Products: Signal Source Analyzer R&S FSUP

Frequency Extension for Phase Noise Measurements with FSUP26/50 and Option B60 (Cross-Correlation)

Application Note 1EF56

This application note describes the use of the R&S FSUP26/50 with frequency dividers to extend cross correlation range to higher frequencies.

ROHDE&SCHWARZ

Contents

1 Overview

This application note decribes the use of the FSUP26/50 with Frequency Dividers for extension of the frequency range for cross correlation.

To extend the range of the FSUP Low Phase Noise Option B60 above 8GHz, a frequency dividing device (prescaler) can be used. To show the functionality we use a device from Hittite, HMC-C005. Devices from other vendors might also work properly, but have not been tested, yet.

The Signal Source Analyzer R&S®FSUP is abbreviated to FSUP for the remainder of this Application Note.

2 Why Cross-Correlation for Phase Noise Measurement (PN)

Up to 20 dB improvement in sensitivity can be achieved by using cross correlation technique.

With cross correlation two symmetrical receiver paths are used (see picture no.1). The input signal from the DUT is inserted in both paths, captured and Fourier transformed. Therefore both paths measure the sum of the phase noise provided by the DUT (**A**) and the additional inherent phase noise provided by the amplifiers, oscillators etc. in the FSUP frontend (**N**)."

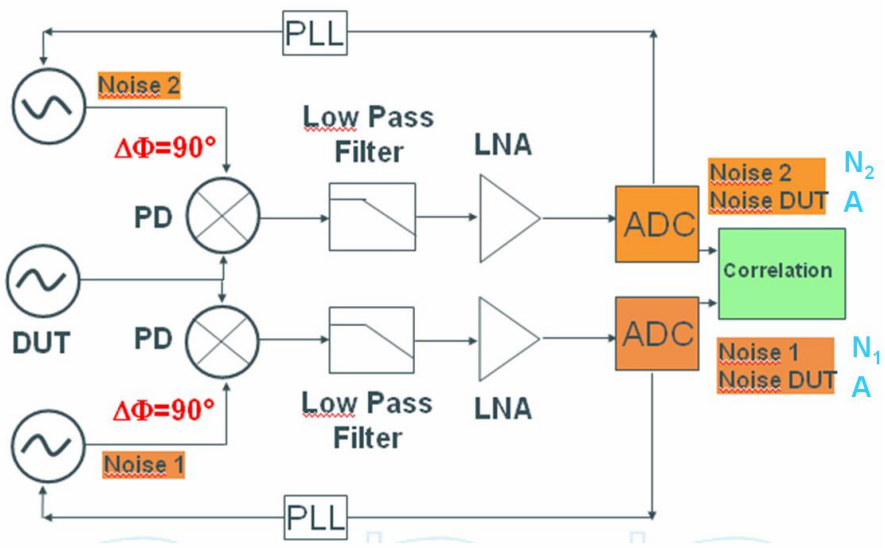

Figure 1.

Then the results are Fourier transformed and cross correlated. This can basically be understood as a vector addition of the samples obtained in both signal parts with subsequent averaging. As the signal noise vector components coming from the DUT are correlated, they'll ideally have identical phase in both paths and will be summed in magnitude, whereas the signal parts coming from the FSUP are uncorrelated as different oscillators are used. Averaging of uncorrelated signals ideally leads to a magnitude of zero

3 Test Setup

If cross correlation technique is needed at higher frequencies, an external prescaler/divider can be used in order to transform the input signal above 8 GHz into one below 8 GHz.

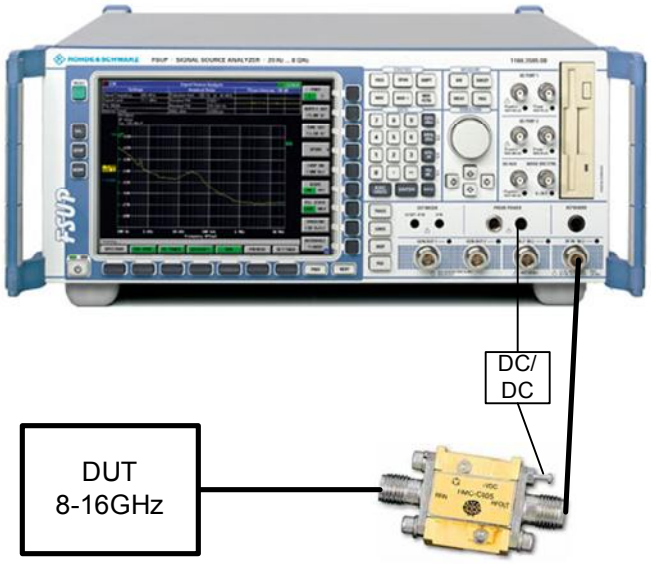

Figure 2

You can use the “Probe Power”-output of the FSUP to drive the divider. However, in this case you have to use a linear voltage regulator (78L05 and some discrete components[1]). Alternatively you can use an external power supply with +5V/100mA.

The divider is operated in a mode which divides the input signal of the DUT by 2. As a result, the input frequency is extended by times 2, up to 16GHz. Below 8GHz the prescaler/divider is not needed and direct measurement can be performed.

Note: *Other devices may be used by the customer but care should be taken regarding the specification*

[1] If more detailed information about this is needed, please contact our service department

4 The Frequency Divider

In this Application Note we use the divider type HMC-C005 from Hittite, which has the following key parameters.

Electrical Specifications, T_A = +25° C, 50 Ohm System, Vcc= +5V

Parameter	Conditions	Min.	Typ.	Max.	Units
Maximum Input Frequency		18	19		GHz
Minimum Input Frequency	Sine Wave Input			0.5	GHz
Input Power Range	Fin = 2 to 4 GHz	-10	-15	+10	dBm
	Fin = 4 to 14 GHz	-15	-20	+10	dBm
	Fin = 14 to 16 GHz	-15	-20	+5	dBm
	Fin = 16 to 18 GHz	-10	-15	0	dBm
Output Power	Fin = 0.5 to 18 GHz	-7	-4		dBm
Reverse Leakage	Fin = 0.5 to 18 GHz		55		dB
SSB Phase Noise (100 kHz offset)	Pin = 0 dBm, Fin = 4.8 GHz		-150		dBc/Hz
Output Transition Time	Pin = 0 dBm, Fout = 882 MHz		100		ps
Supply Current (Icc)			75		mA

Table 1

Functional Diagram

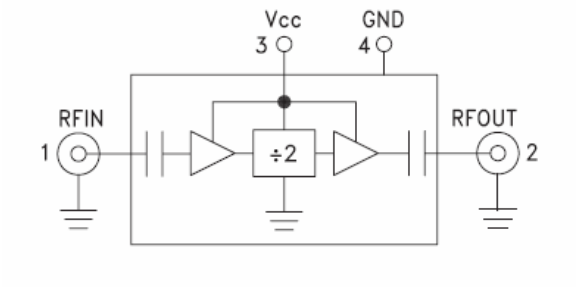

Figure 3

Input Sensitivity Window, T= 25 °C

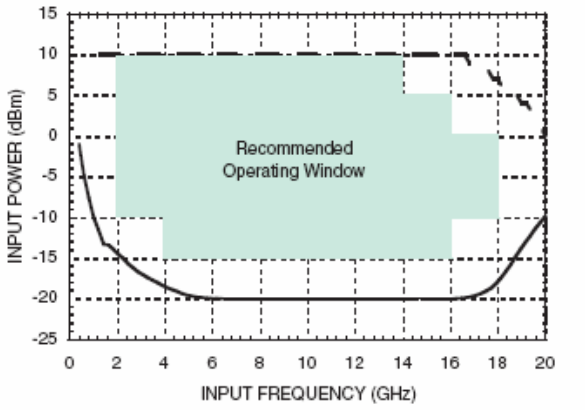

Figure 4

SSB Phase Noise Performance, Pin= 0 dBm, T= 25 °C

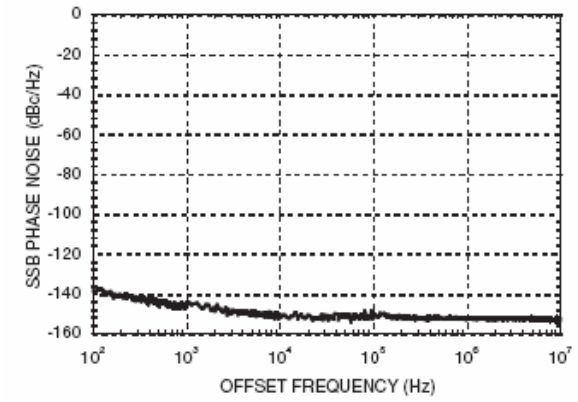

Figure 5

Figure.4 and 5 have to be taken into account when performing a measurement. Figure 4 shows the recommended input power (-15 to +10dBm) and figure 5 shows the limitations for the PN measurement caused by the inherent phase noise of the device.

Note:

For more details refer to the data sheet at www.hittite.com

5 Results and Limitations

Up to 20 dB improvement in sensitivity can be achieved by using cross correlation technique.

With the use of an external divider 6 dB have to be added to the results.

The figure 6 shows a typical measurement on a 12 GHz downconverter source measured with external divider (green curve) and without external divider (yellow curve). The specified value of -128 dBc at 10 kHz offset can be measured with this setup:

-134.99 dBc + 6 dB = -128.99 dBc.

At higher offsets the noise floor of the divider -150 dBc (see specification of Hittite, figure 5) can be seen.

At lower frequencies the R&S FSUP with external divider and cross correlation seems to provide better performance than the phase noise tester used for the plot in the data sheet.

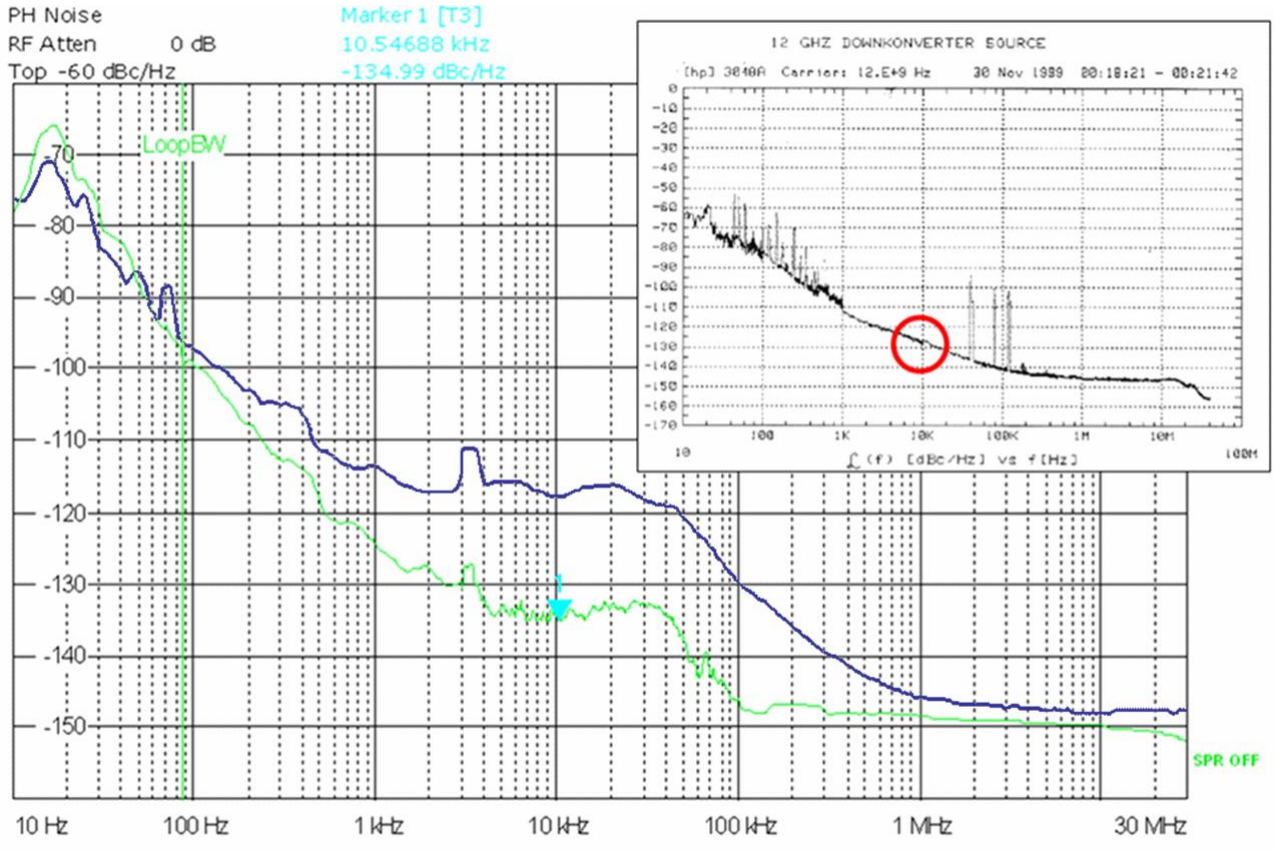

Figure 6

Note:

*The accurate correction factor for frequency division by 2 is calculated as follows :Correction factor =20*log(2)=6,02dB.*

6 Adaptation at "Probe power" connector for divider

To use the divider with the FSUP probe power connector you have to use a little converter or a linear voltage regulator[2], which can be found in nearly every electronic store. The voltage of the pins of this connector is listed below:

Pin	Signal
1	GND
2	-12.6 V; max 150 mA
3	+15 V; max 150 mA

Figure 7

7 Abbreviations

DUT	Device under test
PN	Phase Noise
SSB	single side band
X-Correlation	Cross-Correlation

8 Literature

[1] Christoph Rauscher, Fundamentals of Spectrum Analysis, Rohde & Schwarz, 0002.6635.00, published by Rohde & Schwarz inhouse publisher, available at Rohde & Schwarz sales offices.

[2] Application Note 1EPAN 16E, Josef Wolf, Phase Noise Masurements with Spectrum Analyzers of the FSE family, available at Rohde & Schwarz internet pages

[3] Operation manual, Signal Source Analyzer, R&S FSUP, available at Rohde & Schwarz internet pages

[4] Hittite Microwave Corporation, Specification of Divide-by-2 prescaler module, hmc-c005, v01.0906

9 Additional Information

Please send any comments or suggestions about this application note to **TM-Applications@rsd.rohde-schwarz.com**.

[2] If more detailed information about this is needed, please contact our service department

10 Ordering information

Type of instrument R&S FSUP8	20Hz..8GHz	1166.3505.08
Type of instrument R&S FSUP26	20Hz..26,5GHz	1166.3505.26
Type of instrument R&S FSUP50	20Hz..50GHz	1166.3505.50
Type of instrument R&S FSUP-B60	10MHz..8GHz	1169.5544.02
Connectors and Cables Probe power connector, 3-pin		1065.9480.02

For additional information about spectrum analysers and phase noise measurement equipment, see the Rohde & Schwarz website www.rohde-schwarz.com.

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