

### **1.1.1 Noise Figure Measurements using HOT-COLD**

For HOT-COLD measurement, the HP8970 has to be calibrated directly. The noise source has to be connected at the receiver reference plane and proceed with the HP8970 calibration.

To be able to calibrate the HP8970:

- 1- Enter the ENR into the HP8970
- 2- Select the Frequency range: Fstart, Fstop, Fstep
- 3- Start the calibration

#### **(i) WinNoise Calibration for HOT/COLD Noise Measurement**

This method can be used for HOT/COLD NOISE and POWER measurement because all components are calibrated in full S-parameter. For NOISE measurement only the input tuner is used, the output tuner can be left in the setup initialized and cannot be used during the measurement.

An isolator is needed before the LNA for Noise Measurement. For frequencies higher than 1,6 GHz (depending on the Noise Meter used), a mixer is needed to down convert the RF-noise. In this case a synthesized local oscillator source should be used to drive the mixer (because of its low sideband noise). Our experience with this method is that it is critical in accuracy for DUT noise figures less than 1dB.

#### **1. Calibrate the VNA using the TRL technique at the COAXIAL REFERENCE PLANE (or Wave-Guide).**

**Use the same type of connector as the Noise Source uses. For example you can use a 3,5 mm male connector on VNA Port 1 and a female connector for the VNA Port 2. We suggest using iso-phase adapters on the two VNA ports to facilitate the measurement of non insertable device.**

#### **2. Measure the Noise Source impedance.**

**Connect the Noise Source to the Port 2 of the VNA. Remove the BNC cable. Start WinNoise and select:**

CALIBRATION

COMPONENTS

1-PORT(S22)

MEASURE

Type the filename: NSOURCE.S1P

Type a comment: e.g. The Noise Source serial number

**3. Measure the RECEIVER impedance.**

**Connect VNA Port 1 to the isolator and select:**

CALIBRATION

COMPONENTS

1-PORT(S11)

MEASURE

Type the filename: Nf\_RCVR.S1P

Type a comment: e.g. some Receiver data

**4. INPUT TUNER calibration.**

*Tuner should be calibrated either separately or with the bias tee included at the input side of the tuner using Standard method (if the bias tee is at the output side of the tuner, the reflection factor of the tuner is lower).*

**Initialize TUNER 2 and select:**

CALIBRATION

TUNER

**FILE: Type or Retrieve the tuner calibration filename**

**FREQ: LIST f1 or SWEEP fstart fstop fstep**

**MODE: S11...S22**

**RESOLUTION: Medium**

**OPTIONS: Standard**

**MAX GAMMA: 0,82 to 0.92**

**TITLE, COMMENT and OPERATOR: optional**

**5. Input/Output Network Calibration**

*If the test fixture is used it should be calibrated using TRL method. In that case two blocks will be created. CONA.S2P as an input block for the first half of the test fixture, and CONB.S2P as an output block for the second half of the test fixture.*

*Bias tee can be calibrated either as a part of the test fixture (in that case it will be a part of the output block CONB.S2P), or separately. If it's calibrated separately, then that bias tee calibration file should be added as a separate line below the Output command. The procedure for TRL:*

**CALIBRATION**

**COMPONENTS**

**TRL/TRM (Meas)--> MEASURE**

**CONA.S2P and CONB.S2P are generated**

*If the DUT is used separately, without test fixture, then the input block can be only adapter between the DUT and the tuner, and the output block can be output adapter.*

*That procedure is shown below:*

**CALIBRATION**

**COMPONENTS**

**2-PORT**

**MEASURE**

Type the filename that corresponds with the measured block:

NF\_INPUT.S2P/NF\_OUTPUT.S2P

Type a comment: e.g. some Input data

**6. RECEIVER NOISE calibration**

Connect the noise source at the input of the isolator. Enter the ENR of the noise source into the HP8970.

Create a Setup-File e.g. NF\_CAL.TSF by selecting:

FILE  
NEW

Taken into account the measurements done before the Setup-File could be as follows:

```
Freq
fixed 2.058
!
Load c:\workshop\cal\NF_RCVR.S1P
Nsource C:\workshop\cal\NSOURCE.S1P
!
Input
  Tuner_2 C:\workshop\cal\pmt441n3.tcf
!
Instruments
HP8970A          8          C:\workshop\Cal\HP346a.ENR
E2F5B1FA2048MZFB2068MZSS2MZLF2592MZ
```

, where HP346a.ENR represents the ENR-table of the noise source, E2 activates Mode 1.2 (external LO), F5 sets the Smoothing Factor = 32, B1 selects Lower Single Sideband, FA2048MZ is the START FREQ, FB2068MZ is the STOP FREQ, SS2MZ is the STEP SIZE and LF2592Mz is the LO-frequency

**7. Select in WinNoise:**

Connect Noise Source at the input of the isolator

```
CALIBRATION
  NOISE RECEIVERS
    RECEIVER CALIBRATION
      OPTIONS: HOT/COLD
      START
        Select Frequency: START, STOP, STEP
      START
```

**Note: If we want to calibrate only one freq. f, then the same f should be put in Start and Stop option, and the Step should be 0**

**8. Measure the DUT [S] Parameters:**

**Polarize the DUT and select:**

**CALIBRATION**

**COMPONENTS**

**2-PORT**

**MEASURE**

Type the filename: DUT.S2P

Type a comment: e.g. device name and polarization

**Note: De-embedding of test-fixtures is also possible via the DE-EMBED menu.  
In that case the procedure is the following:**

**CALIBRATION**

**COMPONENTS**

**S-PAR ( DEEMBED)**

**INPUT:test-fixture input: cona.s2p**

**OUTPUT:test-fixture output: conb.s2p**

**MEASURE**

**Type the filename: DUT.s2p**

**Type a comment: the device name and the polarization**

**9. Noise Measurement.**

**Modify the setup file for Noise calibration (e.g. NF\_CAL.TSF) and save it under a different name (e.g. NF\_MEAS.TSF).**

**Taken into account the measurements done before the modified Setup-File could be as follows:**

**Freq**

**Fixed 2.050**

**!sweep 2.050 2.066 0.008**

**!step 2.058**

**!**

**!**

**files**

**! use DUT .0001 to measure THRU**

**! DUT .000001**

**! USE real DUT S\_PARAMETER to measure NF of device**

**DUT C:\workshop\cal\DUT.S2P**

**!**

**Source c:\workshop\cal\NSOURCE.S1P**

**!**

**Input**

**Tuner\_2 C:\workshop\cal\pmt441n3.tcf**

**Cona C:\focus\cal\cona.s2p**

!

**Output**

Conb C:\focus\cal\conb.s2p

C:\focus\cal\bias\_t.s2p ! if that one is calibrated separately than test-fixt

!

Load c:\workshop\cal\NF\_RCVR.S1P

!

**Meas**

NF noisefigure hotcold

!

**instruments**

HP8970A                    8                    C:\workshop\Cal\                    HP346a.ENR  
E2F5B1FA2048MZFB2068MZSS2MZLF2592MZ

**To retrieve the setup file for the noise measurement select:**

FILE

OPEN

Select the filename:NF\_Meas.TSF

**To edit this file select:**

FILE

EDIT SETUP

## Noise Setup (Hot/Cold) at 2,058 GHz

