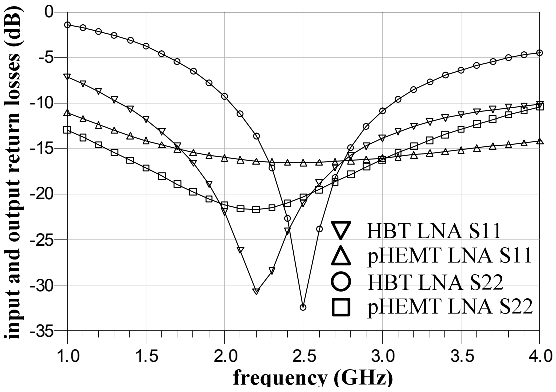
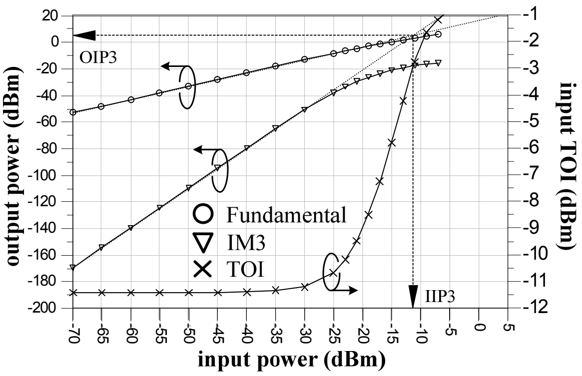
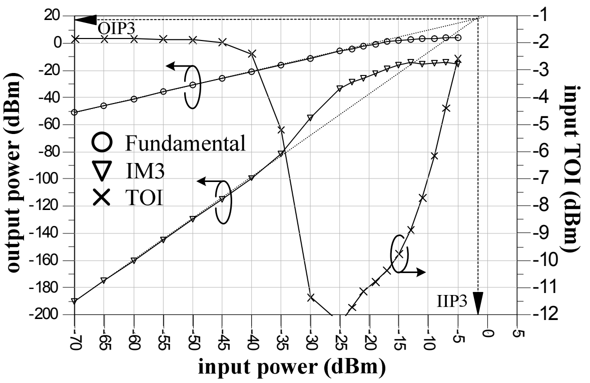


Fig. 5. LNA's simulated input and output return losses



(*a*)



(*b*)

Fig. 6. simulated linearity and input-referred intercept point for (*a*) HBT LNA and (*b*) pHEMT LNA

IV. Conclusion

A 2.4-GHz cascode LNA was designed and simulated in 0.2-µm GaAs Pseudomorphic HEMT process and 0.35-µm HBT SiGe BiCMOS process as a case of comparison between these two popular technologies. As illustrated, the pHEMT LNA consumes a DC current two times more than the HBT LNA to present the identical gain; but it gave the benefits of lower noise figure and wider matching band. Both LNAs presented an identical linearity, but the third-order intermodulation component grew sooner in pHEMT LNA than the one in HBT LNA. As a result, the SiGe HBT process shows a perfect narrow-band characteristics and GaAs pHEMT is a proper choice for broadband and low-noise component designs. The HBT LNA and pHEMT LNA parameters are summarized in the table 1 to simplify the comparison.

TABLE I. Performance Summary

Parameters	**Technology**	
	GaAs pHEMT LNA	***SiGe HBT LNA***
Gain (dB)	16.6	19.2
NF (dB)	1.00	1.62
S_{11} (dB)	< -16.5	< -20.3
S_{22} (dB)	< -20.6	< -22.6
S_{12} (dB)	-22.5	-25
ICP_{1dB} (dBm)	-19	-17
IIP3(dBm)	-11.4	-1.88
Current (mA)	28	14
Supply Voltage (V)	3	
Frequency (GHz)	2.4 ~ 2.5	
1-dB Gain BW (GHz)	> 3	> 1.5
Matching BW (GHZ) [S_{11} < -10]	> 6.8	> 2.6
Matching BW (GHZ) [S_{22} < -10]	> 3.4	> 1

References

[1] Behzad Razavi, RF Microelectronics (Prentice Hall PTR, 1998).

[2] E. C. Niehenke, R. A. Pucel, I. J. Bahl, Microwave and Millimeter-Wave Integrated Circuits, IEEE Trans. Microwave Theory Tech., vol. 50, March 2002, pp. 846 – 857.

[3] H. Morkoc, Semiconductor with Strained InGaAs Layer, U.S. Patent No.4,827,320, May 2, 1989.

[4] T. Whitaker, IEDM Highlights Include SiGe HBTs Operating at 350 GHz, Compound Semiconductor Magazine, Institute of Physics Publishing Ltd., London, January 2003; available at http://www.compoundsemiconductor.net/articles/magazine/9/1/2/1

[5] Chris Bowick, RF Circuit Design (Newnes, 2007).

[6] Steve Marsh, Practical MMIC Design (Artech House, 2006).

[7] J. Laskar, B. Matinpour, S. Chakraborty, Modern Receiver Front-Ends (Wiley Interscience, 2004).

[8] Thomas H. Lee, The Design Of CMOS Radio-Frequency Integrated Circuits (Cambridge University Press, 1998).

[9] I. Bahl, P. Bhartia, Microwave Solid State Circuit Design (Wiley-Interscience, 2003).