"Hot-Cold" (Y-Factor) Noise Measurement Method

In the case of "hot-cold" noise source the loss of the tuner has to be known, but the S-parameters of the DUT interfere only via Friis' relationship, i.e. in the second stage correction factor: NF(Gs) = NFtotal - (NFrec - 1) /Gav.dut (Sij). This means that DUT S-parameter sets measured previously and saved in files can be used without sensitive loss of accuracy, especially if NFrec is low (~1dB) and the VNA and switches need not be part of the setup. However this technique is, for very low noise figures, not so accurate as the "cold noise source" method, it can be used with confidence for minimum noise figures larger than 0.5dB, whereas the "cold" method is reliable for noise figures as low as 0.1dB.

$$NF(\Gamma_S) = NF_{total} - \frac{NF_{rec} - 1}{G_{av.DUT}(S_{ij})}$$

where Gav.dut(Sij) = available gain of the DUT at the specific source impedance, NFrec=Noise Figure of the receiver.

"Cold Noise Source" Measurement method

This method requires a "hot-cold" noise source only in order to calibrate the noise receiver. During transistor noise measurements the noise source itself is not used, only its internal thermal 50Ohm resistance. The thermal noise of this source resistance, combined with the noise power generated by the DUT are reflected at the source impedance, generated by the tuner, and the combination is amplified by the DUT and generates the Output Noise Power (NP), which is amplified by the LNA and detected by the Noise Receiver or Spectrum Analyzer. The following relation applies:

$$\text{Noise Figure} = \frac{P_N}{T_0 kBG} \cdot \frac{|1 - S_{11} \cdot \Gamma_S|^2 \cdot |1 - \Gamma_{rec} \cdot \Gamma_{out}|^2}{(1 - |\Gamma_S|^2) \cdot |S_{21}|^2} - \frac{T_C}{T_0} + 1$$

Where NP = Noise Power at DUT output; Gs = Source Reflection Factor; Gout = Reflection Factor at DUT output; Grec = Reflection Factor of Noise Receiver Input; kBG = Gain-Bandwidth constant of Receiver ;Tc = Room Temperature (in Kelvin); To = Standard Temperature (290K); Sij = Scattering parameters of DUT at the specific bias point.