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A.	B. G. Perumana et al, "Resistive-Feedback CMOS Low-Noise Amplifiers for Multiband Applications," IEEE Transactions on Microwave Theory and Techniques, Vol. 56, Issue, May 2008.

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11. B. G. Perumana et al, "Resistive-Feedback CMOS Low-Noise Amplifiers for Multiband Applications" was published in IEEE Transactions on Microwave Theory

and Techniques, Vol. 56, Issue 5. IEEE Transactions on Microwave Theory and Techniques, Vol. 56, Issue 5 was published in May 2008. Copies of this publication were made available no later than the last day of the publication month. The article is currently available for public download from the IEEE digital library, IEEE Xplore.

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Executed on: 5 November 2018

ATTACHMENT A

Resistive-Feedback CMOS Low-Noise Amplifiers for Multiband Applications

5 Author(s) Bevin G. Perumana ; Jing-Hong C. Zhan ; Stewart S. Taylor ; Brent R. Carlton ; Joy Laskar View All Authors

Abstract:
Extremely compact resistive-feedback CMOS low-noise amplifiers (LNAs) are presented as a cost-effective alternative to multiple narrowband LNAs using high-*Q* inductors for multiband wireless applications. Limited linearity and high power consumption of the inductorless resistive-feedback LNAs are analyzed and circuit techniques are proposed to solve these issues. A 12-mW resistive-feedback LNA, based on current-reuse transconductance boosting is presented with a gain of 21 dB and a noise figure (NF) of 2.6 dB at 5 GHz. The LNA achieves an output third-order intercept point (IP3) of 12.3 dBm at 5 GHz by reducing loop-gain rolloff and by improving linearity of individual stages. The active die area of the LNA is only 0.012 mm^2. A 9.2-mW tuned resistive-feedback LNA utilizing a single compact low-*Q* on-chip inductor is presented, showing an improved tradeoff between performance, power consumption, and die area. At 5.5 GHz, the fully integrated LNA achieves a measured gain of 24 dB, an NF of 2 dB, and an output IP3 of 21.5 dBm. The LNA draws 7.7 mA from the 1.2-V supply and has a 3-dB bandwidth of 3.94 GHz (4.04-7.98 GHz). The LNA occupies a die area of 0.022 mm^2. Both LNAs are implemented in a 90-nm CMOS process and do not require any costly RF enhancement options.

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SECTION I.
Introduction

Low-Noise Amplifiers (LNAs) occupy a significant percentage of the total die area in wireless front-ends today. This is because the performance of the LNA is dependent on the Q's of the multiple on-chip inductors. Since the area requirement of high-Q on-chip inductors is high, the die area occupied by the LNA is also high. Often, costly process steps are required to enhance the Q of the

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inductive source degeneration [1], the predominant LNA implementation used in CMOS wireless front-ends, require three high-Q inductors for achieving input impedance matching, high gain, and low noise figure (NF). in spite of the high die area requirements, cascode LNAs have been used extensively in narrowband wireless applications because they provide high gain, low noise, and high linearity at relatively low power consumption. with the advent of multiple-input multiple-output (MIMO), multistandard, and multiband wireless systems; however, the use of the area intensive cascode LNAs is becoming increasingly expensive, leading to the pursuit of alternative LNA implementations.

A multiband receiver can be implemented by using a single multiband or wideband LNA, as shown in Fig. 1. Cascode LNAs based on inductive source degeneration are not suitable for this implementation since it is extremely difficult to switch the three on-chip inductors to make the same cascode LNA work across all the required frequency bands without compromising performance. Multiband receivers can also be implemented by using multiple narrowband LNAs, each designed for a different frequency band, as shown in Fig. 2. If cascode LNAs with inductive degeneration are used for this implementation, the die area and cost will both be prohibitively high.

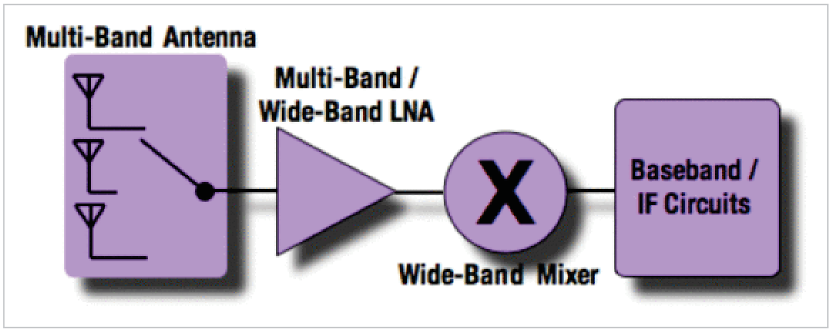


Fig. 1.
Multiband receiver implementation using a multiband/wideband LNA.

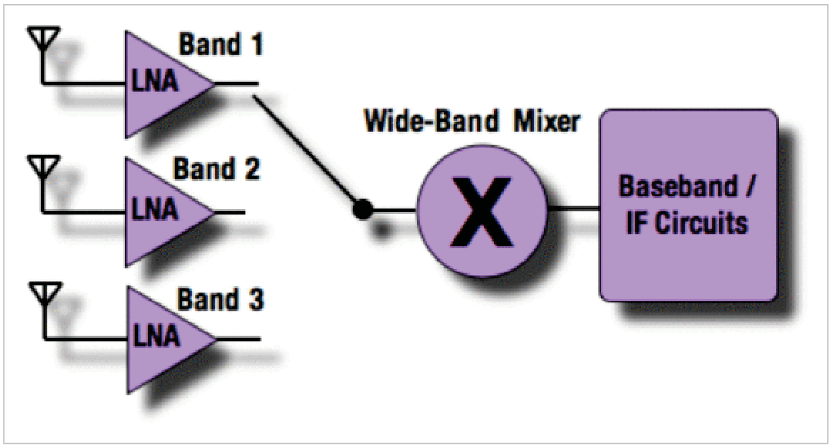
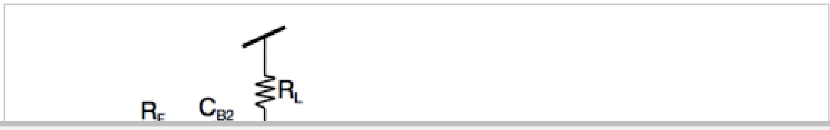


Fig. 2.
Multiband receiver implementation using multiple narrowband LNAs.

Inductorless resistive-feedback CMOS LNAs [2]–[3][4] have been shown to be a viable option for implementing multiband receivers, as shown in Fig. 1. These circuits require very small die area and can be implemented in a digital CMOS process without any additional RF enhancements. Hence, this approach can potentially significantly reduce the cost of the wireless front-end implementation. Resistive-feedback LNAs achieve high gain and reasonably low NF [4]. However, novel circuit techniques are required to reduce power consumption and improve linearity.



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