Application Note No. 114

Investigation of BFR740L3 Ultra Low Noise SiGe:C Transistor as 1.7 - 2.3 GHz "iBURST" Low Noise Amplifier

RF & Protection Devices

Never stop thinking

Edition 2007-08-22

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Revision History: 2007-08-22, Rev. 1.2

Previous Version: 2005-07-22, Rev. 1.1

Page	Subjects (major changes since last revision)
All	Small changes in figure descriptions

1 Investigation of BFR740L3 Ultra Low Noise SiGe:C Transistor as 1.7 - 2.3 GHz "iBURST" Low Noise Amplifier

Applications

- General purpose LNA for iBURST system

Overview

- Infineon BFR740L3 Ultra Low Noise SiGe:C Transistor in reduced-height TSLP-3-8 package is shown in a low-cost, low-parts count, broadband resistive feedback low noise amplifier.
- LNA is characterized for the 1.7 - 2.3 GHz frequency range.
- Transistor package size is 1 x 0.6 x 0.39 mm (leadless, RoHS compliant package).
- Note that "0201" size passive components are used.
- Current consumption is 12.9 mA at 3.0 volts.
- Amplifier is unconditionally stable (K>1) over 5 MHz - 8 GHz frequency range.

Summary of Results

Table 1 Summary of Results (T = 25 °C)

Frequency MHz	dB[s11]²	dB[s21]²	dB[12]²	dB[22]²	*NF* * dB	IIP_3 dBm	OIP_3 dBm	IP_{1dB} dBm	OP_{1dB} dBm
1700	10.4	18.3	23.4	10.7	1.0				
2000	11.8	17.3	22.4	10.9	1.0	+0.3	+17.6	-10.0	+6.3
2300	13.0	16.2	21.5	10.6	1.0				

* Note that PCB loss is not extracted. If PCB loss were extracted, NF would be 0.1 to 0.2 dB lower.

Cross Sectional Diagram of PC Board

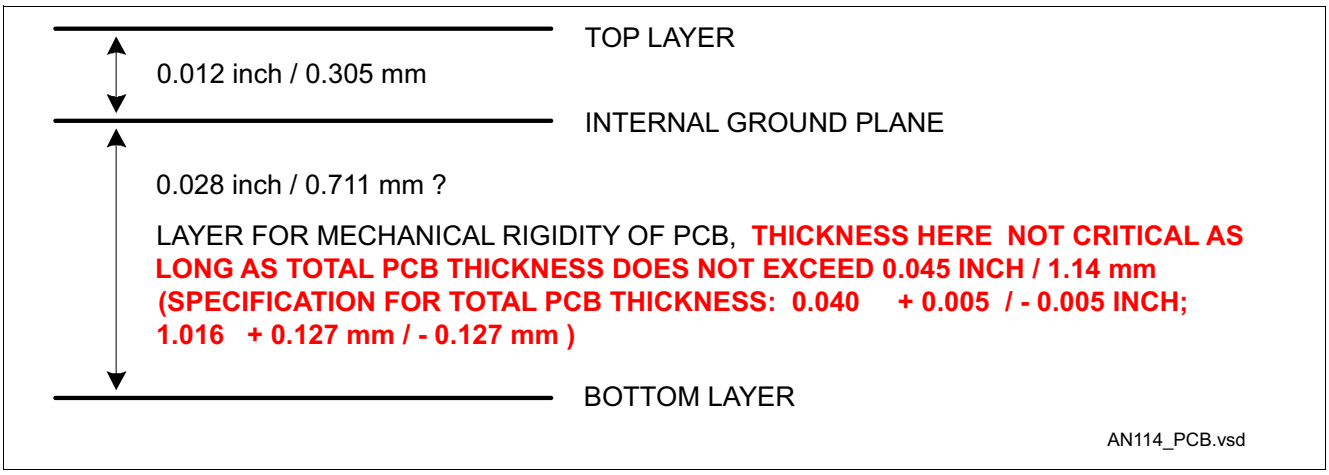


Figure 1 PCB - Cross Sectional Diagram

Schematic Diagram

Note: “0201” case size passives are used

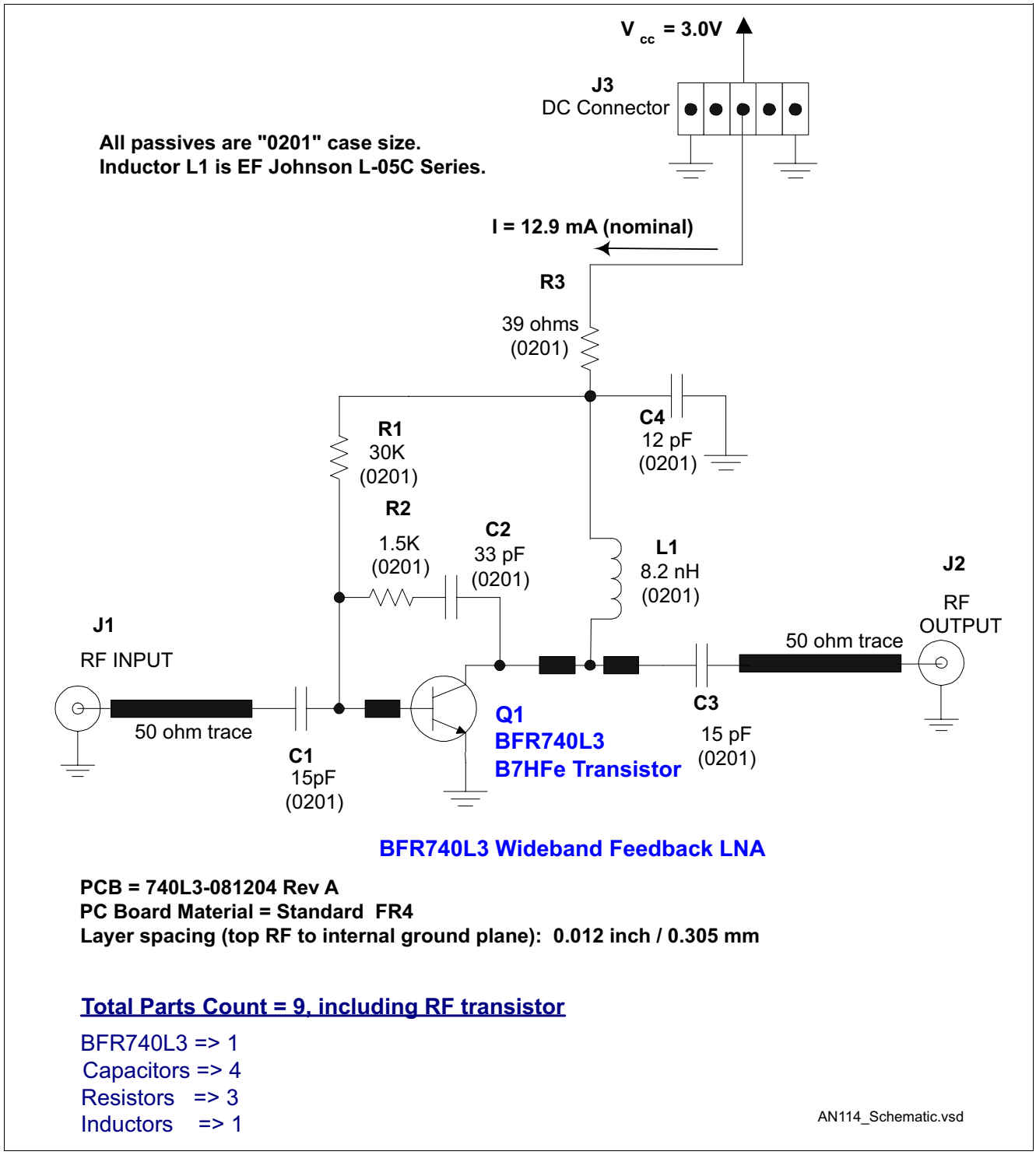


Figure 2 Schematic Diagram

Details on TSLP-3-8 Leadless Package, dimensions in millimeters (mm)

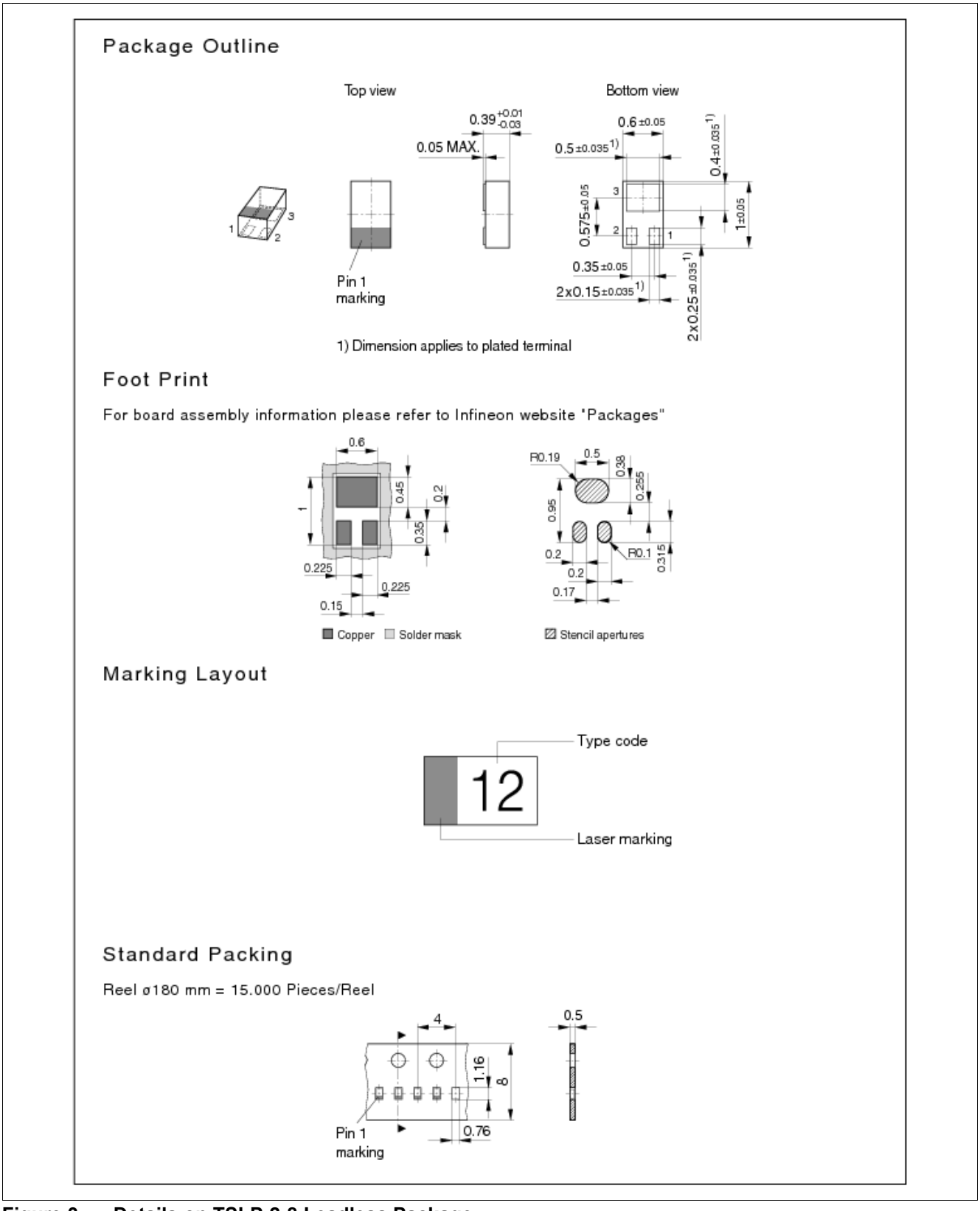


Figure 3 Details on TSLP-2-8 Leadless Package

Noise Figure, Plot, 1.4 to 2.6 GHz. Center of Plot (x-axis) is 2.0 GHz.

Rohde & Schwarz FSEK3

22 Jul 2005

Noise Figure

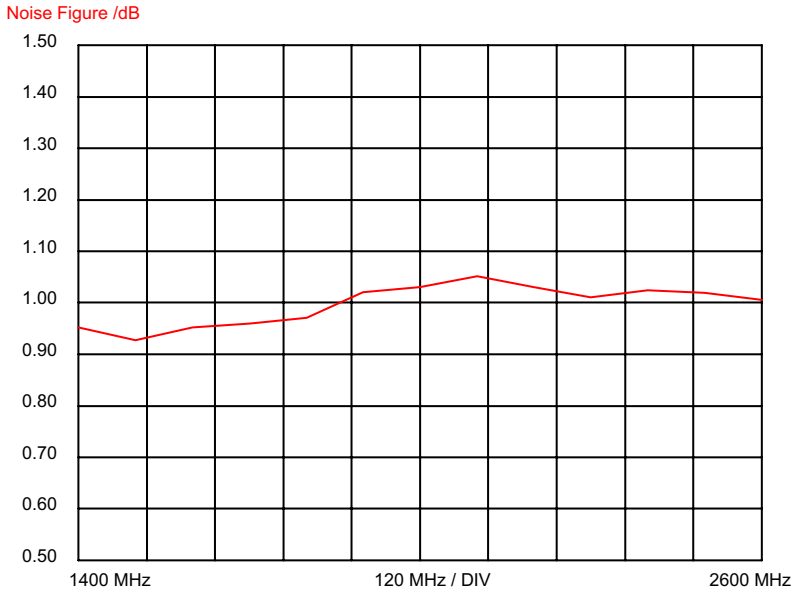
EUT Name: BFR740L3 1.7 - 2.3 GHz iBURST LNA,
Manufacturer: Infineon Technologies AG
Operating Conditions: V=3.0V, I=12.9mA, T = 25 C
Operator Name: Gerard Wevers
Test Specification: LWR SD00083 LNA P
Comment: On PCB 740L3-081204 Rev A
22 July 2005

Analyzer

RF Att: 0.00 dB RBW : 1 MHz Range: 40.00 dB
Ref Lvl: -41.00 dBm VBW : 100 Hz Ref Lvl auto: ON

Measurement

2nd stage corr: ON Mode: Direct ENR: HP346A.ENR



AN114_plot_nf.vsd

Figure 4 Noise Figure

Noise Figure, Tabular Data

From Rhode & Schwarz FSEK3 + FSEM30 + System PreAmp

Table 2 Noise Figure

Frequency	Noise Figure
1400 MHz	0.95 dB
1504 MHz	0.93 dB
1600 MHz	0.95 dB
1700 MHz	0.96 dB
1800 MHz	0.97 dB
1904 MHz	1.02 dB
2000 MHz	1.03 dB
2100 MHz	1.05 dB
2200 MHz	1.03 dB
2300 MHz	1.01 dB
2400 MHz	1.02 dB
2500 MHz	1.02 dB
2600 MHz	1.01 dB

Scanned Image of PC Board

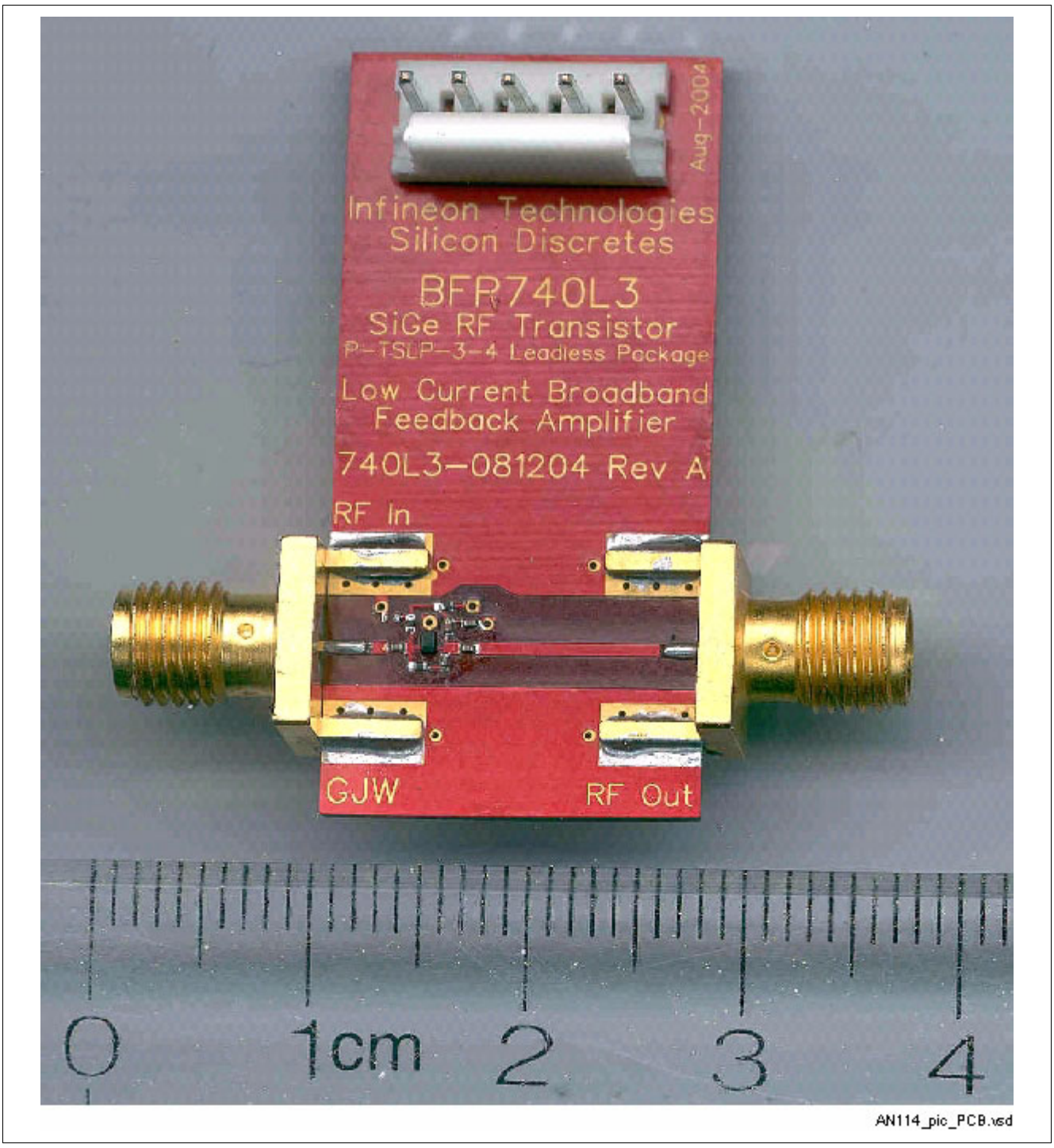


Figure 5 Image of PC Board

Scanned Image of PC Board, Close-In Shot

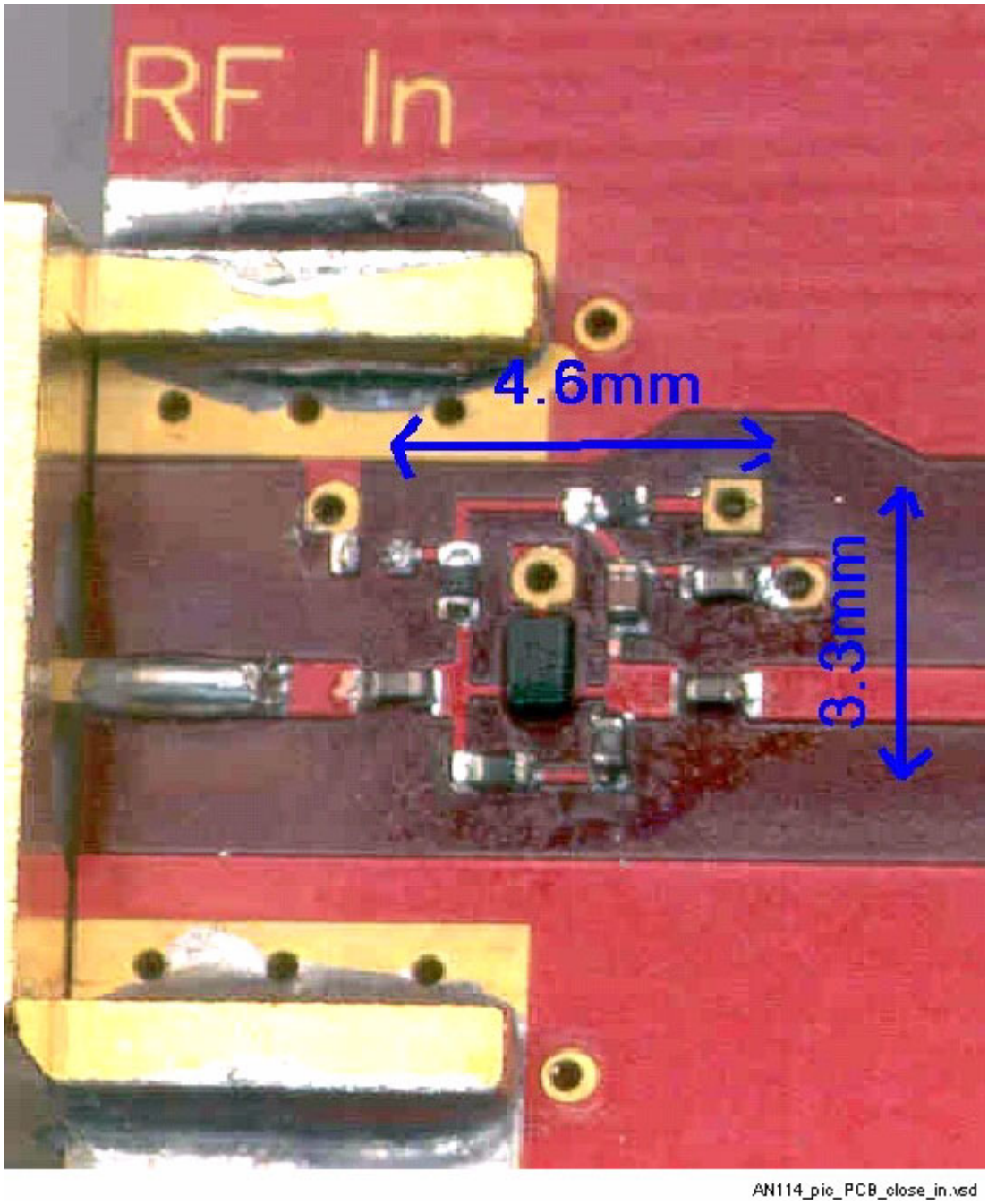


Figure 6 Image of PC Board, Close-In Shot

Gain Compression at 3.5 GHz

Amplifier is checked for 1 dB compression point at V_{CC} = 3.0 V, I_C = 12.9 mA (with V_{CE} = 2.5 V). An Agilent power meter was used to ensure accurate power levels are measured (as opposed to using Vector Network Analyzer in "Power Sweep" mode).
Output $P_{1dB} \cong$ +6.3 dBm; Input P_{1dB} = +6.3 dBm - (Gain - 1 dB) = +6.3 dBm -16.3 dB = -10.0 dBm

Table 3 Gain Compression

P_{OUT}, dBm	Gain, dB
-7.0	17.3
-6.0	17.3
-5.0	17.3
-4.0	17.3
-3.0	17.3
-2.0	17.3
-1.0	17.3
0.0	17.3
+1.0	17.2
+2.0	17.2
+3.0	17.1
+4.0	17.0
+5.0	16.9
+6.0	16.5
+7.0	15.8

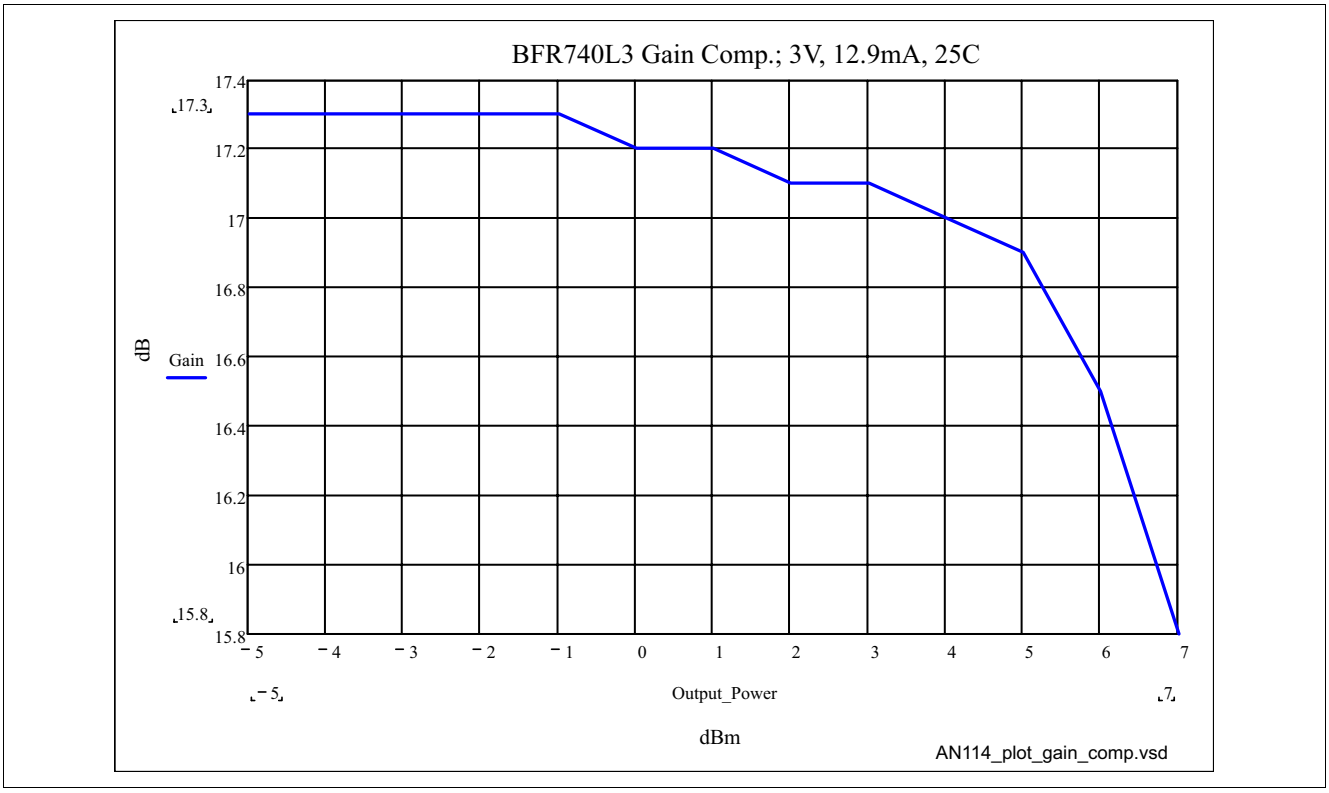


Figure 7 Gain Compression at 3.5 GHz

Stability

Rohde and Schwarz ZVC Network Analyzer calculates and plots Stability Factor "K" in real time, from 5 MHz to 8 GHz.
Note K>1 from 5 MHz to 8 GHz. Amplifier is Unconditionally Stable over 5 MHz - 8 GHz frequency range

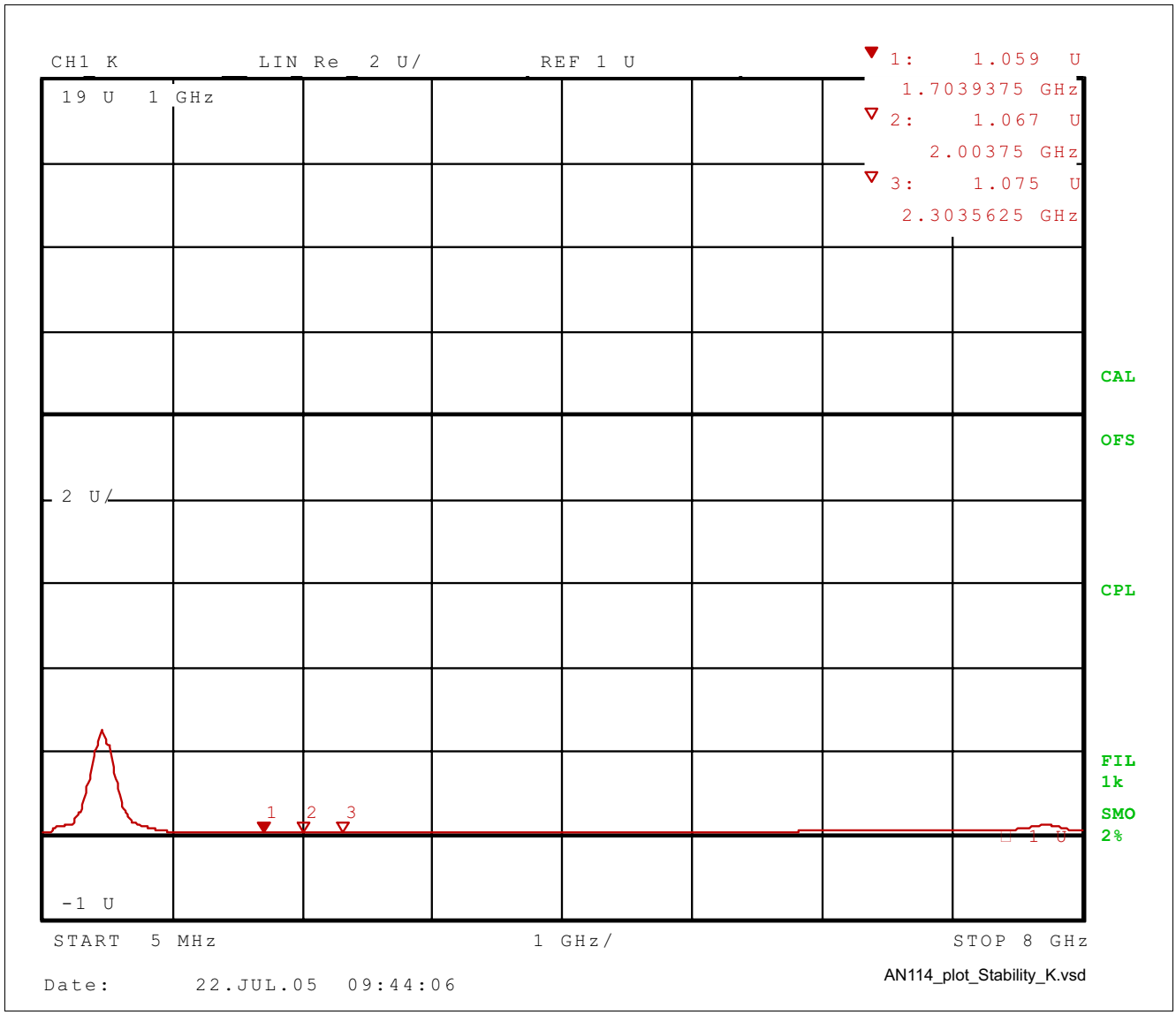


Figure 8 Plot of K(f)

Note: All plots are from Rohde and Schwart ZVC Network Analyzer, T = 25 °C, Source Power ≅ -30 dBm, V_{CC} = 3.0 V, I = 12.9 mA

Input Return Loss, Log Mag

5 MHz to 8 GHz Sweep

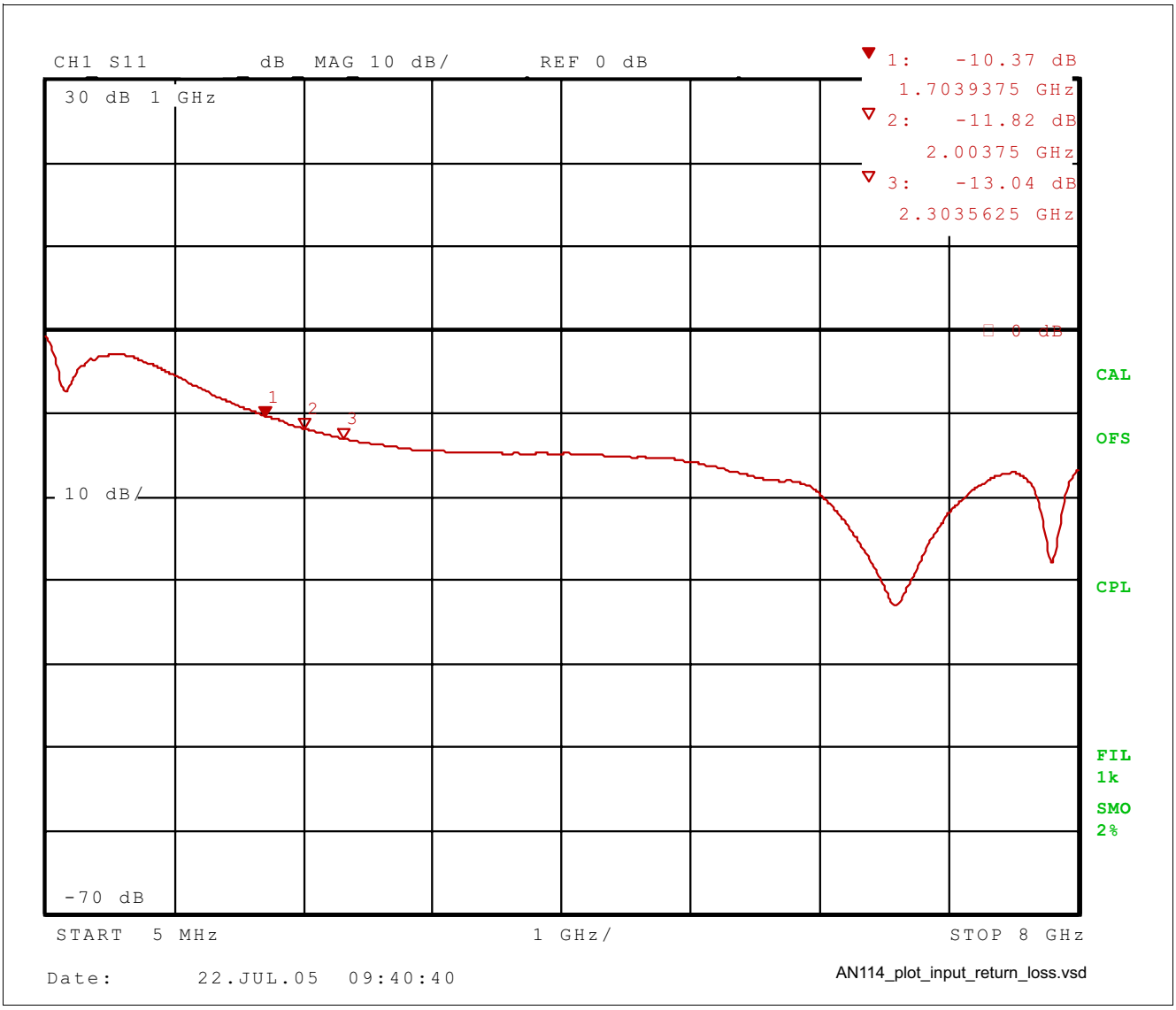


Figure 9 Plot of Input Return Loss

Input Return Loss, Smith Chart

Reference Plane = Input SMA Connector on PC Board
5 MHz to 8 GHz Sweep

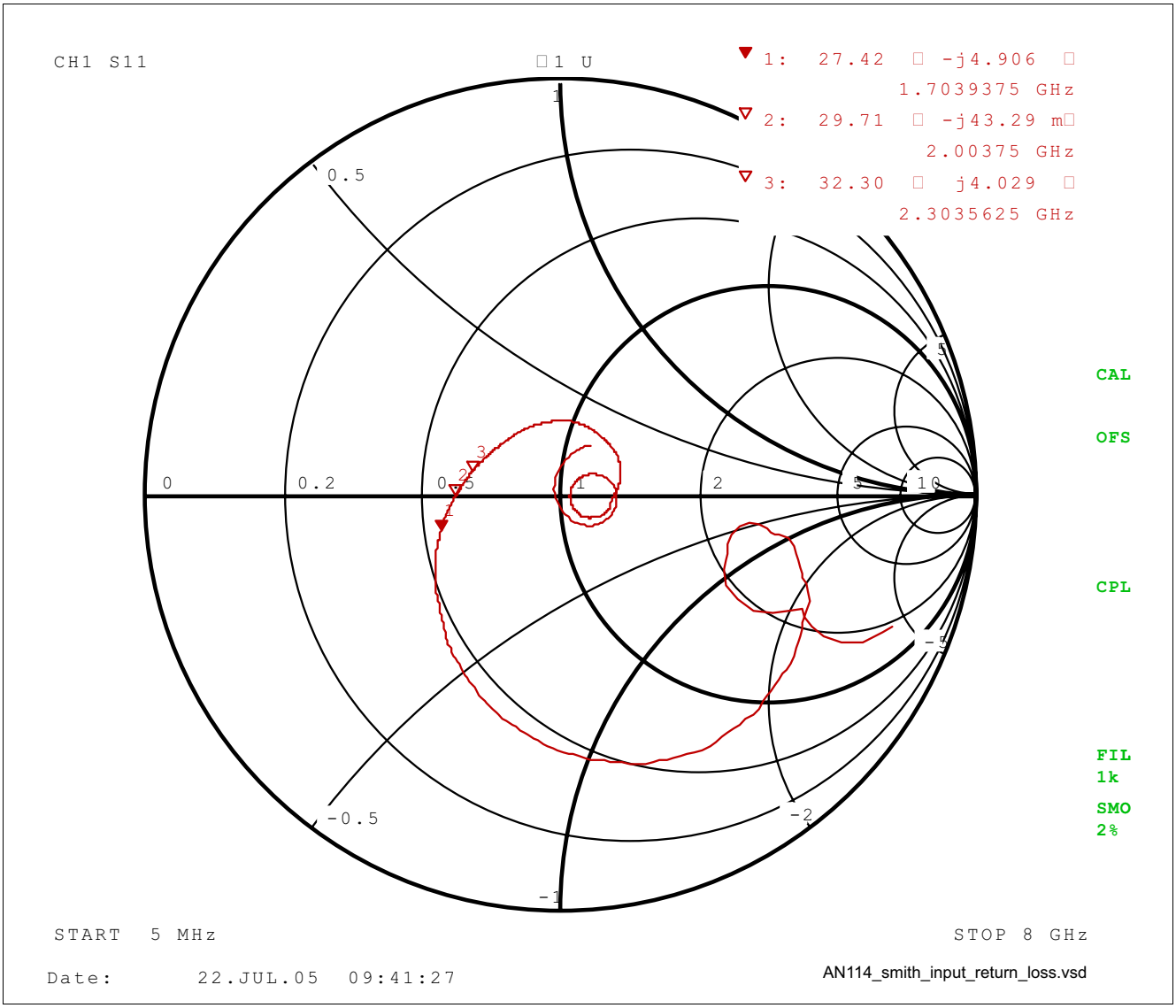


Figure 10 Smith Chart of Input Return Loss

Forward Gain, Wide Sweep

5 MHz to 8 GHz Sweep

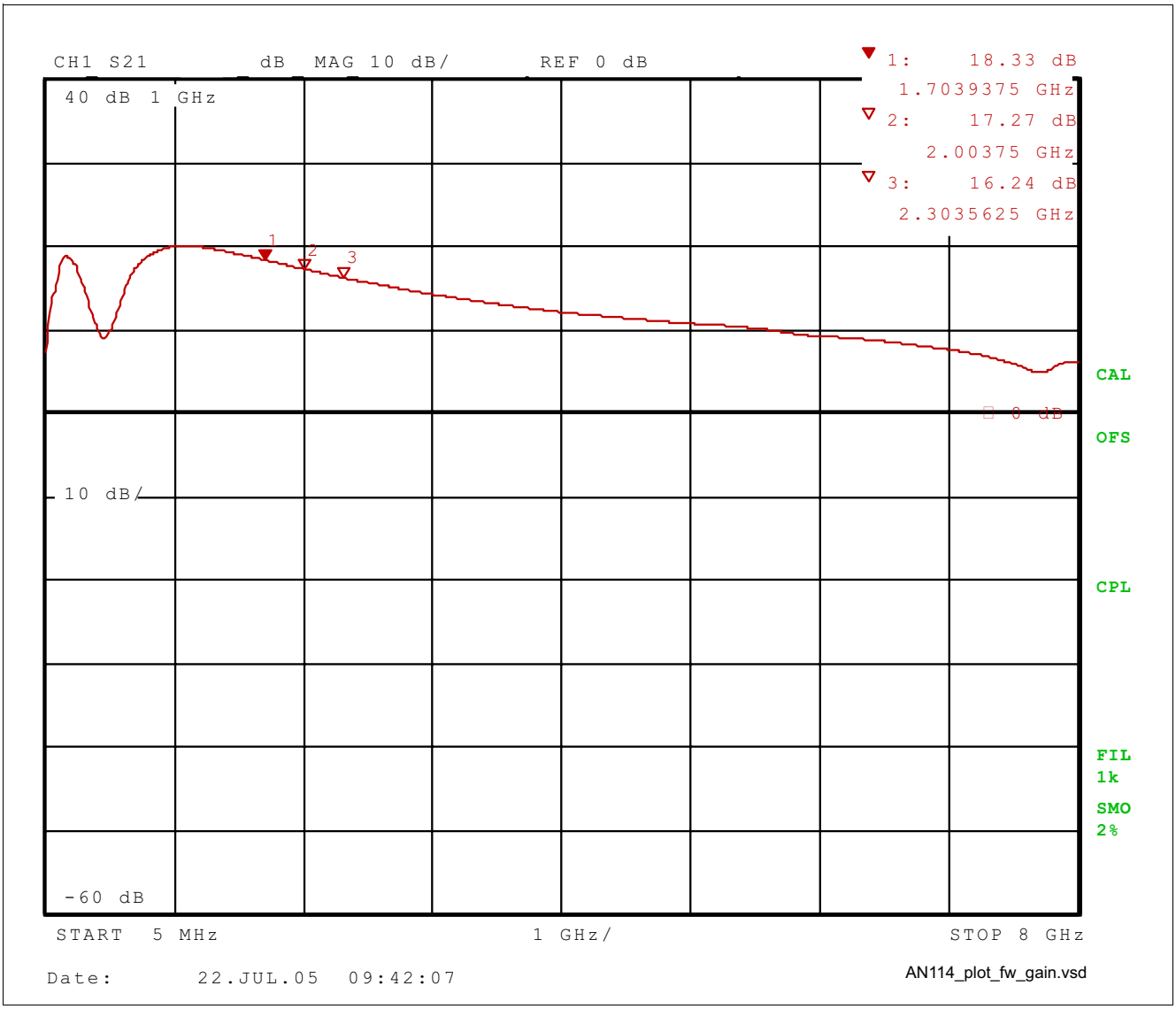


Figure 11 Plot of Forward Gain

Reverse Isolation

5 MHz to 8 GHz

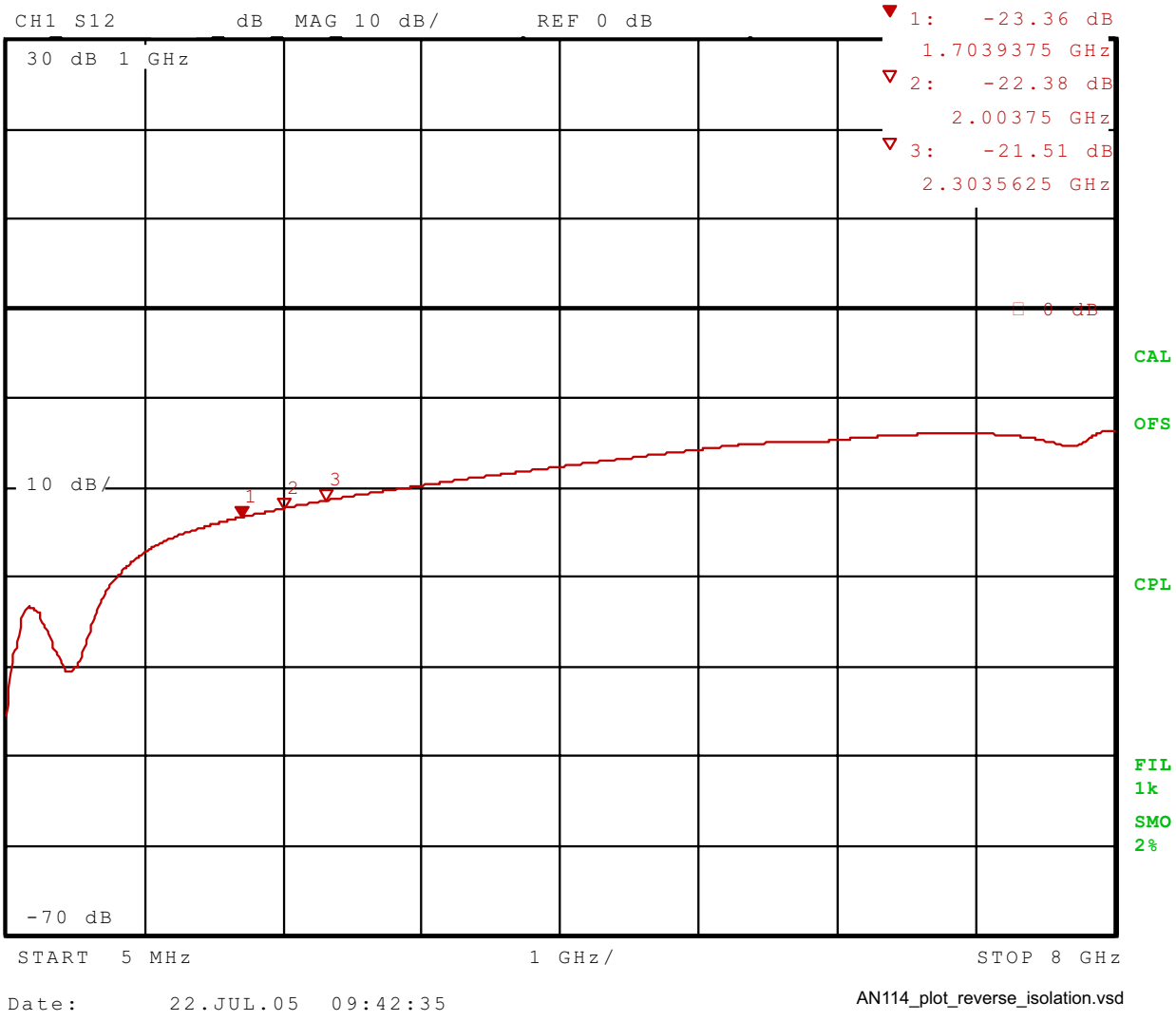


Figure 12 Plot of Reverse Isolation

Output Return Loss, Log Mag

5 MHz to 8 GHz

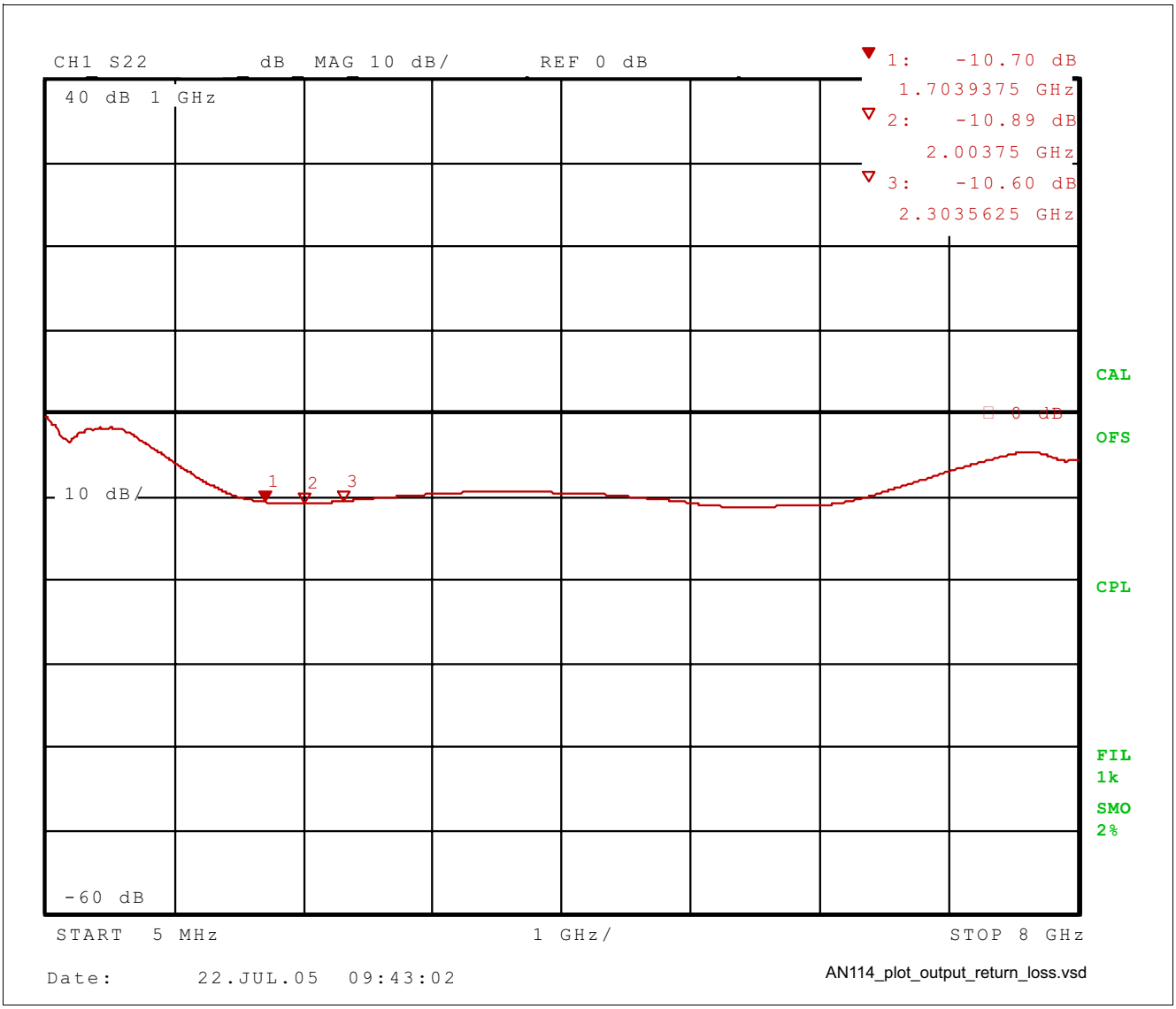


Figure 13 Plot of Output Return Loss

Output Return Loss, Smith Chart

Reference Plane = Output SMA Connector on PC Board
5 MHz to 8 GHz Sweep

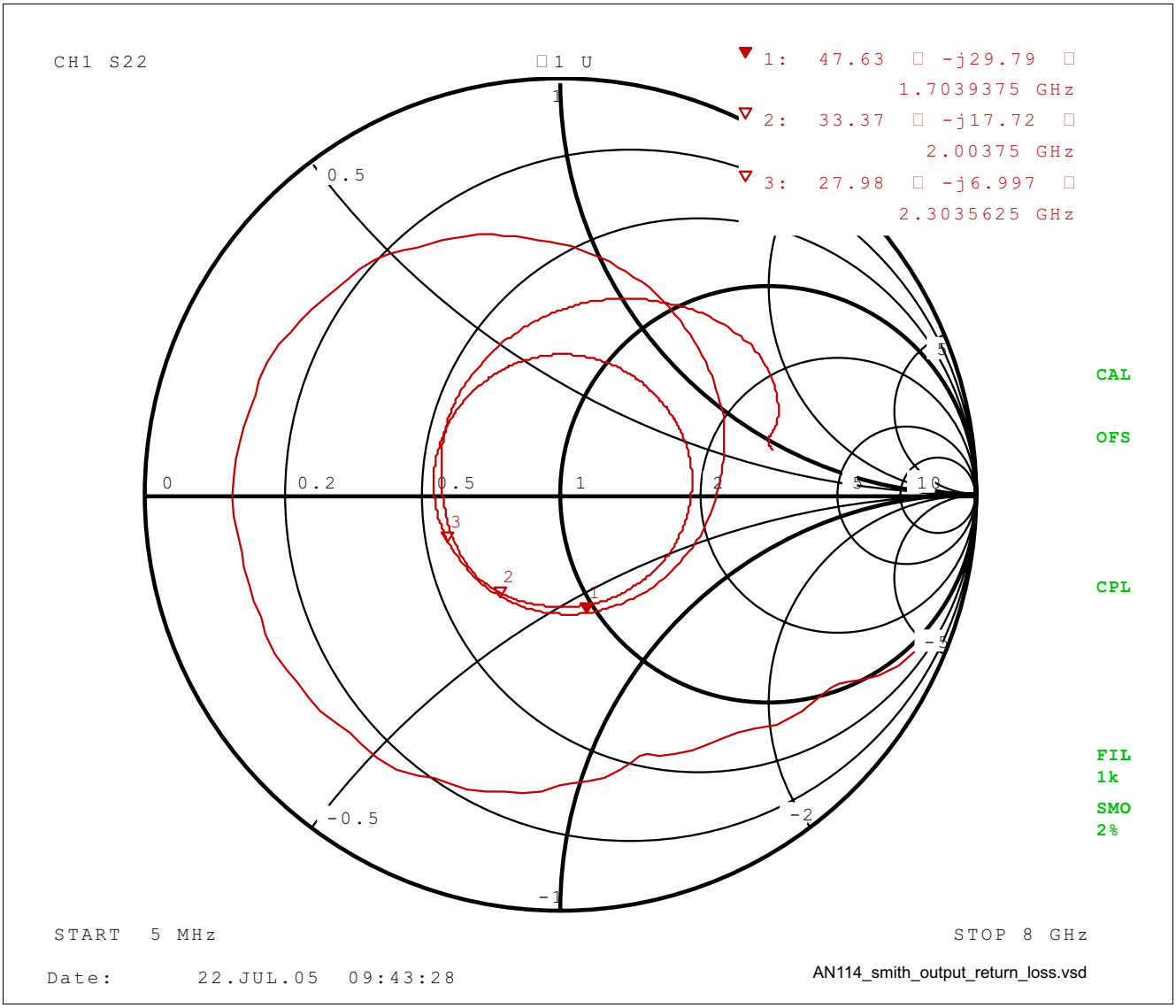


Figure 14 Smith Chart of Output Return Loss

Two-Tone Test, 2.0 GHz

Input Stimulus for Amplifier Two-Tone Test
f_1 = 2000 MHz, f_2 = 2001 MHz, -23 dBm each tone
Input IP_3 = -23 + (46.5 / 2) = +0.3 dBm
Output IP_3 = +0.3 dBm + 17.3 dB gain = +17.6 dBm

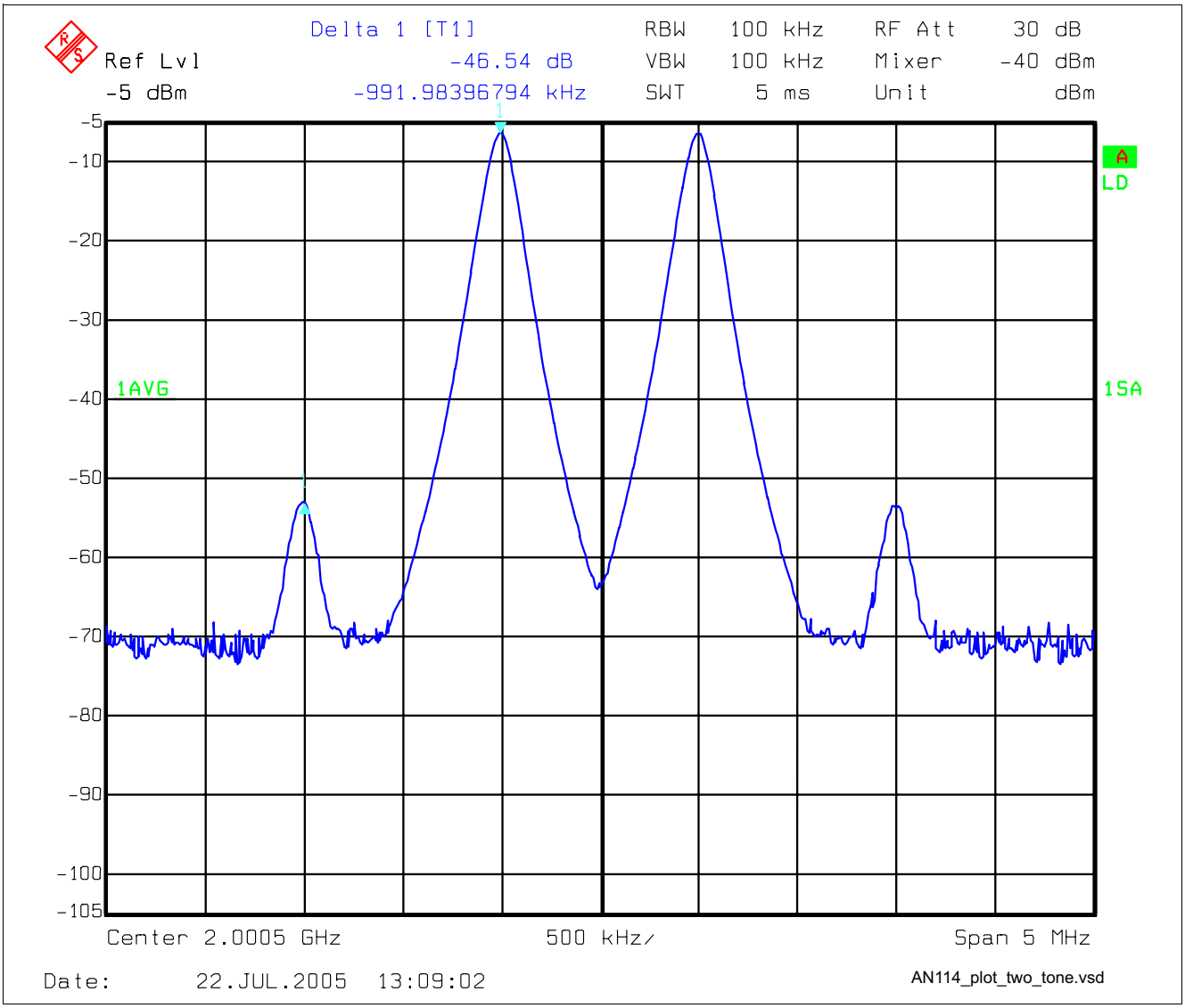


Figure 15 Tow-Tone Test