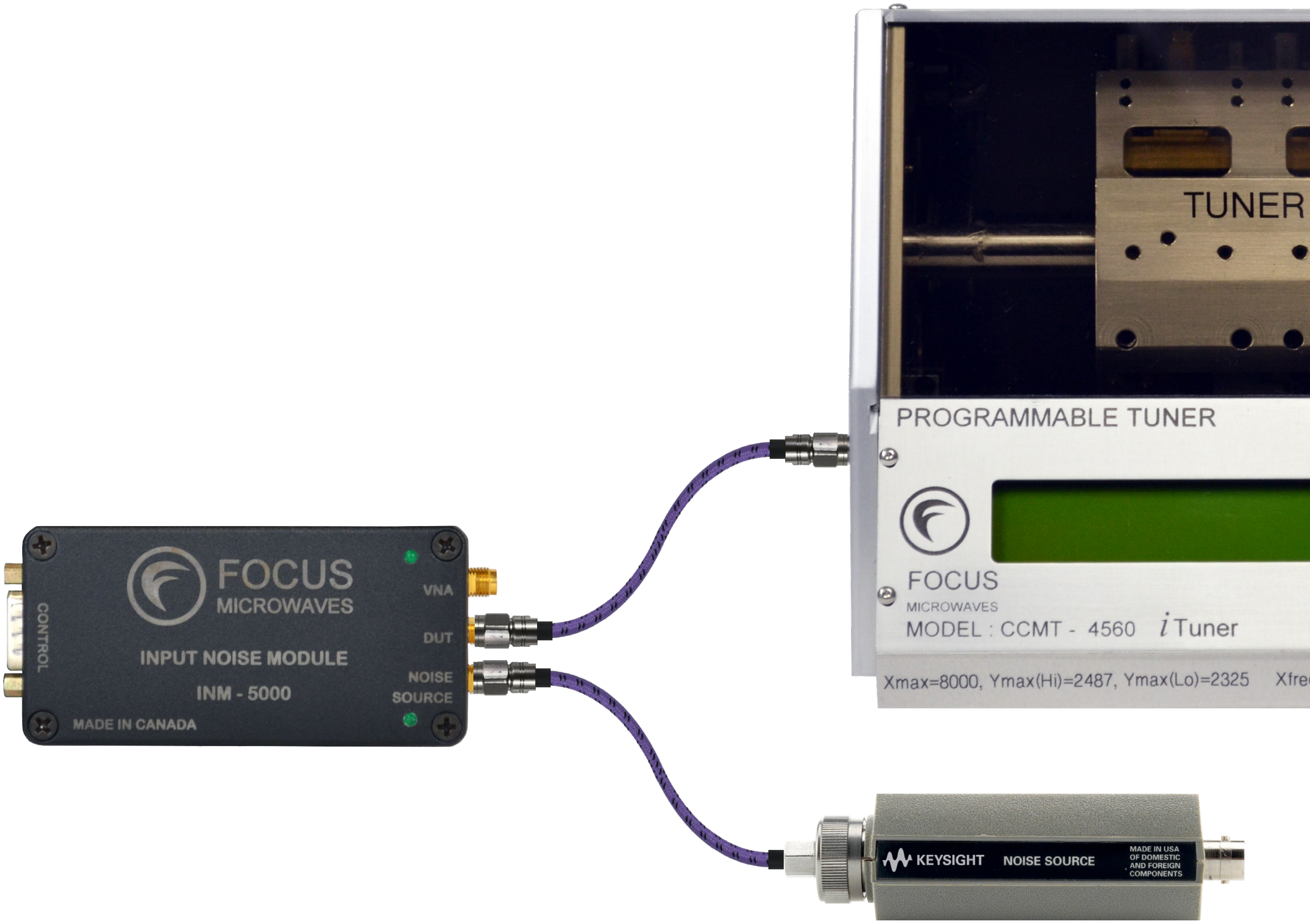
Noise Measurements



Wideband noise parameters extraction

Noise

Noise measurements allow the determination of the four Noise Parameters of a device (transistor).

Noise Parameters: These are four numbers that fully describe the noise behaviour of an active or passive device (twoport) at a given frequency. For practical reasons we use the following quantities as Noise Parameters:

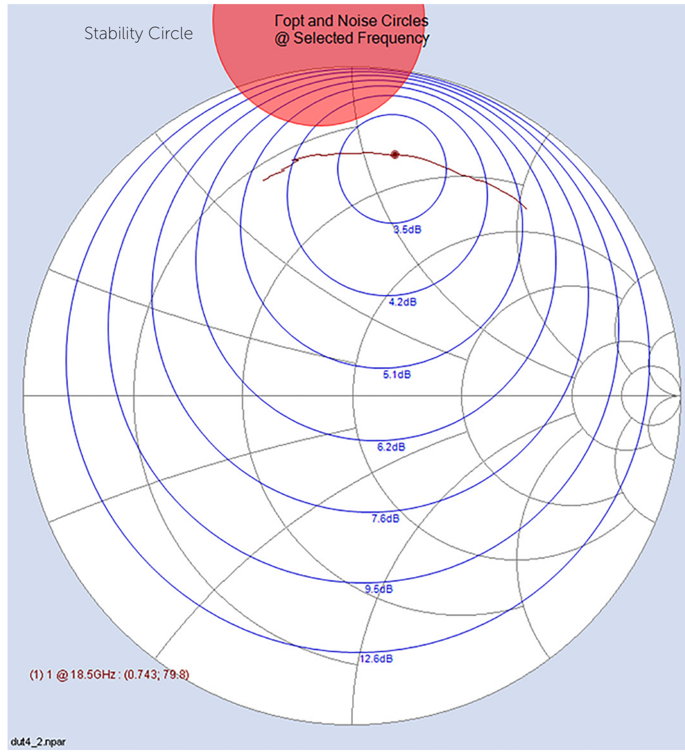
- Minimum Noise Figure (**Fmin**): This is the smallest Noise Figure that the device can reach at a given frequency and bias, if it is optimally matched at the source.
- Equivalent Noise Resistance (**Rn**): This is a number with the dimension Ohm that indicates how fast the Noise Figure increases when we mismatch the input (source).
- Optimum Noise Reflection Factor (**Γopt**), is often used also as Optimum Admittance **Yopt**: Is the source admittance required for the DUT to perform Fmin ; (Yopt=Gopt+jBopt), 2 parameters.

The Noise Figure does not depend on the Load impedance presented to the device . It only depends on the Source Impedance. There exist a simple relation between the four Noise Parameters:

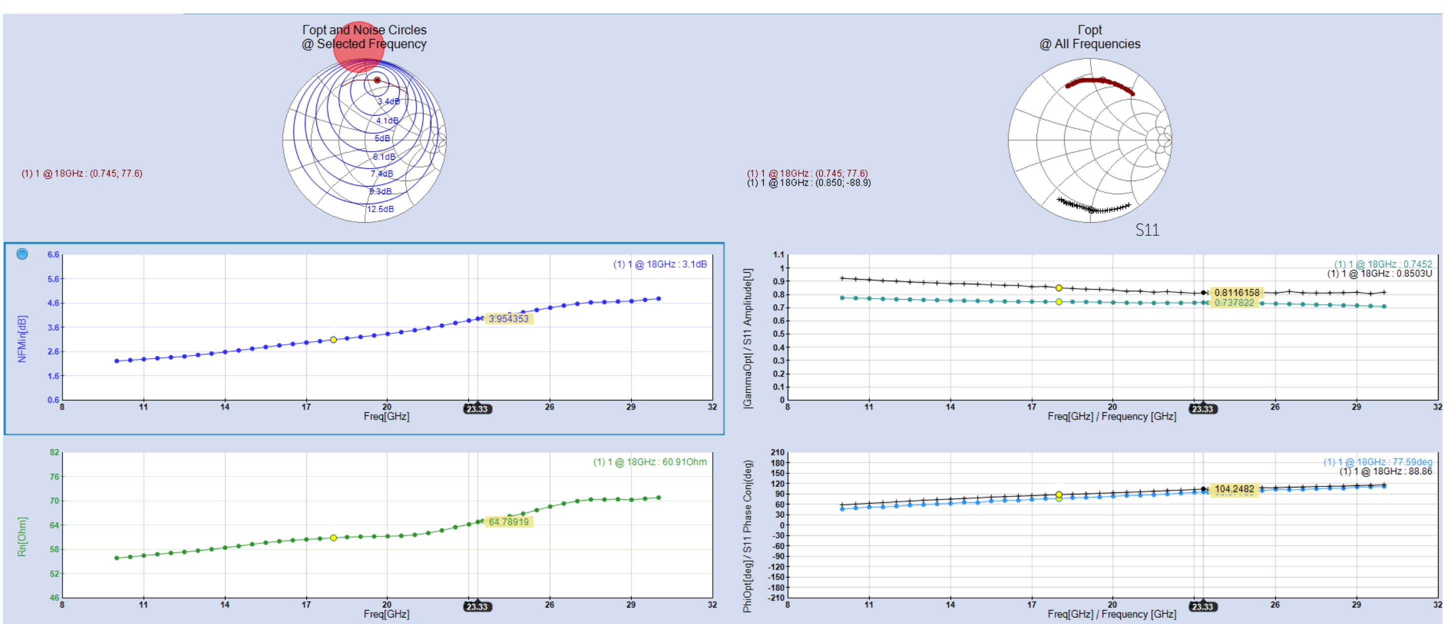
Noise Figure $F(Ys) = Fmin + (Rn/Gs)*| Ys - Yopt|^2$

where Ys = Gs +jBs. This is the equation of a set of isometric circles on the Smith Chart (Noise Circles) for which the value of the Noise Figure is the Level on each circle.

This Circle Representation is only possible because the Noise behaviour of transistors is a Small Signal Phenomenon.

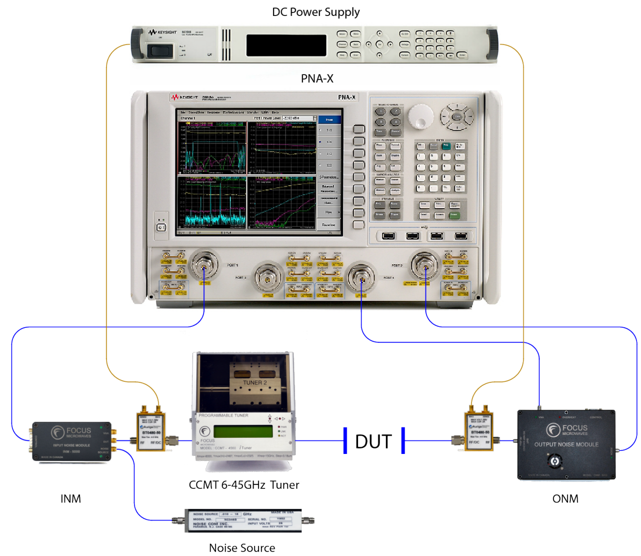


Noise Circles & Instability Regions



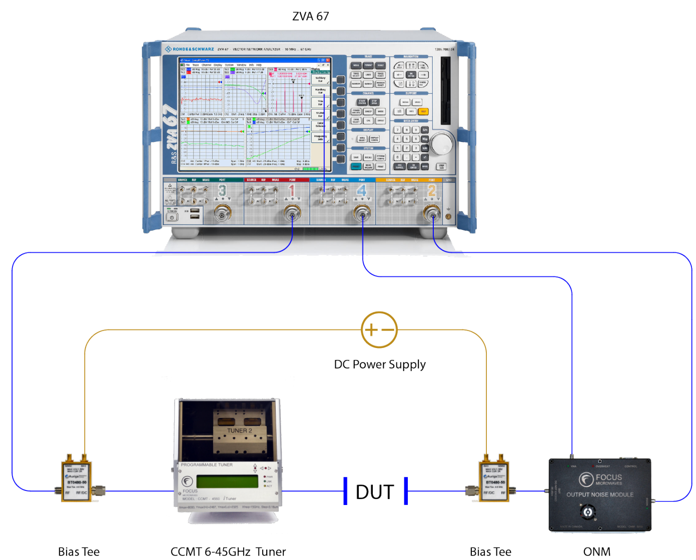
Noise Measurements Using PNA-X

Focus' noise parameter extraction routines leverage the PNA-X's unique implementation of the cold-source noise figure measurement technique. This specific technique requires a noise source to determine the kBG (gain-bandwidth constant) of the system and a passive mechanical tuner is used to characterize the noise receiver across both the impedance and frequency space. This step is imperative to obtain fully vector-source-corrected measurements. A RF down conversion stage might be required if the frequency of noise measured exceeds the receiver's bandwidth. Focus offers noise modules which support down conversion for optimal speed and performance.



Noise Measurements Using ZVA

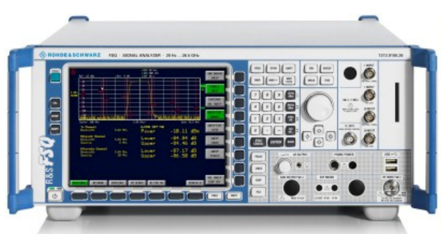
A new and smart method enables the extraction of the four noise parameters of an active device with a Rohde & Schwarz vector network analyzer. The rather simple and straight forward approach does not require a calibrated noise source with a given ENR (Excess Noise Ratio). Instead, the technique uses the CW signal from the VNA source. Using different detectors it measures the 'signal' respectively and the 'signal + noise' output power of the DUT. Combined with a Focus wideband fundamental tuner and advanced characterization software, the user can extract the four s-parameters and noise parameters in a single sweep.



Noise Measurements with Noise Receiver

Keysight X-Series

Focus' system architecture supports all of the X-series analyzers. Keysight's N9069A/W9069A noise figure measurement application uses the Y-factor method to calculate the noise figure.



The R&S® FSV/FSW

Focus also supports R&S' K30 option which plots Noise figure and gain measurements based on Y-factor method. The FSV/FSW calibrated internal pre-amp is a great alternative to external LNAs.

Legacy Noise Receivers

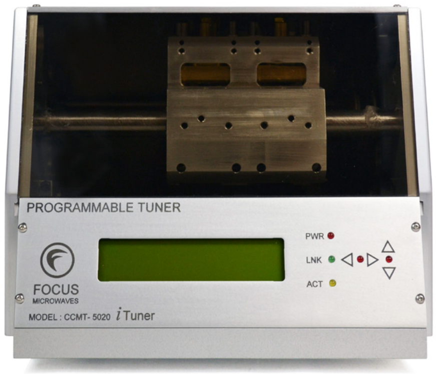
Considered as an industry standard for decades the soon to be discontinued N897XA family of noise figure analyzers is still supported by Focus' FDCS measurement suite.

Model Specifications

Tuner Models: CCMT-XXYY(Y): XX=Fmax (in GHz); YY=Fmin (in x 0.1GHz)

Popular CCMT Tuners

Model	Frequency	VSWR	Connector
CCMT-308	0.8-3GHz	≥12:1 (typ. 15:1)	APC-7, 7/16, N T.
CCMT-708	0.8-6.5GHz	≥12:1 (typ. 15:1)	APC-7, N Type
CCMT-808	0.8-8GHz	≥20:1	APC-7, N Type
CCMT-1808	0.8-18GHz	≥10:1 (typ. 15:1)	APC-7, N Type
CCMT-710	1-7GHz	≥10:1 (typ. 12:1)	APC-7, N Type
CCMT-2110	1-21GHz	≥10:1 (typ. 12:1)	2.9mm
CCMT-2610	1-26.5GHz	≥10:1 (typ. 12:1)	2.9mm
CCMT-716	1.6-6.5GHz	≥12:1 (typ. 20:1)	APC-7, 7/16, N T.
CCMT-1816	1.6-18GHz	≥10:1 (typ. 15:1)	APC-7, N Type
CCMT-1818	1.8-18GHz	≥10:1 (typ. 15:1)	APC-7, N Type
CCMT-2620	2-26.5GHz	≥10:1 (typ. 12:1)	3.5mm
CCMT-3620	2-36GHz	≥10:1 (typ. 12:1)	2.9mm (K®)
CCMT-5010	1-50GHz	≥10:1	2.4mm
CCMT-5020	2-50GHz	≥10:1 (typ. 12:1)	2.4mm
CCMT-4030	3-40GHz	≥10:1 (typ. 12:1)	2.9mm (K®)
CCMT-5080	8-50GHz	≥12:1 (typ. 15:1)	2.4mm
CCMT-67100	10-67GHz	≥10:1 (typ. 15:1)	1.85mm
CCMT-110100	10-110GHz	≥8:1	1.0mm



Input Noise Module

Model	Frequency	Connector	Insertion Loss	VSWR
INM-2600	up to 26.5GHz	3.5mm	0.80dB	1.60
INM-4000	up to 40GHz	2.9mm	0.91dB	1.80
INM-5000	up to 50GHz	2.4mm	0.99dB	1.80
INM-6700	up to 67GHz	1.85mm	1.12dB	1.90

Output Noise Module

Model	Frequency	Connector	Downconverter	Minimum Gain (dB)	Maximum VSWR
ONM-2600	up to 26.5GHz	3.5mm		29	1.8:1
ONM-4000	up to 40GHz	2.9mm		30 for ≤26.5GHz, 29 for 26-40GHz	2.1:1
ONM-4000-DC	up to 40GHz	2.9mm	▼	30 for ≤26.5GHz, 29 for 26-40GHz	2.1:1
ONM-5000	up to 50GHz	2.4mm		27 for ≤26.5GHz, 27 for 26-40GHz, 28 for 40-50GHz	2:1
ONM-5000-DC	up to 50GHz	2.4mm	▼	27 for ≤26.5GHz, 27 for 26-40GHz, 28 for 40-50GHz	2:1
ONM-6700	up to 67GHz	1.85mm		29 for ≤26.5GHz, 28.5 for 26-40GHz, 28 for 40-50GHz, 21 for 50-65GHz	3:1
ONM-6700-DC	up to 67GHz	1.85mm	▼	29 for ≤26.5GHz, 28.5 for 26-40GHz, 28 for 40-50GHz, 21 for 50-65GHz	3:1

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