



Comparison of 50 Ohm Power Sweeps with LSNA & PNA

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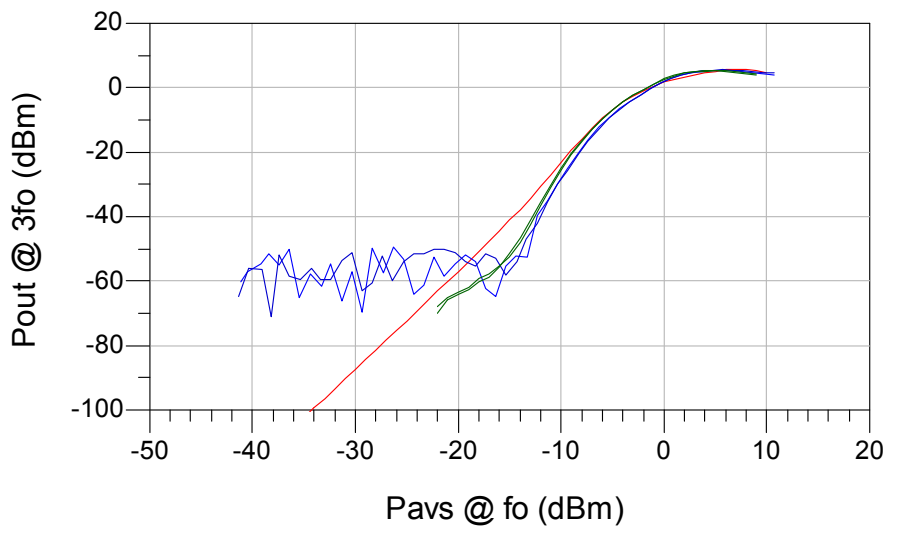
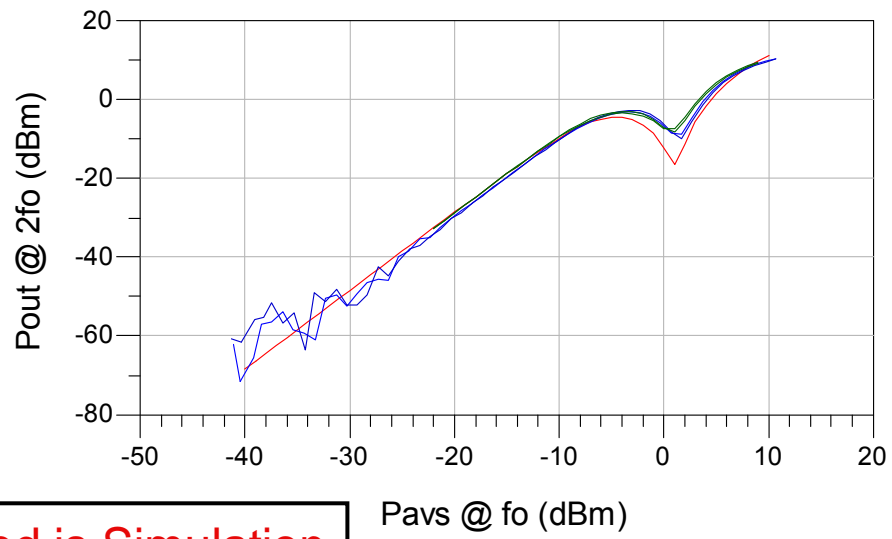
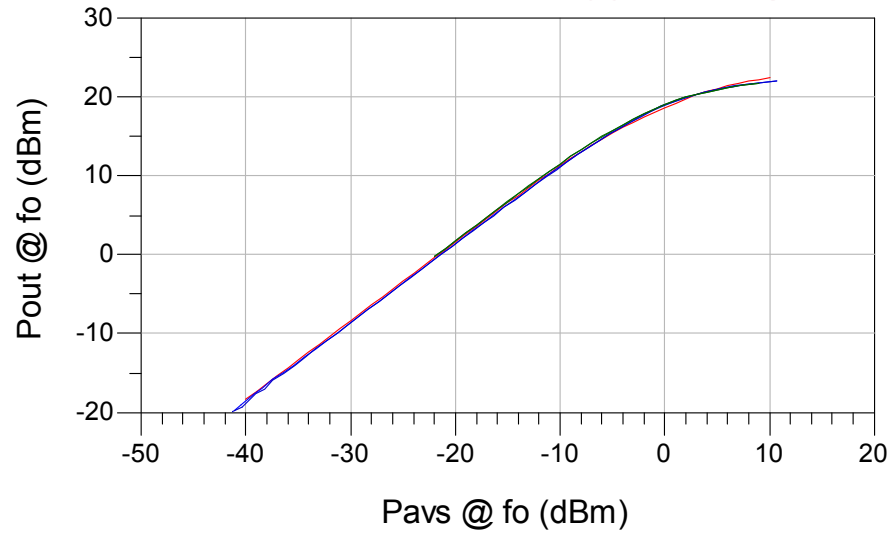
Introduction

- **RFMD purchased a Maury MT4463A LSNA to support various modeling and characterization needs.**
- **In talking to Kate Remley of NIST, she mentioned a project where she was comparing power measurements from several different groups.**
- **We at RFMD decided to do a similar thing and compare 50 Ohm power sweep measurements taken with our LSNA and with a PNA test stand and compare those to our large-signal model.**

Test Conditions & Outputs

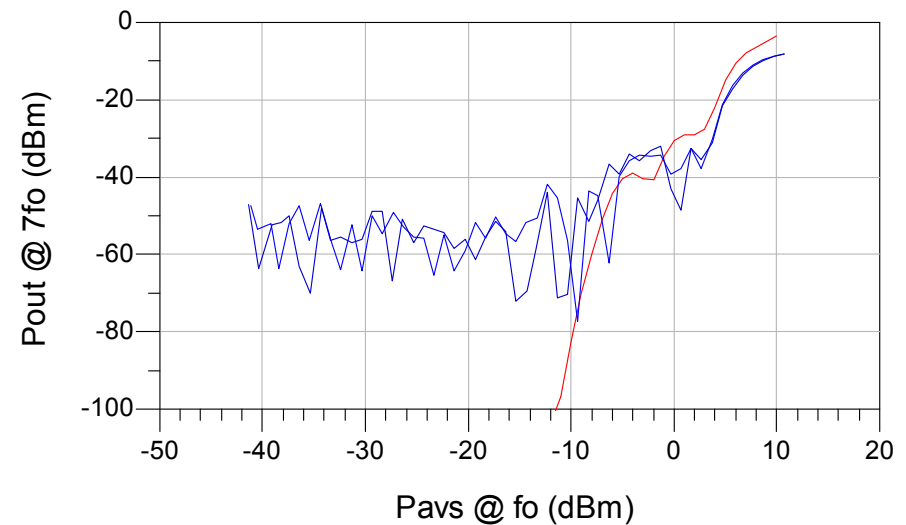
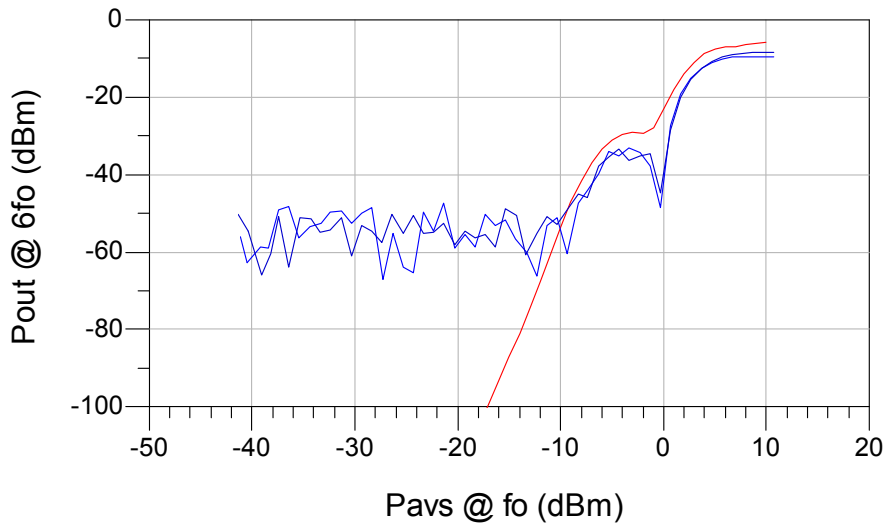
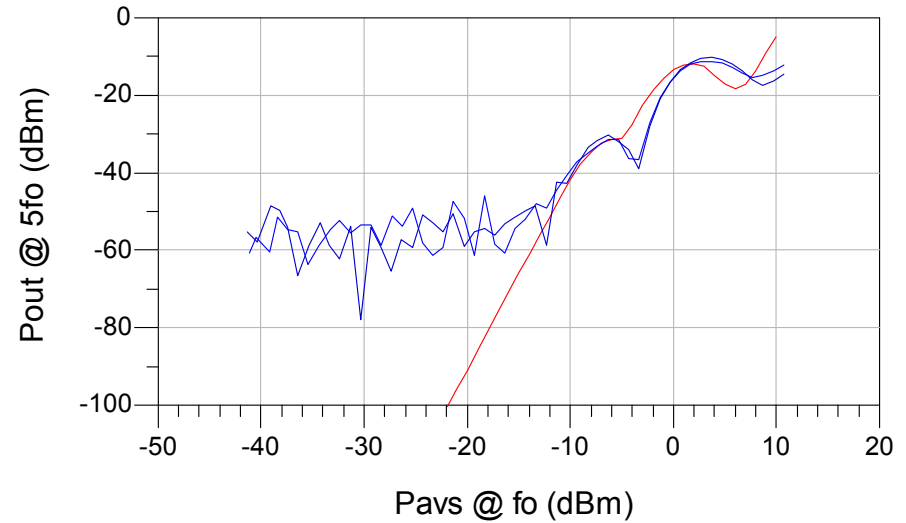
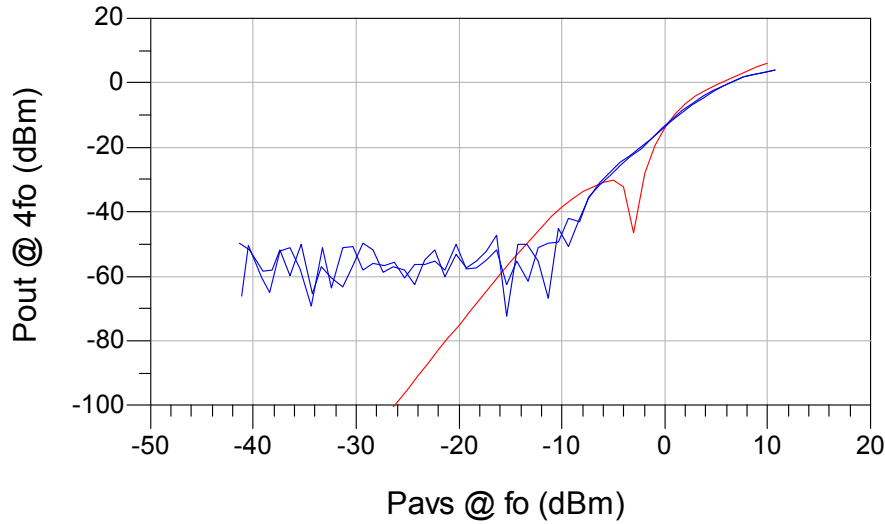
- **Device: Production RFMD GaAs HBT**
(Same two devices measured on both stands)
 - $V_c = 3.5 \text{ V}$
 - $I_{cq} = 20 \text{ mA}$
 - Bias provided by E5270 parameter analyzer with a 315 ohm series resistor in base line.
- **RF Input at 1800 MHz**
 - LSNA & Simulation: -40 to +10 dBm
 - PNA: -22 to +9 dBm
- **Source & Load set as closely to 50 ohms as possible**
- **Outputs**
 - LSNA: Voltage and current waveforms to 7th harmonic
 - PNA: Vector transmission and reflection and Scalar 2nd & 3rd harmonic power
 - Simulation: Voltage and current waveforms to 11th harmonic

Pout at Fund., 2nd, & 3rd Harmonics



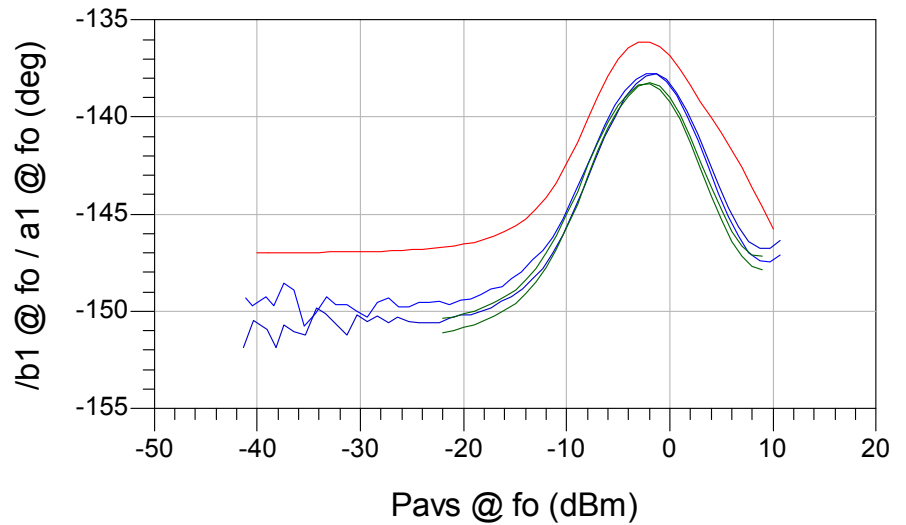
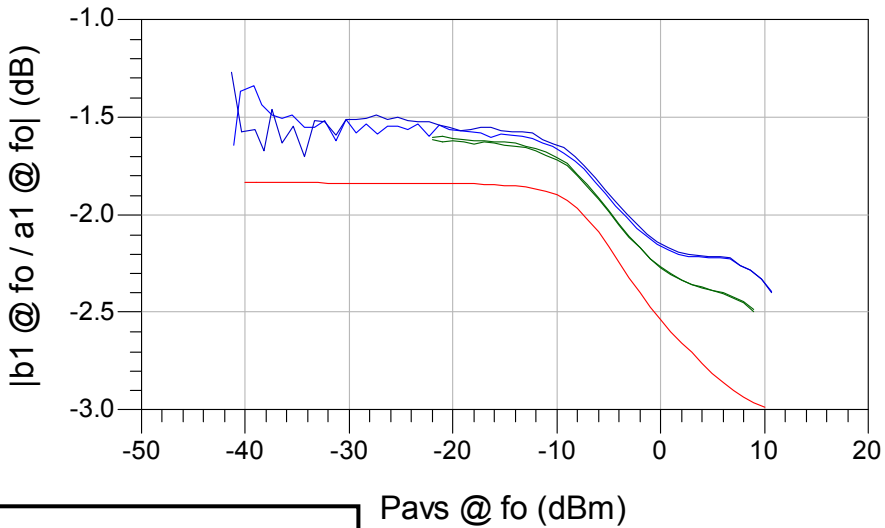
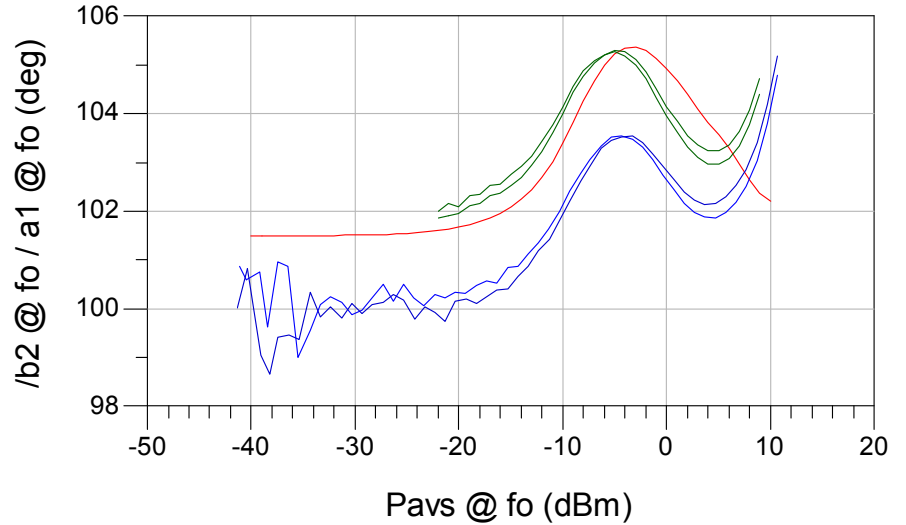
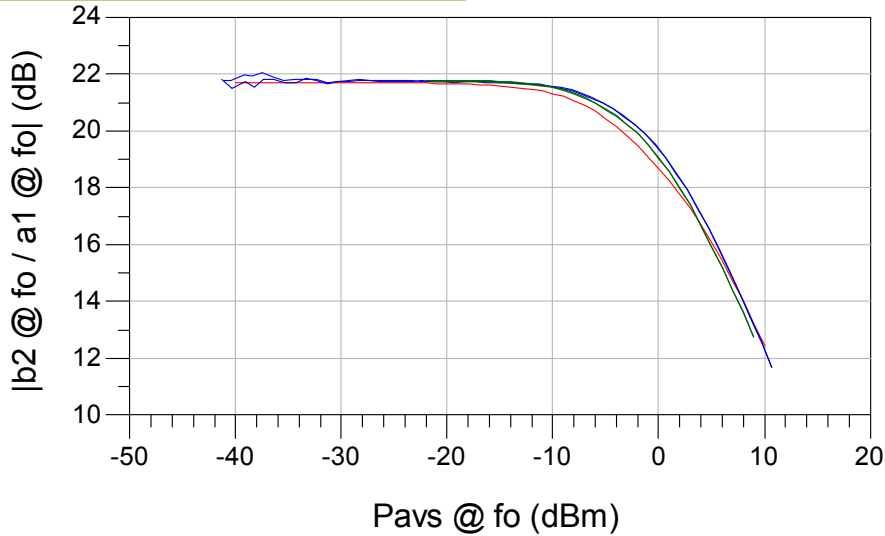
Red is Simulation
 Blue is LSNA
 Green is PNA

4th, 5th, 6th, & 7th Harmonics



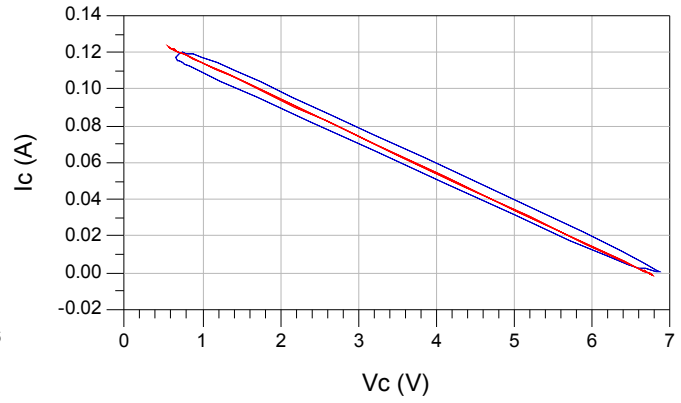
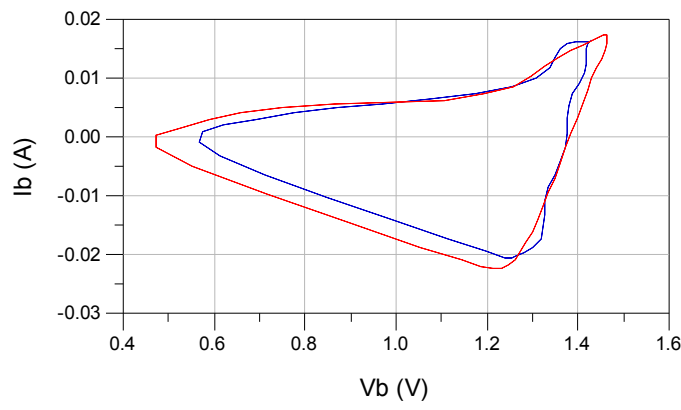
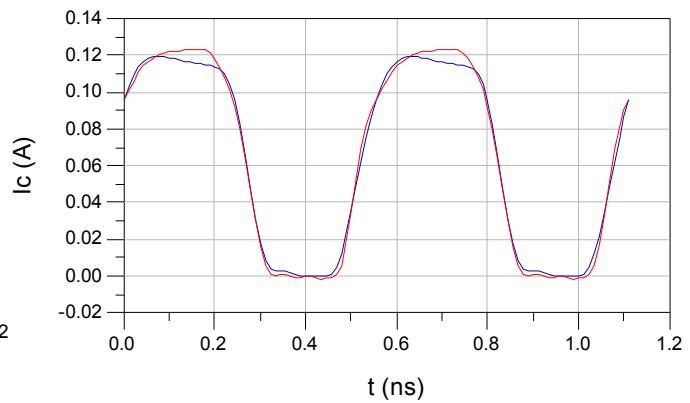
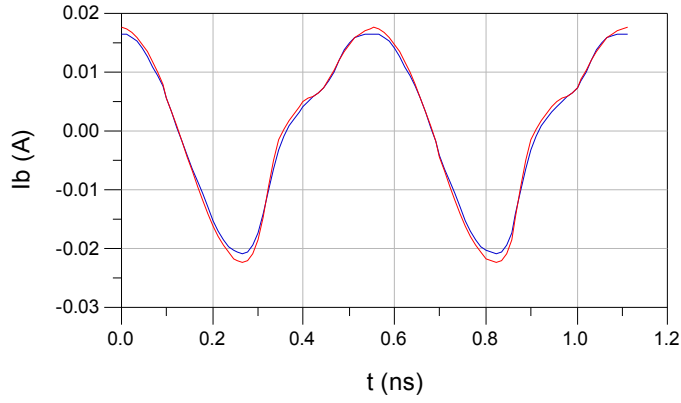
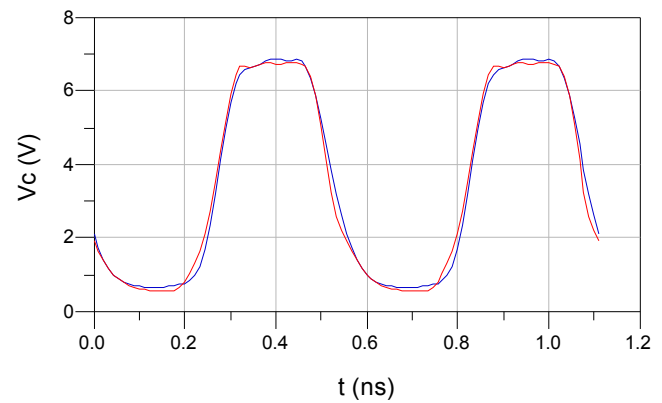
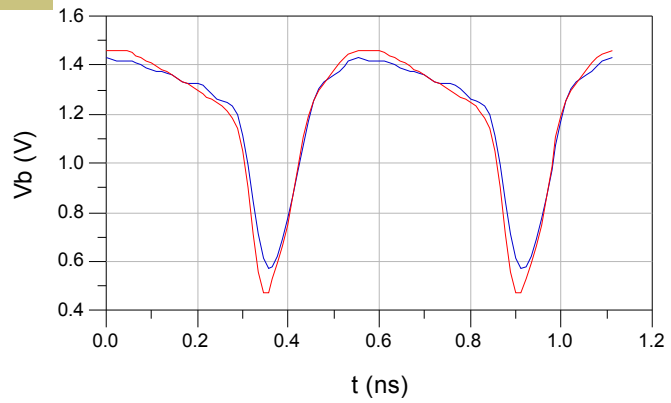
Red is Simulation
 Blue is LSNA

“S21” & “S11” at fo



Red is Simulation
Blue is LSNA
Green is PNA

Waveforms at Pavs = +5 dBm



Red is Simulation
 Blue is LSNA



Conclusions

- **The LSNA measurements, PNA measurements, and simulations show fairly good agreement over device operating range.**
- **The LSNA provides additional information that is unavailable from conventional measurements.**
- **What have other users done to cross-check their systems?**

RFMD

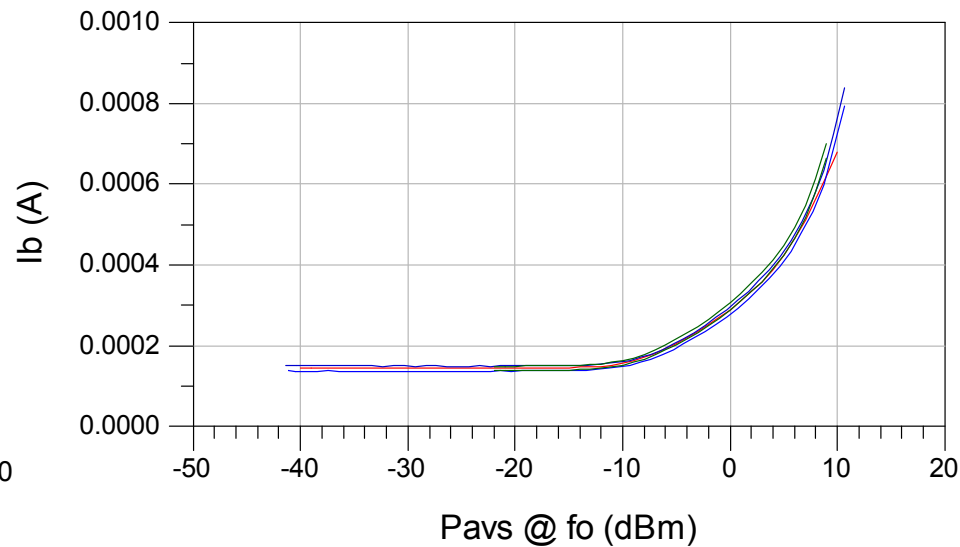
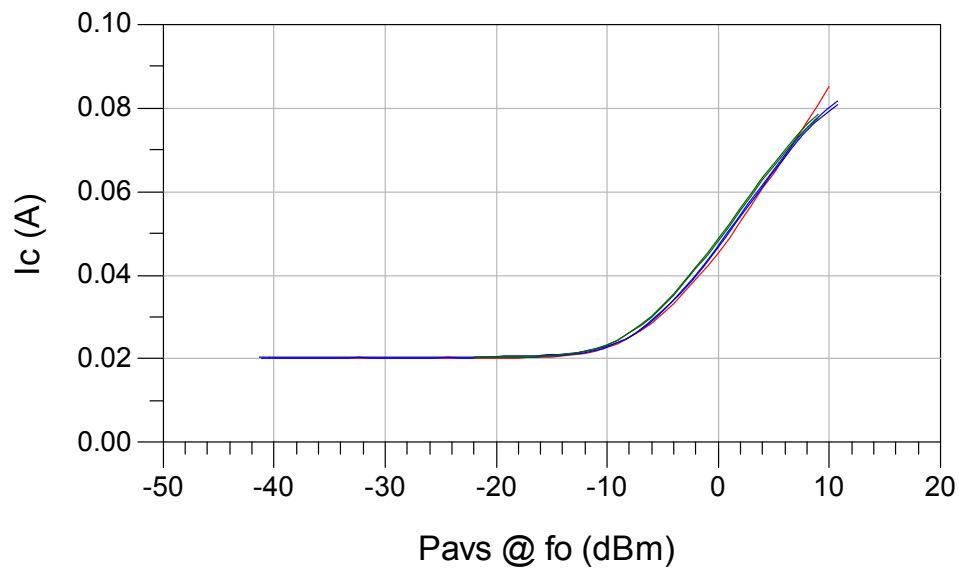


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Back-Up Slides

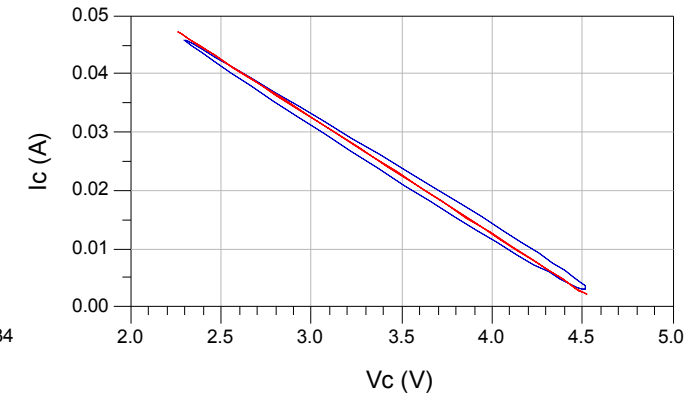
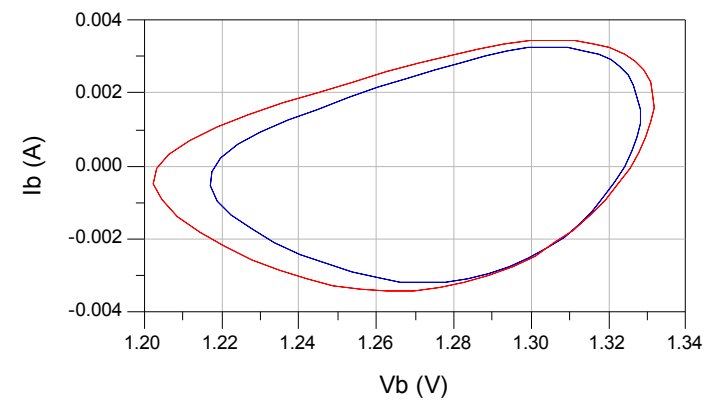
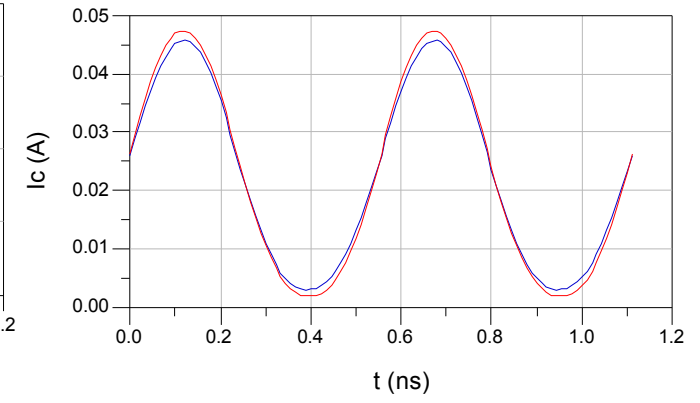
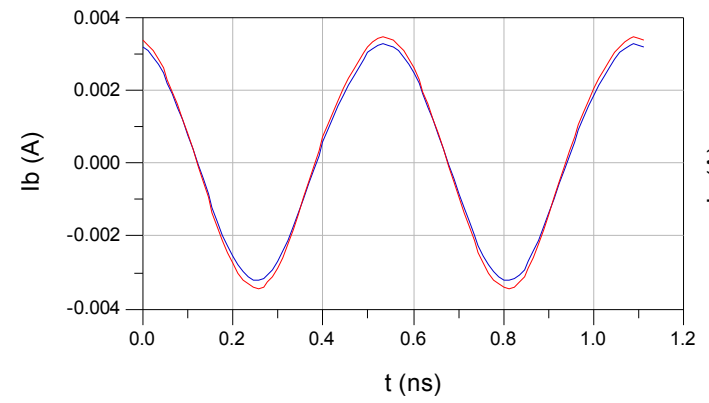
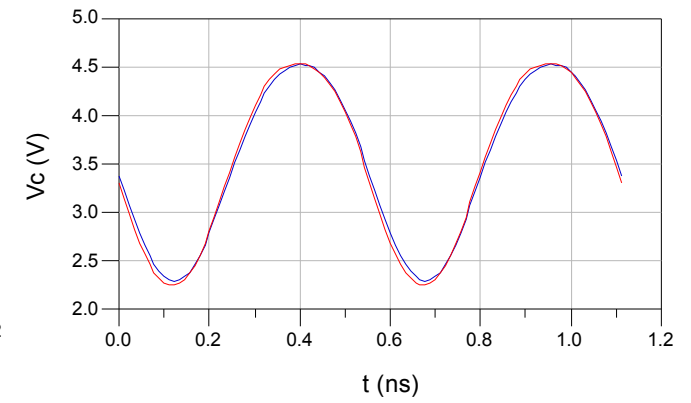
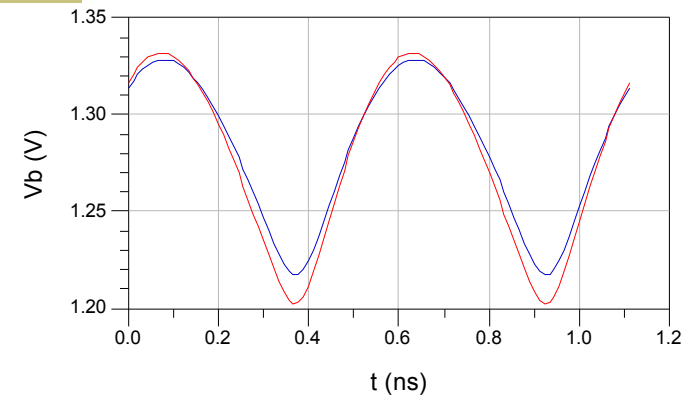


Ic & Ib



Red is Simulation
 Blue is LSNA
 Green is PNA

Waveforms at Pavs = -10 dBm



Red is Simulation
 Blue is LSNA



Terminations

index	LSNA_S2	stoz(LSNA_S2)
1.800 GHz	0.073 / -62.602	52.998 - j6.867
3.600 GHz	0.070 / -9.463	57.413 - j1.330
5.400 GHz	0.135 / -60.100	55.568 - j13.297
7.200 GHz	0.122 / -73.667	52.055 - j12.422
9.000 GHz	0.126 / 67.900	53.416 + j12.622
10.80 GHz	0.151 / -26.198	64.946 - j8.837
12.60 GHz	0.128 / 172.460	38.718 + j1.322

index	PNA_S	stoz(PNA_S)
1.800 GHz	0.043 / -167.660	45.944 - j0.850
3.600 GHz	0.085 / 7.199	59.247 + j1.278
5.400 GHz	0.044 / -160.079	45.984 - j1.390
7.200 GHz	0.023 / 8.472	52.333 + j0.356
9.000 GHz	0.095 / -76.182	51.416 - j9.540
10.80 GHz	0.040 / -136.015	47.115 - j2.637
12.60 GHz	0.135 / -156.569	38.760 - j4.245
14.40 GHz	0.153 / 135.190	39.338 + j8.709
16.20 GHz	0.197 / -4.735	74.435 - j2.524
18.00 GHz	0.031 / 88.364	49.994 + j3.062
19.80 GHz	0.213 / -27.449	71.492 - j14.683

index	LSNA_L	stoz(LSNA_L)
1.800 GHz	0.037 / -57.851	51.927 - j3.298
3.600 GHz	0.050 / 104.917	48.498 + j4.718
5.400 GHz	0.023 / -126.880	48.599 - j1.798
7.200 GHz	0.045 / -100.667	48.989 - j4.323
9.000 GHz	0.092 / 55.927	54.752 + j8.404
10.80 GHz	0.035 / -7.593	53.609 - j0.499
12.60 GHz	0.084 / -151.078	43.034 - j3.513

index	PNA_L	stoz(PNA_L)
1.800 GHz	0.028 / -55.399	51.565 - j2.386
3.600 GHz	0.052 / 23.053	54.936 + j2.226
5.400 GHz	0.024 / -67.051	50.892 - j2.245
7.200 GHz	0.043 / 75.837	50.882 + j4.237
9.000 GHz	0.008 / 60.619	50.382 + j0.689
10.80 GHz	0.044 / -111.572	48.240 - j3.974
12.60 GHz	0.069 / -113.005	47.010 - j5.988
14.40 GHz	0.051 / -24.734	54.775 - j2.330
16.20 GHz	0.068 / 44.636	54.818 + j5.260
18.00 GHz	0.060 / 111.632	47.535 + j5.343
19.80 GHz	0.148 / 90.987	47.612 + j14.429