Application Note No. 051

SIEGET45 - Low Noise Amplifier with BFP520 Transistor at 1.9 GHz

RF & Protection Devices

Never stop thinking

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Revision History: 2007-01-08, Rev. 2.0

Previous Version:

Page	Subjects (major changes since last revision)
All	Document layout change

Trademarks

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1 SIEGET®45 - Low Noise Amplifier with BFP520 Transistor at 1.9 GHz

This application note describes an example of a Low Noise Amplifier with the BFP520 (5th Generation, SOT343) SIEGET®45-line. Improved performance in Gain (16 dB) and OIP_3 (15 dBm) are the outstanding features at low current I_C = 7 mA (@ V_{CC} = 2 V). Consider while designing, the device shows potential instability in the frequency range around 1 GHz. Due to the hard stability matching conditions the 2nd example is still stable over the whole frequency range. The 1st example is unstable at 1 GHz nevertheless the gain exceeds 16.5 dB, noise figure ~ 1.4 dB.

Table 1 Simulation and Measurement results

Data @ 1.9 GHz	Simulation result	Measurement result
Gain (S21)	16 dB	16.5 dB
R_{LIN} |S11|	13 dB	> 11 dB
R_{Lout} |S22|	17 dB	> 20 dB
IP_3	-	15 dBm
NF	1.5 dB	1.5 dB

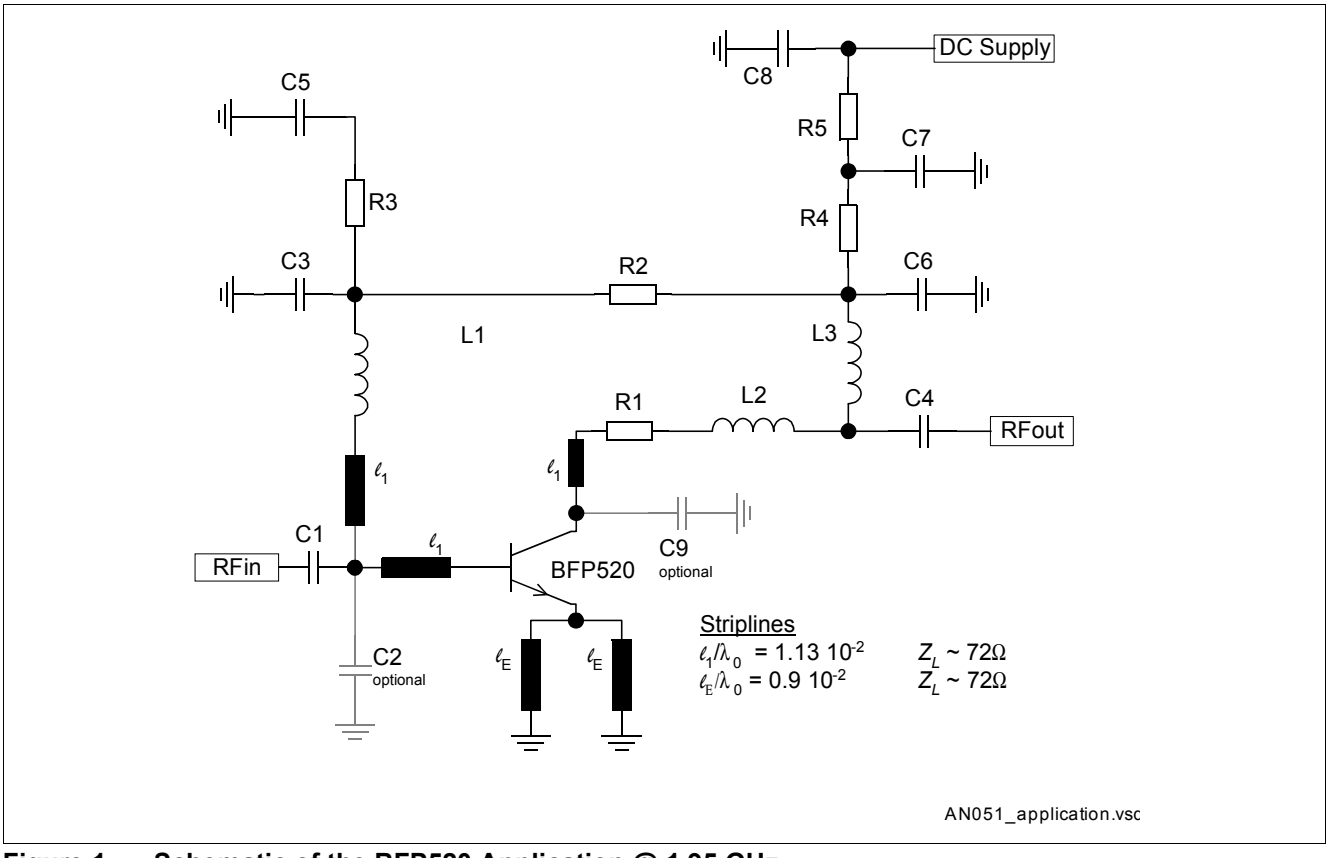


Figure 1 Schematic of the BFP520 Application @ 1.95 GHz

1.1 PCB Layout and Component Placement

Fixed components: J1: connector / J2: switch / C8: 4.7 uF (Elko)

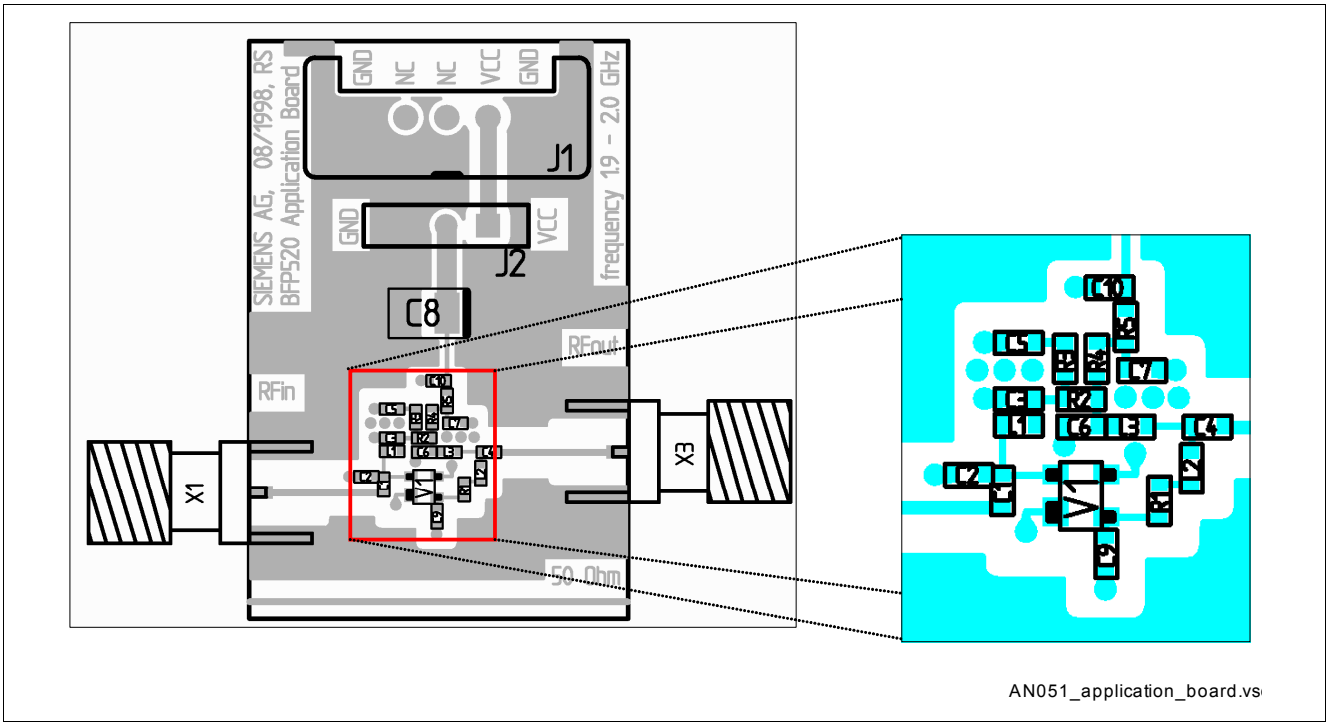


Figure 2 Application board (scale 3:1) - original size 23 x 35 mm

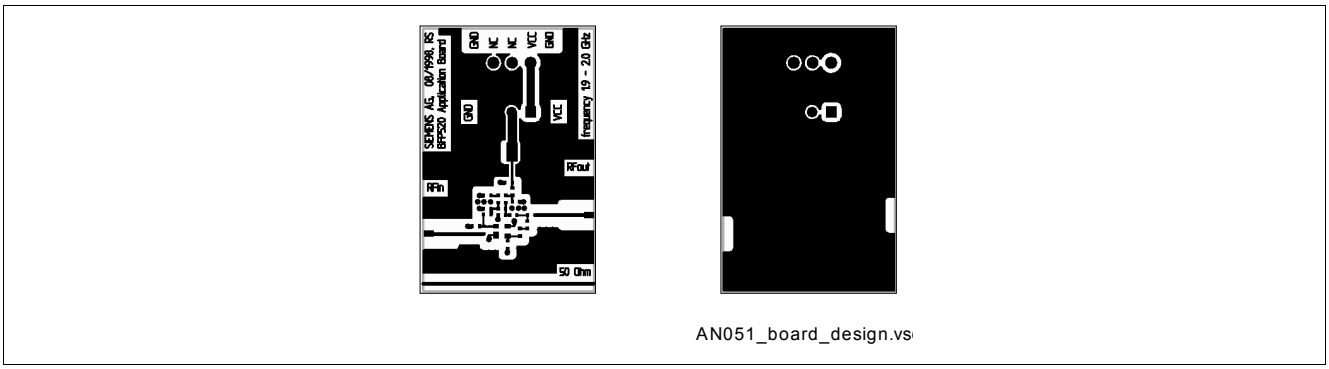


Figure 3 Board design - Top Layer and Layer-2 - scale 1:1

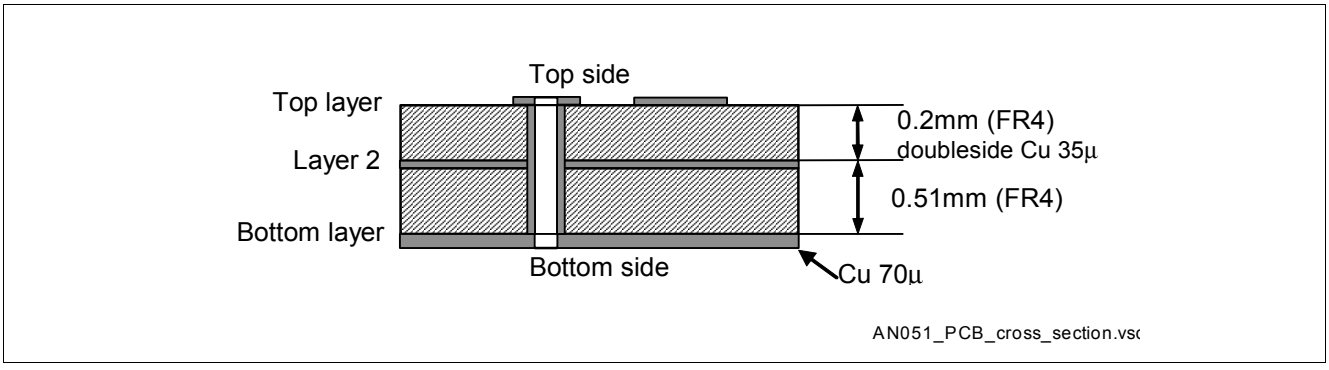


Figure 4 PCB cross section

1.2 Circuit modeling and simulation

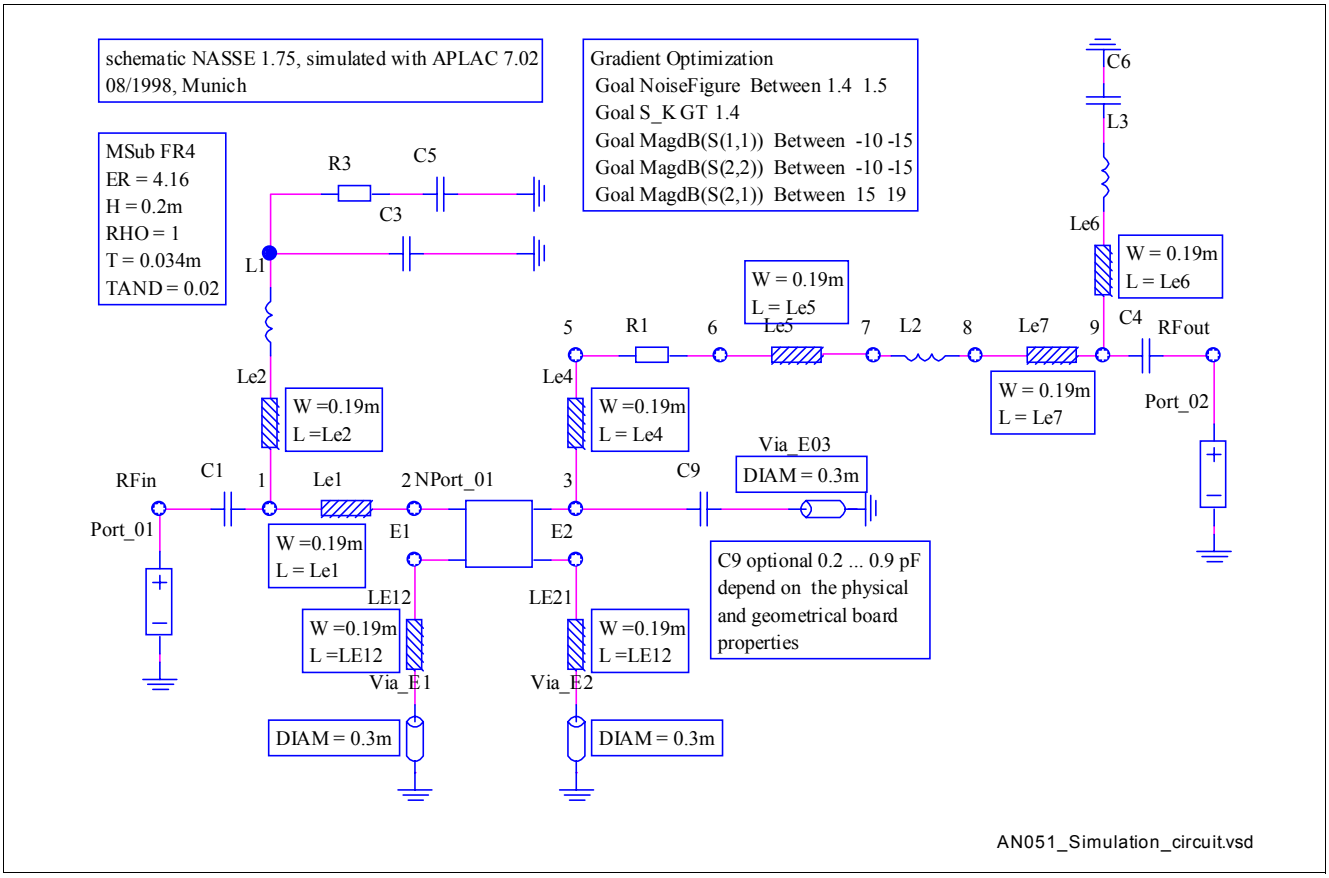


Figure 5 RF Simulation Circuit of the BFP520 Application

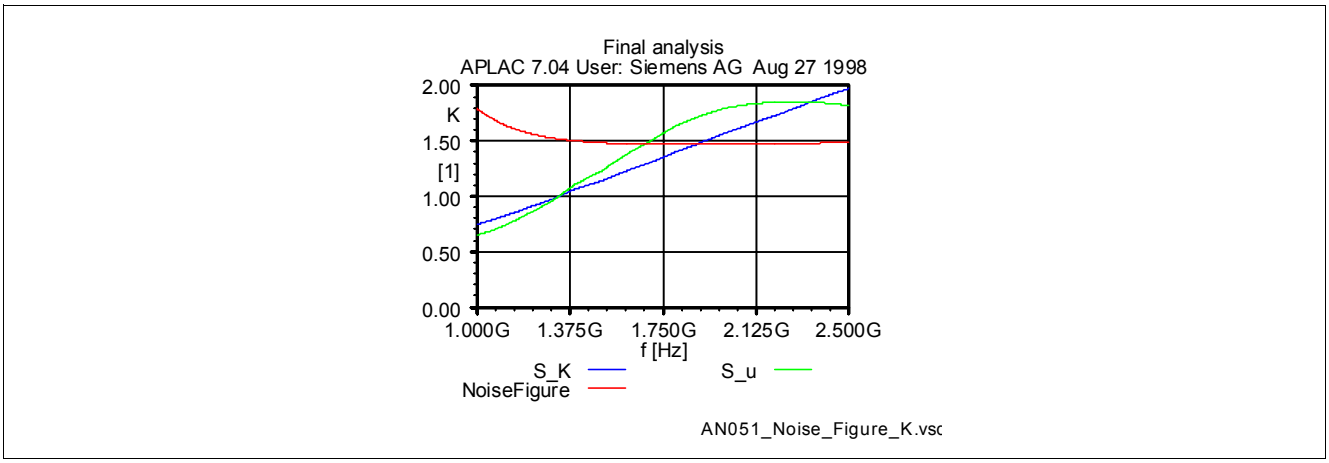


Figure 6 Noise Figure, Stability K (S_k) μ (S_u)

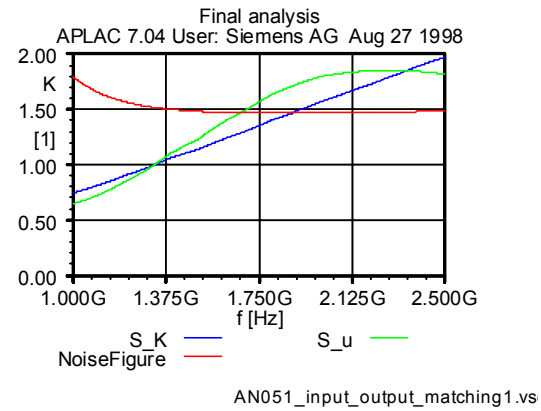


Figure 7 Input and output matching

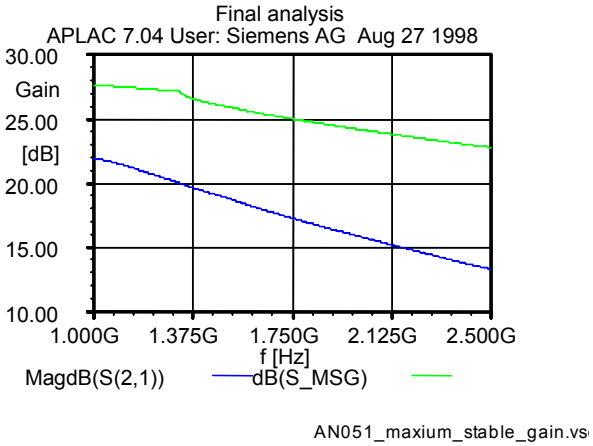


Figure 8 Maximum stable gain and transducer gain

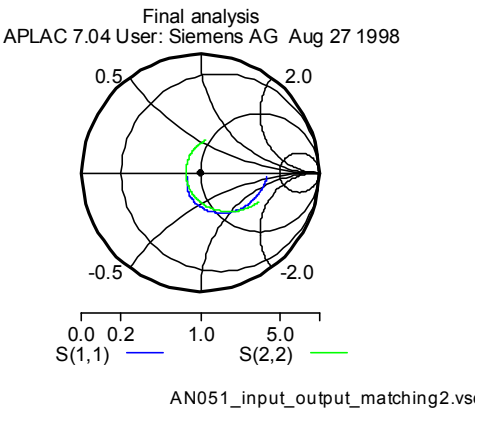


Figure 9 Input and output matching

1.3 1st application circuit measurement results

Stable under proved condition (50 Ω); best noise and performance. The application shows potential instability at 1 GHz.

Table 2 Components of 1st application

Component	Value	Comment	Component	Value	Comment
C1	15 pF[1)]	Input match	L1	12 nH[2)]	Input match
C2		Improve stability	L2	2.2 nH[2)]	Output match
C3	15 pF[1)]		L3	15 nH[2)]	Output match
C4	100 pF[1)]	Output match			
C4	100 pF[1)]		R1	27 Ω[3)]	Improve stability
C6	15 pF[1)]		R2	18 Ω[3)]	Bias; I_C= 6 mA
C7	68 pF[1)]		R3	33 Ω[3)]	
C8	1 nF[1)]		R4	33 Ω[3)]	
C9		Improve stability	R5	0 Ω[3)]	V_{CC} = 2 V

1) Murata
2) Toko 0402
3) S & M 0402

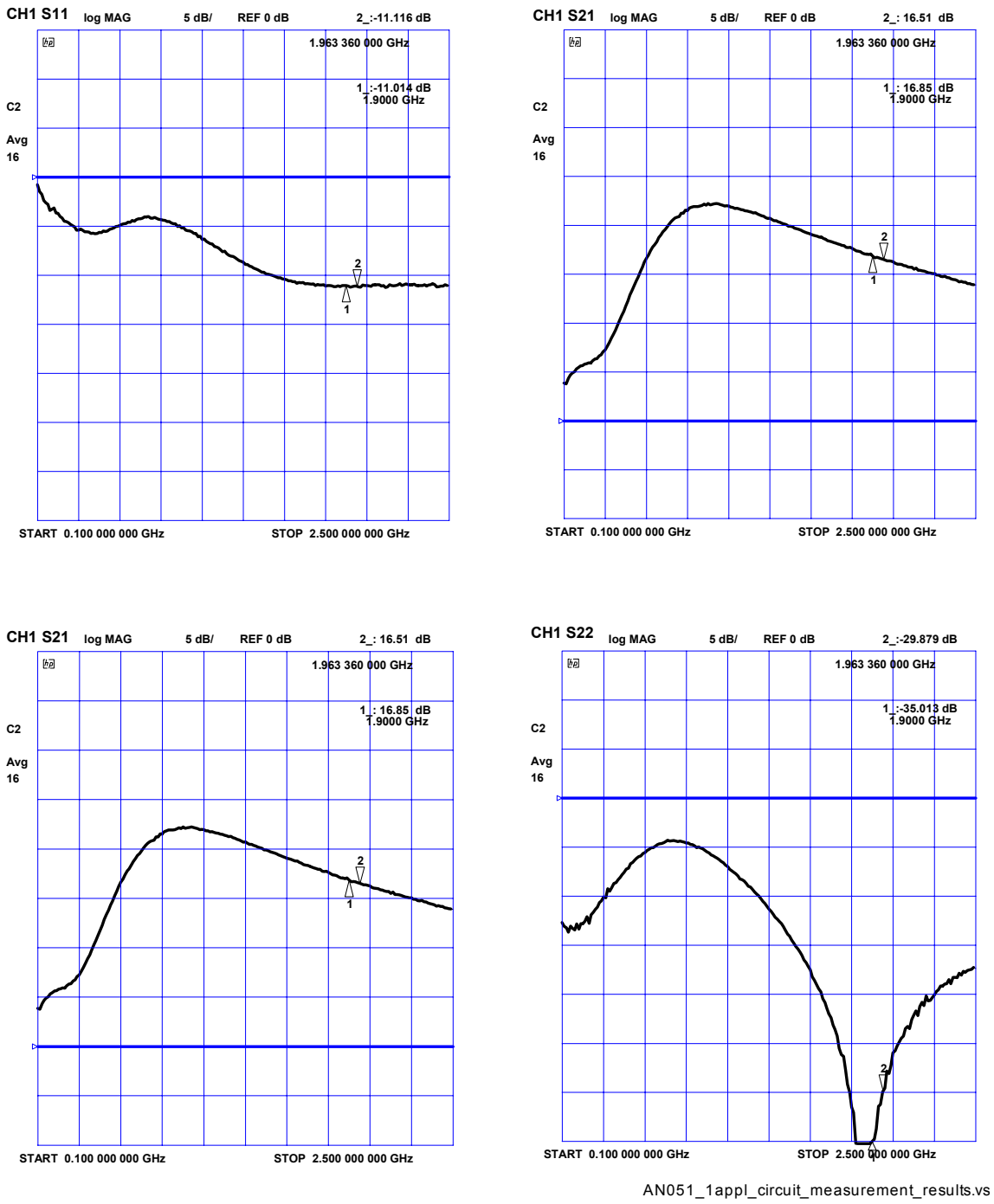


Figure 10 Measurement results of 1st application

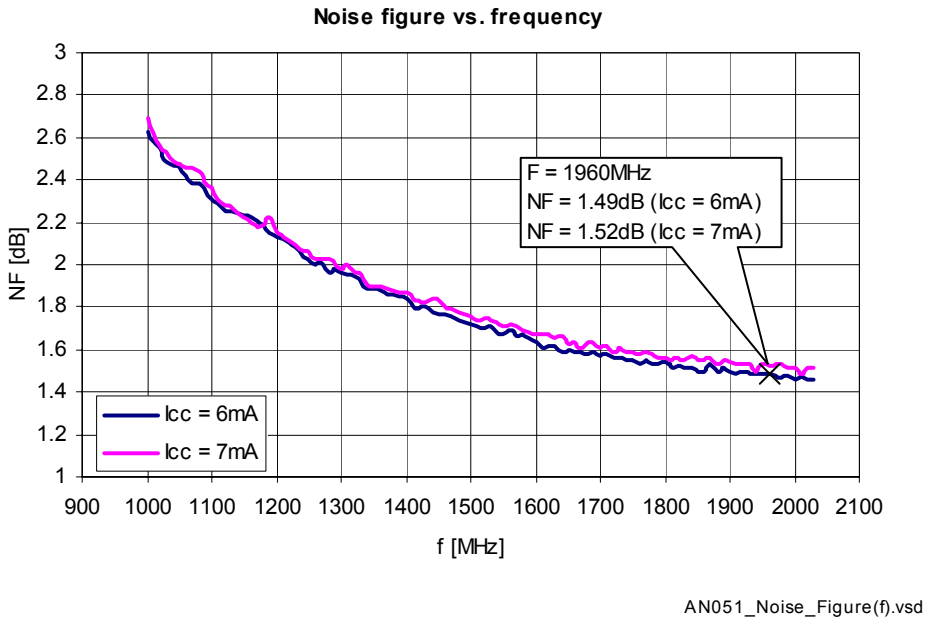


Figure 11 Noise Figure (V_{CC} = 2 V, T_C = 25 °C)

1.4 2nd application circuit measurement results

Absolutely stable over the whole frequency range (k > 1, 0.1... 2.5 GHz, see stability circles in **Figure 12** and **Figure 13**). Less performance in noise figure (1.5 dB) and gain (15 dB) than the application example above.

Table 3 Components of 1st application

Component	Value	Comment	Component	Value	Comment
C1	15 pF[1)]	Input match	L1	6.8 nH[2)]	Input match
C2		Improve stability	L2	1.2 nH[2)]	Output match
C3	15 pF[1)]		L3	5.6 nH[2)]	Output match
C4	100 pF[1)]	Output match			
C4	100 pF[1)]		R1	22 Ω[3)]	Improve stability
C6	15 pF[1)]		R2	18 Ω[3)]	Bias; I_C= 6 mA
C7	68 pF[1)]		R3	33 Ω[3)]	
C8	1 nF[1)]		R4	33 Ω[3)]	
C9	0.5 pF[1)]	Improve stability	R5	0 Ω[3)]	V_{CC} = 2 V

1) Murata
2) Toko 0402
3) S & M 0402

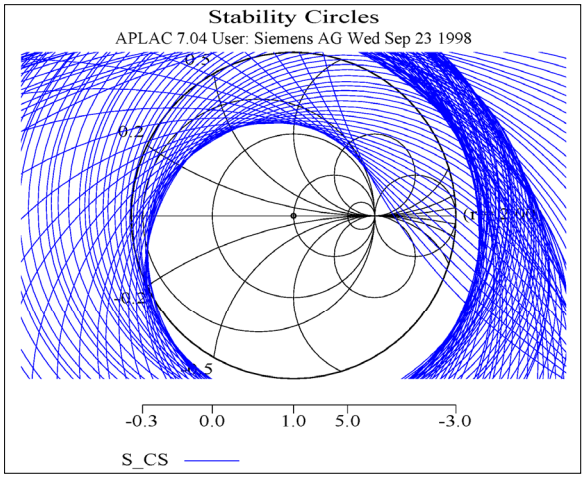


Figure 12 Source stability circules

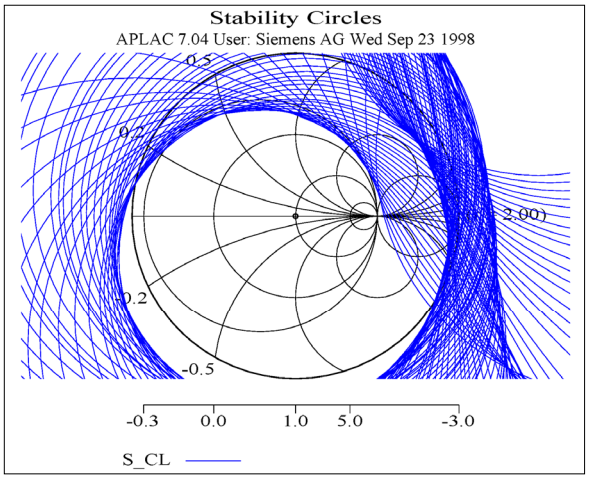
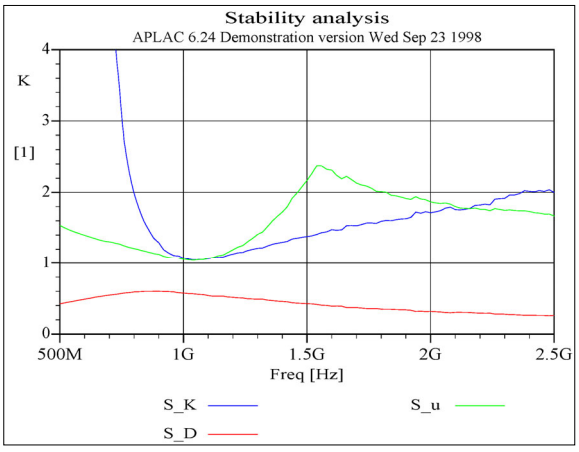


Figure 13 Load stability circules



Stability definitions:

S_D	the stability factor k
S_D	the magnitude of the S-matrix determinant |Δ|
S_u	a stability factor μ (s)

AN051_stability_analysis.vsd

Figure 14 Stability analysis

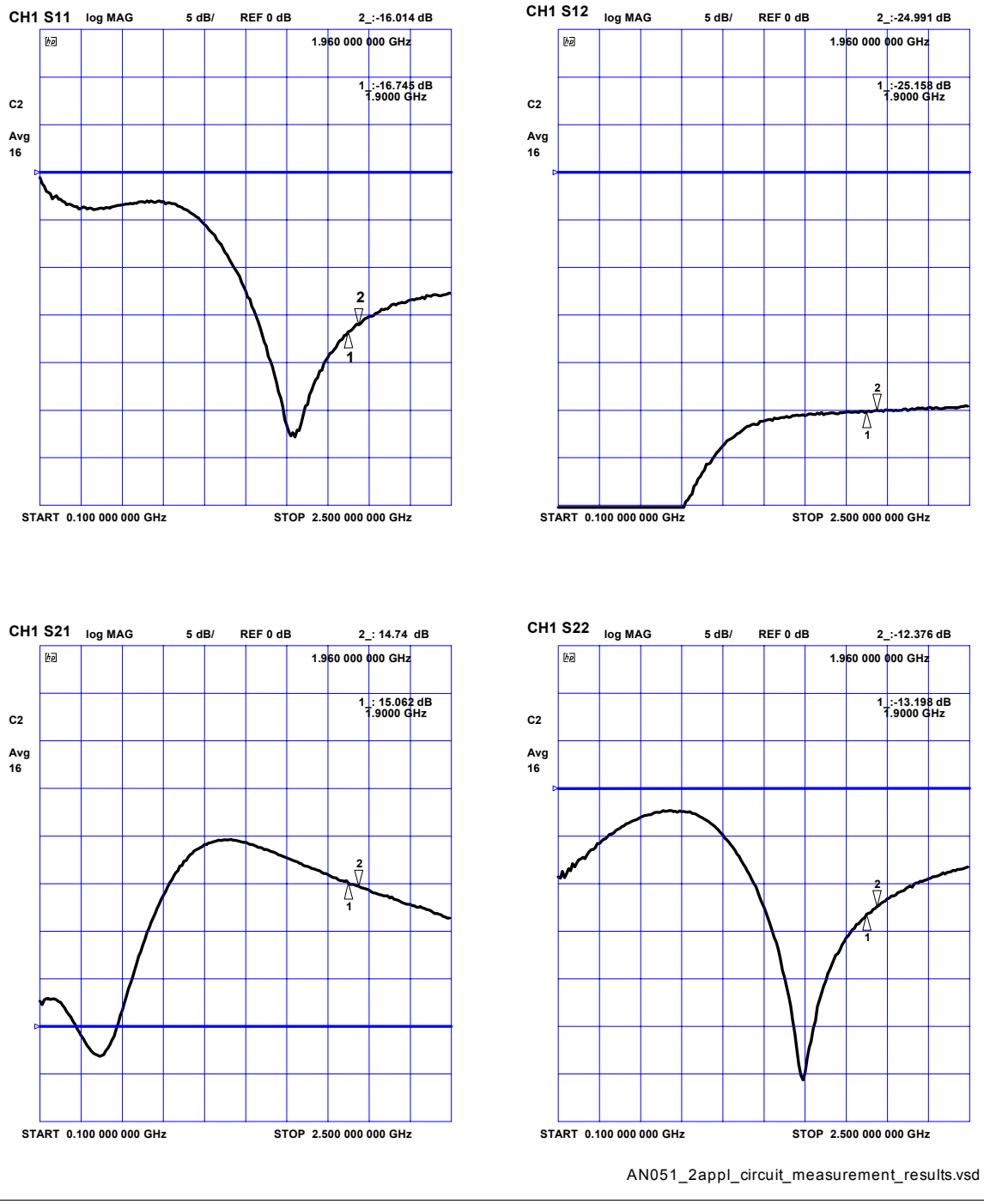


Figure 15 Measurements results of 2nd application